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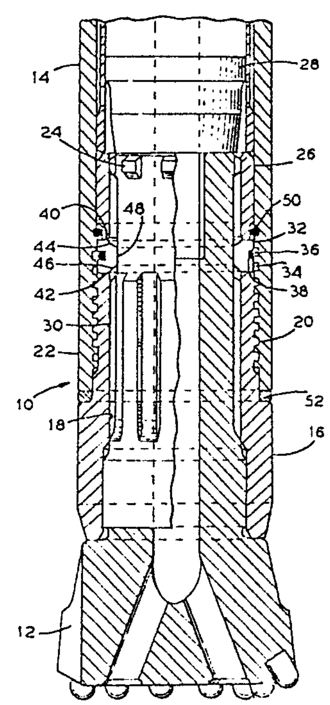
(54) **Bit retaining ring for recovering drill string components.**

(57) A drill bit retaining ring (32) for securing a drill bit (12) to a percussion hammer (14) having a percussion piston (28). The bit (12) has a shank (18) that extends into a chuck sleeve (16, 22) which forms part of the hammer (14). The bit has a set of upper splines (24) and a set of lower splines (30) that allow the bit to move vertically within the chuck sleeve but such movement is limited when the splines abut against the retaining ring (32) which is secured within the chuck sleeve. If the drill bit (12) becomes stuck in the hole, at least the hammer and the associated drill bit can be recovered thanks to the ring according to the present invention which is designed to fracture when a sufficient outward force (i.e. a force in a direction to move the drill string out of the hole) is applied to the drill string thereby releasing the hammer from the bit. However, the ring (32) must be sufficiently strong to withstand the impact forces from the splines (24, 30) under normal operation.

FIG.1

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# BIT RETAINING RING FOR RECOVERING DRILL STRING COMPONENTS

## TECHNICAL FIELD

The instant invention relates to drilling in general and more particularly to an apparatus or a system for recovering drill string components within a hole.

## BACKGROUND ART

It is quite common when drilling holes into various media (hard rock, earth, concrete, oil deposits, shale strata, etc.) for the drill bit to become stuck. Generally the reasons for stuck bits can be traced to a worn drill bit, obstructions in the hole, collapse of the drilled formation about the bit and drill string, metal fatigue, etc. This becomes an expensive problem since oftentimes the bit, the hammer, the stabilizer and a substantial portion of the drill string must be abandoned within the hole because they cannot be removed without great expense due to lost manpower, equipment costs and downtime. In many instances the cost of recovery does not justify the expense of removal.

Naturally this state-of-affairs leads to increased costs due to lost equipment. Hammers, stabilizers and otherwise good drill pipe are relatively expensive commodities and to leave them in the ground is simply a waste of resources. For example, a hammer costs about 7000 (Canadian) and a five foot (1.5m) drill rod costs about 440 (Canadian).

For reasons of safety, drilling equipment components are often equipped with shear pins that are designed to break when predetermined maximum stresses are experienced by the equipment (usually rotational forces). The pins are designed to shear thus freeing the component in question and preventing injury to personnel and damage to related components.

A problem with shear pins is that they require a drilled hole to pass through and means for maintaining their position during normal (i.e., nonstressful) working situations. It is difficult to form a hole through a number of hardened drill components and maintain the alignment of the hole so as to allow the pin to bridge the various components. In addition, shear pins usually are not contemplated for equipment recovery purposes although that may be an unintended result.

Representative safety designs may be found in U.S. Patents 4,064,953, 2,094,682, 3,187,825, 1,414,207 and 881,075.

More particularly, drill bits are usually attached to a percussion hammer. Usually a steel bit retaining ring is disposed around the drill bit shank to maintain the drill bit within the hammer. Under normal operating conditions, the ends of the splines on the drill bit act as stops against the ring as the bit is driven by the piston in the hammer to cause reciprocating percussive movement.

When the bit becomes stuck, the entire assembly (bit, hammer, rod, etc.) will be left in the hole when there are no economical means to retrieve them.

## SUMMARY OF THE INVENTION

Accordingly, there is provided a bit retaining ring having a predetermined shear strength registered with a drill bit. The bit retaining ring is constructed to break upon a predetermined loading so as to allow for the recovery of selected components.

## BRIEF DESCRIPTION OF THE DRAWING

Figure 1 is an elevation in partial cross section of the invention in combination with drilling components.

Figure 2 is a plan view of an embodiment of the invention.

## PREFERRED MODE FOR CARRYING OUT THE INVENTION

Figure 1 depicts the distal end 10 of a drill string. A drill bit 12 is affixed to a percussion hammer 14 via threaded chuck 16.

The chuck 16 is threaded 20 to mate with lower extension 22 of the hammer 14 and maintain the position of the bit 12 within the hammer 14.

The shank 18 of the bit 12 includes a plurality of upper splines 24 that slide against support guide 26. The support guide 26 is secured by ring 50. Blow energy is imparted against the bit 12 by hammer piston 28. Vertical reciprocating travel of the bit 12 is limited by the upper splines 24 and a plurality of lower splines 30 meeting breakaway bit retaining ring 32.

The ring 32 is disposed within the void 34 formed between the bottom of the support guide 26 and top of the chuck 16.

Turning to Figure 2 the bit retaining ring 32 is comprised of two half circles 32A and 32B of a preferably elastic material (such as nylon) having a predetermined maximum shear strength. An O-ring

36 girdles the bit retaining ring 32 in groove 38 to assist in keeping the half circles 32A and 32B of the bit retaining ring 32 in place about the shank 18.

The ring 32 has flat upper and lower surfaces 40 and 42, canted upper and lower intermediate surfaces 44 and 46 and a shank registering surface 48 essentially perpendicular to the parallel upper and lower surfaces 40 and 42. During operation of the hammer 14, the shank 18 will slide in a constrained reciprocating fashion over the surface 48. The canted upper intermediate surface 44 acts as a lower limit stop for the upper splines 24 and conversely the canted lower intermediate surface 46 acts as an upper limit stop for the lower splines 30.

To assemble the distal end 10, the drill bit 12 is inserted into the chuck 16. The two halves of the retaining ring 32 are placed about the shank 18 between the upper splines 24 and the lower splines 30 and held together and in place by the O-ring 36. The bit-shank-ring assembly is then screwed into the extension 22 of the hammer 14. Gasket 52 prevents dirt from entering the threads 20. The hammer 14 is then affixed to a drill rod and ultimately to the drilling rig in the usual manner.

Simply for the purposes of establishing a non-limiting convention, the expression "negatively applied load" means any affirmative load that ultimately tends to pull and separate the hammer away from the bit and away from the end of the hole. Using this convention, drilling an object into a medium requires a positive load; withdrawing the object requires a negative load. Accordingly, after a down hole has been drilled, a negatively applied load would pull the components upwardly. Similarly to retrieve components in an up hole, a negatively applied load would be in the down position. The embodiment in Figure 1 is pictured in a downward direction.

In the event the drill string becomes stuck in the hole and it has been determined that the bit 12 cannot be removed from the hole but that the remaining components are still salvageable, a known negatively applied load may be applied to the entire drill string. The negatively applied load will cause the hammer 14 to rise so that the upper splines 24 are brought into contact with the upper intermediate surface 44 of the bit retaining ring 32. As the load is increased, the bit retaining ring 32 will ultimately shear, thereby freeing the hammer 14 from the bit 12. The hammer 14 will slide free of the bit 12. The rod and hammer 14 circumscribing the chuck 16 can then be removed upwardly through the hole leaving only the bit 12 entombed in the hole.

The physical dimensions and the materials of the bit will, of necessity, be a function of the dimensions of the bit, hammer and contemplated drilling conditions. By way of a non-limiting example a nylon bit retaining ring of about 4.5 inches (11.4 cm) outside diameter was about 0.63 inches (1.6 cm) thick and about 0.5 inches (1.3 cm) high was designed to shear when subjected to a pull of about 12 tons (107 kN) vertical pull.

In a series of experimental tests, six nylon bit rings 32 were tested to determine a useful shearing force.

| Test No. | Force (tons) |
|---|---|
| 1 | 12.0 (107 kN) |
| 2 | 13.0 (116 kN) |
| 3 | 12.5 (111 kN) |
| 4 | 11.0 ( 98 kN) |
| 5 | 12.5 (111 kN) |
| 6 | 13.0 (116 kN) |
| AVERAGE | 12.33 (110 kN) |

A set of the rings 32 were installed on a high pressure hammer at the end of an in-the-hole drill. After having drilled 946 ough hard rock, the bit retaining ring 32 failed after drilling a breakthrough hole. As a consequence, it was determined that the bit retaining ring 32 may be designed to be somewhat thicker and stronger.

A negatively applied pull on the drill string may be engendered by any jacking device. For example, a twenty-four inch (61 cm) square base plate having a thickness of one inch (2.5 cm) and a central aperture was placed over a down hole with the rod extending through the aperture. The plate was carefully placed over the hole so as to be perpendicular to the drill string. A hollow hydraulic jack with a clamp for securing the rod to the jack was energized to pull up on the rod. A set of prototype nylon bit rings 32 successfully sheared at 20 tons (178 kN) of pull freeing the hammer 14 and associated rod.

It is conventional practice to utilize a strong metallic retaining ring. After a hole is completed the worn bit is removed to be remachined or disposed of and replaced with a new bit. In each instance, the same metallic (usually steel) ring is used again. The metallic ring usually doesn't fail because it has always been selected under the assumption that it must be strong enough to withstand the repeated rigors of drilling. (The hammer generally delivers about 800 blows a minute.) It, along with the remaining drill components were considered to be expendable when stuck in a hole.

However, as discussed earlier, when the drill bit becomes stuck in the hole and cannot be removed, there is no low cost method of removing the remaining drill string components. Upon introduction of the instant invention in assignee's mines, it is expected that about 200,000 (Canadian) will be saved a year in the retrieval of previously lost equipment.

Even though the breakaway bit retaining ring 32 is designed and sized with the expectation that ultimately it may have to be affirmatively sheared, the ring 32 still must be strong enough to resist premature failure resulting from the typical stresses experienced during normal drilling operations. The drill bit 12 and the hammer 14 are subjected to tremendous physical forces, heat, dirt, corrosive material, etc. Therefore, although the shear resistance of the breakaway bit retaining ring 32 is less than a conventional metallic ring, it still must exhibit sufficient physical resistance so that it will shear only when such a state-of-affairs is desired by the operator. A weak ring 32 is worthless and an extremely strong one will only duplicate the properties of the prior art rings. Rather the shear strength of the ring should be selected to be: (1) greater than the typical shear experienced by the bit ring; (2) within the shear causing capabilities of the jack; and (3) less than the shear characteristics exhibited by prior art rings.

It should be apparent that the instant invention lends itself to all types of drilling where there is a problem of irretrievable drill string components.

## Claims

1. A system for freeing a percussion hammer and related components from a drill bit stuck in a hole, the system comprising the percussion hammer, a drill bit having a shank extending into the percussion hammer, means for coupling the shank to the hammer, a breakaway drill bit retaining ring securing the drill bit within the hammer, the breakaway drill bit retaining ring having a predetermined maximum shear strength and adapted to fail upon the application of an affirmatively applied negative load at or above the predetermined maximum shear strength.

2. The system according to claim 1 including means for applying the affirmative negative load to the hammer and bit.

3. The system according to claim 2 including a jack.

4. The system according to claim 1 wherein the breakaway retaining ring is comprised of two semicircles.

5. The system according to claim 1 wherein the bit retaining ring is made from an elastic material having a predetermined shear strength.

6. An improved drill bit/percussion hammer combination including the drill bit having a shank extending into the percussion hammer, the improvement comprising a breakaway bit retaining ring disposed between the bit and the hammer, the breakaway bit retaining ring having a predetermined maximum shear strength and adapted to fail upon the application of an affirmatively applied negative load at or above the predetermined maximum shear strength.

7. A breakaway bit retaining ring adapted to secure a drill bit to a percussion hammer, the ring including a predetermined maximum shear strength and adapted to fail upon the application of an affirmatively applied negative load at or above the predetermined maximum shear strength and preferably wherein the ring comprises two semicircles.

8. The ring according to claim 7 wherein the ring is constructed from an elastic material.

9. The ring according to claim 7 including a pair of upper and lower surfaces, a pair of canted surfaces communicating with the upper and lower surfaces and a surface substantially perpendicular to the upper and lower surfaces and communicating with the canted surfaces.

10. The ring according to claim 7 included within a drill string.

FIG.1

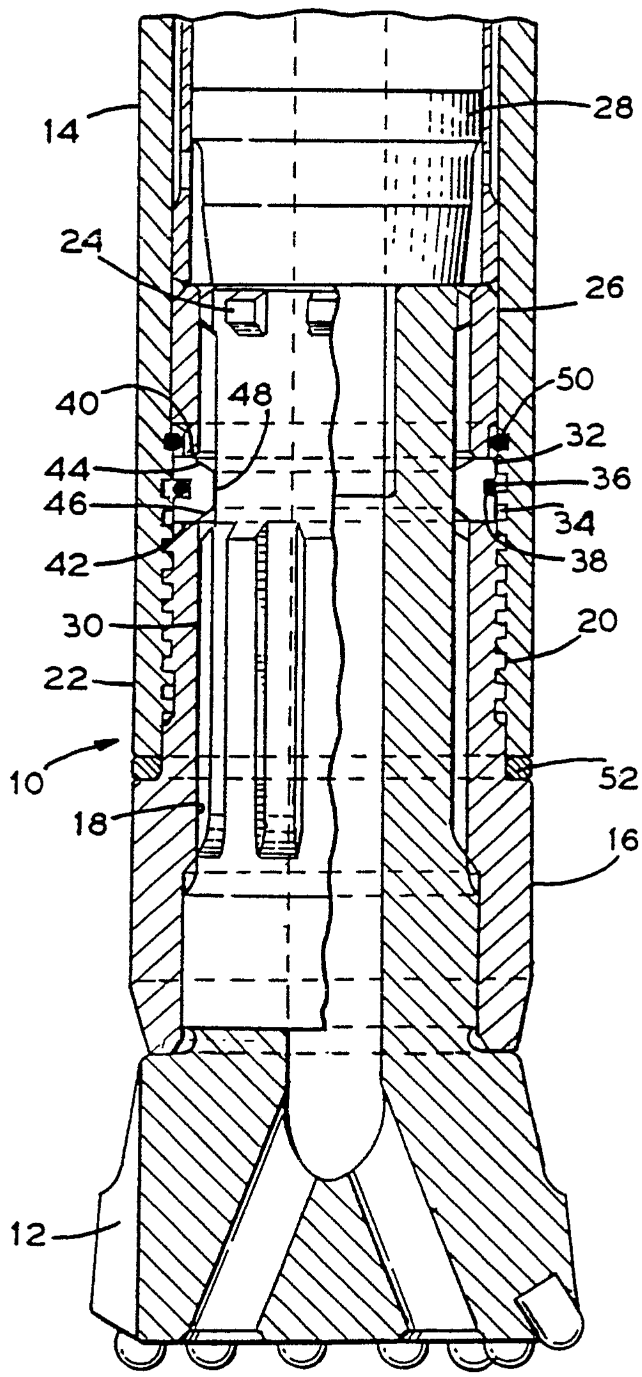
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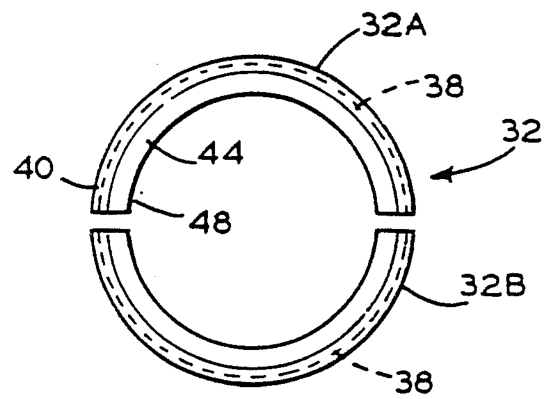
FIG. 2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32B
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