

NOZZLE RETENTION SHROUD FOR ROCK BITSBACKGROUND OF THE INVENTION1. Field of the Invention

5 This invention relates to replaceable nozzles for rock bits utilizing drilling mud to remove detritus from an earthen formation borehole.

More particularly, this invention relates to a nozzle retention shroud designed to retain an extended nozzle that is fabricated from a composite of materials to both resist  
10 erosion of the nozzle from the drilling mud and to prevent nozzle breakage caused by contact of the nozzle tip with obstructions in the formation borehole during a drilling operation.

2. Background

15 Extended nozzles of varying length have been used in petroleum bits for several years. Obviously, the longer the nozzle is the more vulnerable it is to breakage since the extended end is normally unsupported.

Moreover, composite hydraulic nozzles have been  
20 developed and patented by others in the rock bit industry.

U. S. Patent number 3,111,179 teaches the fabrication of a jet nozzle of composite material. The nozzle consists of a thin walled inner shell of tungsten carbide material that is bonded to a plastic body. The body serves to back  
25 up and support the erosion resistant but brittle tungsten carbide inner shell. The patent further teaches that, should the nozzle be ejected from the rock bit, it would easily be ground up by the cutter cones and removed from the borehole along with the formation cuttings since the  
30 hard shell is brittle and the back up material is relatively soft.

This nozzle could not be readily extended since the back up material taught would not be strong enough to support the thin inner shell.

35 U. S. Patent Number 4,392,534 discloses a composite

nozzle for earth boring bits. The nozzle consists of a ceramic body encased within a thin metal cylindrical shell and a metal reinforcing end plate at the nozzle exit plane. This nozzle also is disadvantaged in that it lacks  
5 sufficient support to withstand an exposure to the rock formation should the nozzle be extended beyond the bit body.

U. S. Patent Numbers 4,665,999; 687,067; and 4,711,311 assigned to the same assignee as the present invention all  
10 reflect rock bit nozzle designs and are incorporated herein by reference.

The '999 reference teaches the use of standard nozzles mounted within extended portions of the bit body. The '067 patent is an extended nozzle fabricated entirely of  
15 tungsten carbide and the '311 reference is a means to retain a nozzle body within a nozzle receptacle formed in the bit body.

The extended nozzle taught by the '067 reference, while its performance is outstanding, is vulnerable to  
20 breakage should the extended end of the nozzle encounter an obstruction downhole. Should the nozzle break, nozzle washout is a possible consequence.

It is an object of this invention to provide a shroud to protect the nozzle portion that extends beyond the body  
25 of the bit.

#### SUMMARY OF THE INVENTION

According to this invention there is provided a nozzle retention shroud designed to retain an extended nozzle mounted within a rock bit and to protect an extended  
30 portion of said nozzle that protrudes beyond a body of the rock bit from breakage during operation of said rock bit within a borehole, said shroud comprising;

a cylindrical body forming a first upstream open end and a second open exit end, an outer wall formed by  
35 said body forming means to secure said shroud within the

rock bit, an interior wall formed by said body forming a means to secure said extended nozzle between said shroud and said rock bit, said second open exit end concentrically surrounding and extending over an extended portion of said nozzle protruding beyond the bit body a sufficient distance to protect said extended portion of the nozzle from contact with an obstruction exterior to said rock bit.

Preferably said shroud extends over said extended portion of said extended nozzle from about 50 percent to 100 percent.

Advantageously an annular space is formed between said interior wall formed by said shroud and said exterior wall formed by said extended portion of said extended nozzle, said annular space allowing for some lateral movement of said shroud surrounding said extended portion of said nozzle.

Preferably there is provided a shroud retaining sleeve that is secured within said nozzle retention aperture formed by said rock bit, said sleeve forming a first upstream opening that communicates with a fluid chamber formed by said rock bit and a second downstream opening that extends a distance beyond an exit opening of said nozzle retention aperture, said shroud retaining sleeve enabling said shroud to further protect said extended portion of said extended nozzle by extending the shroud over the nozzle an added distance equal to the distance said sleeve extends past said exit opening of said nozzle retention aperture.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a perspective view of a typical three cone rock bit with extended nozzles protruding from the bit body;

Figure 2 is a cutaway segment of one leg of the roller

cone rock bit illustrating the inner plenum chamber that directs drilling fluid through the nozzle;

Figure 3 is a cross-section of a composite extended nozzle illustrating a tungsten carbide nozzle throat portion, a ceramic matrix material downstream of the throat and a steel jacket enclosing the composite material;

Figure 4 is a cross-section of an alternative extended nozzle having a steel jacket with a tungsten carbide matrix interior;

Figure 5 is a cross-section of yet another alternative extended nozzle disclosing an extended nozzle having a ceramic liner with a ceramic cap adjacent the exit plane of the nozzle, the ceramic end of the nozzle serving to minimize erosion;

Figure 6 is a cross-section of a nozzle retainer shroud designed to protect the extended end of the nozzle;

Figure 7 is a cross-section of a nozzle with a protective sleeve shroud and a retainer shroud secured within the sleeve, the retainer shroud extending close to the exit plane of the nozzle, and

Figure 8 is a cross-section of yet another variation of the extended nozzle illustrating an extended portion of the nozzle retention body that is metalurgically bonded to the dome of the bit body to enable a wide variation of nozzle extension relative to a borehole bottom while utilizing the basic composite extended nozzle.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

#### AND BEST MODE FOR CARRYING OUT THE INVENTION

With reference to Figure 1, the rotary cone rock bit generally designated as 10 consists of rock bit body 12, pin end 14 and a cutting end, generally designated as 16. A fluid chamber 13 is formed within bit body 12. The fluid chamber 13 communicates with the open pin end 14 so that hydraulic fluid may enter the rock bit body through an attached drillstring [not shown]. A dome portion 17

defines a portion of the fluid chamber 13 within body 12. Rock bit legs 20 extend from bit body 12 toward the cutting end of the bit. A cutter cone 18 is rotatably fixed to leg 20 through a journal bearing extending into the cone from shirttail 22 of the leg [not shown].

Each cone 18, for example, has a multiplicity of cutter inserts 19 equidistantly spaced around each of the cones 18.

A lube reservoir system 24 supplies a lubricant to bearing surfaces defined between the interior of the cones 18 and the journal.

An extended nozzle, generally designated as 30, is shown protruding from a nozzle retention portion formed in a dome 17 of bit body 12.

As few as one and as many as four extended nozzles 30 may be supported by a nozzle retention body 15 adjacent to the bit dome 17. Typically, three nozzles 30 are positioned about 120 degrees apart around the outer periphery of the dome 17 and one center jet nozzle is positioned in the dome to prevent or minimize "balling" of the bit [not shown].

With reference now to Figure 2, the sectioned leg 12 of bit 10 forms a plenum chamber 13 that directs drilling fluid into the pin end 14 toward the inlet 57 of nozzle retainer sleeve 56. The sleeve 56 is designed to provide a receptacle for the extended nozzles 30 and its threaded nozzle retention shroud generally designated as 40. The sleeve, for example, is welded into the nozzle retention body. Weld 61 secures the sleeve 56 within the opening 23 of body 15. The sleeve further forms a support shoulder 55 that seats the upstream or entrance end 35 of the nozzle 30. In addition, an annular seal gland or groove 58 is formed adjacent to the end 35 of the nozzle 30. An O-ring 59 retained within the seal gland 58 prevents fluid from washing out the nozzle from the inside.

The threaded retainer shroud 40 is designed to extend a distance from a planar surface 21 formed by nozzle port 15 of bit body 12. Distance "A" represents a section of the slim portion 37 of the nozzle that coincides with shoulder 38 of the nozzle 30 to the end 43 of the shroud 40. Distance "L" represents the total distance of the extended portion 37 of the extended nozzle 30 to the exit end 34 of the nozzle.

An annular space 48 separates the exterior wall 39 of the nozzle from the interior wall 41 of the shroud to allow the shroud to absorb the shock of contact with an object downhole without damage to the nozzle. The extended, slimmed down or reduced-in-diameter portion of the nozzle 37 begins at shoulder 38 of the nozzle 30 to the exit 34 formed by the nozzle hence, the nozzle shroud 40 protects about 50 percent of the extended portion 37 of the nozzle.

It would be obvious to eliminate the annular space between the shroud and the extended portion of the nozzle without departing from the scope of this invention.

The shroud forms an internal shoulder 44 that seats against an annular complimentary shoulder 38 formed by nozzle 30. The cylindrical upstream end 45 formed by the shroud serves to close out gland 58 of sleeve 56 and the opposite end 43 forms, for example, a hex head for ease of mechanically securing the shroud into the sleeve 56.

The nozzle 30 is, for example, formed of a steel body 31 with a hard, erosion resistant matrix interior 36. The material 36 could, for example, be tungsten carbide or any combination of tungsten carbide and ceramic thereof. Alternative nozzle material combinations will be taught with reference to Figs. 3 to 5.

The upstream entrance plane 35 of the extended nozzle 30 is designed to provide an uninterrupted flow of fluid from the plenum chamber 13 into the interior of the nozzle past restricted throat 33 and out through exit 34 of the

nozzle.

Turning now to Figures 3, 4, and 5 the alternative extended nozzles illustrated are examples of various material combinations that may be utilized to fabricate the nozzles.

Figure 3 depicts a nozzle generally designated as 130 having a steel body jacket 131. An upstream portion forming entrance 132 is formed from erosion resistant tungsten carbide that extends past and forms the throat 133 of the nozzle 130. The interior portion downstream of the throat 133 is fabricated from a matrix material 136 that may include a ceramic composite mix.

A shoulder 138 is formed in the steel jacket. The plane of the shoulder 138 is substantially aligned with a plane 139 that intersects the downstream end 140 of the tungsten carbide portion 137 and the upstream end 141 of the ceramic portion 136. In the unlikely event that the end 134 of the extended nozzle 130 encounters an obstacle downhole large enough to fracture the nozzle, it will break along the break line 139 coincident with the plane formed along shoulder 138. Hence, the integrity of the major portion of the nozzle will remain intact and the nozzle will not wash out causing the bit to be tripped from the hole for repair or replacement.

Figure 4 illustrates an alternative nozzle 230 having a steel body 231. An inner liner formed from a matrix material 236 extends from upstream portion 232, past throat 233 to exit 234. The liner 236 is an erosion resistant matrix material such as a matrix of tungsten carbide. An annular shoulder 238 formed in steel body 231 provides a seat for the nozzle retainer shroud 40.

The matrix material is, for example, a mixture of tungsten carbide materials (WC and/or cast carbide  $W_2C$ ) in an infiltrating binder. A typical binder material is a copper based material alloyed with Ni, Mn, Zn and sometimes

used in addition with or substituted with Sn or Fe. Alternatively, the above carbide could be replaced with sintered crushed carbide (WC + Co) and/or conventionally carburized carbide (WC) or macrocrystalline carbide (WC) with equivalent results without departing from the scope of this invention.

Figure 5 depicts yet another alternative nozzle 330 with a steel body 331 outwardly forming an annular shoulder 338. This nozzle is lined internally with , for example, a layer of ceramic material 336 that extends from entrance 332 to the exit 334. An annular ceramic ring 337 caps the exit nozzle 334 for added erosion protection.

With reference now to Figure 6, the partially broken away nozzle retention shroud 40 is threaded into sleeve 56; shoulder 44 seating against annular shoulder 38 formed on the nozzle body 31. The cylindrical upstream end 45 formed by the body 42 ends substantially at the seal gland 58. The hexagonal opposite end 46 forms a cylindrical passage through surface 43 that is annularly spaced from the exterior wall of the nozzle [48]. As heretofore stated, the annular space 48 allows for slight lateral movement of the shroud without contacting the nozzle for added nozzle protection.

The shroud 40 is designed to protect the nozzle from breakage by surrounding the slim section of the nozzle 30. The shroud can be made from any machinable steel, or like material, that provides the desired properties of strength to protect the nozzle from breakage. Since the shroud is located around the outside of the nozzle, it has better mechanical properties [larger moment of inertia] to protect the nozzle. The properties of the nozzles are constrained to be very wear resistance due to the abrasiveness of the fluid or drilling mud that flow at high velocity through it. The shroud 40 is not constrained to be highly wear resistant which allows a better selection of materials to

protect the mini-extended nozzle from impact breakage.

The percent coverage of the shroud 40 over the extended portion 37 of the nozzle is defined by  $A/L * 100$  and should be within the range of 10 percent to 100 percent. Fig. 6, for example, illustrates a shroud that protects 50 percent ["A"] of the extended slim section of the nozzle 30 ["B"].

Figure 7 teaches an alternative nozzle retention means that provides for even more nozzle protection. A sleeve shroud generally designated as 150 comprises a sleeve body 147 that forms an extended flange portion 151 that protrudes a distance "B" from surface 21 of bit body 12. Otherwise the sleeve is identical to sleeve 56 described with respect to Figures 2 and 6.

The nozzle 30 and shroud 40 mount within the extended sleeve 150. This combination results in about an 80 percent coverage of the extended portion of the nozzle thus substantially protecting the entire nozzle.

Sleeve 150 is, for example, welded through surface 21 at juncture 149 thus securing the sleeve within the nozzle port 15 formed in body 12 of the rock bit 10.

Figure 8 is an alternative means to project a mini-extended nozzle closer to a borehole bottom utilizing the basic nozzle retention and protection means described heretofore.

A separate nozzle retention segment generally designated as 100 consists of, for example, an "elbow" shaped steel body 101. Body 101 forms upstream end 102 that directs fluid into passage 103. The opposite end 105 of body 101 may be extended any desired length from dome 117 of the bit 110 depending upon the limitations set by the mini-extended nozzle mounted therein. Body 101 forms a shoulder 104 that is seated to planar surface 116 formed at the base of nozzle retention portion 115 of bit body 112. Weld 106 secures the extended segment 100 to the bit

adjacent dome 117.

It will of course be realized that various modifications can be made in the design and operation of the present invention without departing from the scope thereof. Thus while the principal preferred construction and mode of operation of the invention have been explained in what is now considered to represent its best embodiments which have been illustrated and described, it should be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically illustrated and described.

**CLAIMS:**

1. A nozzle retention shroud designed to retain an extended nozzle mounted within a rock bit and to protect an extended portion of said nozzle that protrudes beyond a body of the rock bit from breakage during operation of said rock bit within a borehole, said shroud comprising;  
a cylindrical body forming a first upstream open end and a second open exit end, an outer wall formed by said body forming means to secure said shroud within the rock bit, an interior wall formed by said body forming a means to secure said extended nozzle between said shroud and said rock bit, said second open exit end concentrically surrounding and extending over an extended portion of said nozzle protruding beyond the bit body a sufficient distance to protect said extended portion of the nozzle from contact with an obstruction exterior to said rock bit.
2. A shroud as claimed in claim 1 wherein said shroud extends over said extended portion of said extended nozzle from about 50 percent to 100 percent.
3. A shroud as claimed in claim 1 or 2 wherein an annular space is formed between said interior wall formed by said shroud and said exterior wall formed by said extended portion of said extended nozzle, said annular space allowing for some lateral movement of said shroud surrounding said extended portion of said nozzle.
4. A shroud as claimed in claim 1 or 2 further comprising a shroud retaining sleeve that is secured within said nozzle retention aperture formed by said rock bit, said sleeve forming a first upstream opening that communicates with a fluid chamber formed by said rock bit and a second downstream opening that extends a distance beyond an exit opening of said nozzle retention aperture,



said shroud retaining sleeve enabling said shroud to further protect said extended portion of said extended nozzle by extending the shroud over the nozzle an added distance equal to the distance said sleeve extends past  
5 said exit opening of said nozzle retention aperture.

5. A nozzle retention shroud substantially as herein described with reference to and as shown in each of the embodiments of the accompanying drawings.