United States Patent [19]

Dysart

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[54] **ROTARY ROCK BIT WITH CONE MOUTH AIR SCREEN**

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[52] **U.S. Cl.** **175/337;** 175/339; 175/372; 308/8.2

[51] **Int. Cl.²** .. **E21B 9/10;** E21C 13/00; E21B 9/35; F16C 33/78

[58] **Field of Search** 175/337, 339, 340, 371, 175/372, 227, 228, 229; 308/8.2

[56] **References Cited**

UNITED STATES PATENTS

3,193,028	7/1965	Radzimovsky	175/372
3,534,823	10/1970	Frederick	175/337
3,680,873	8/1972	Garner	308/8.2 UX
3,713,707	1/1973	Bennett	308/8.2
3,719,241	3/1973	Bell	175/228
3,866,695	2/1975	Jackson	175/228

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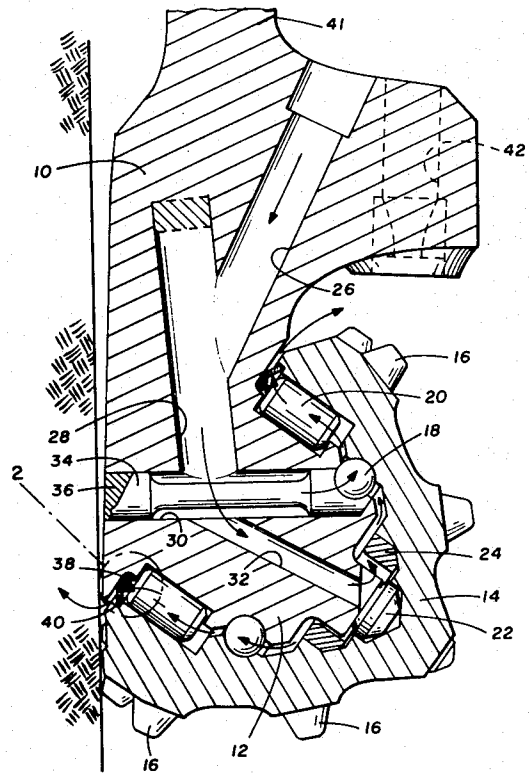
[57] **ABSTRACT**

Drill cuttings in the borehole are prevented from entering the area between the bearing pin and the cone cutter of a rotary rock bit by a cone mouth air screen. The cone cutter includes an internal cavity and a cone mouth positioned over the bearing pin. Bearings are located within the internal cavity between the bearing pin and the cone cutter. A passage extends through the bit body and the bearing pin for conducting a gaseous drilling fluid to the internal cavity for cooling the bearings. A screen means is positioned in the cone mouth between the cone cutter and the bearing pin for preventing solids in the borehole from entering the internal cavity and for allowing the circulating gaseous drilling fluid to pass from the internal cavity into the borehole.

5 Claims, 3 Drawing Figures



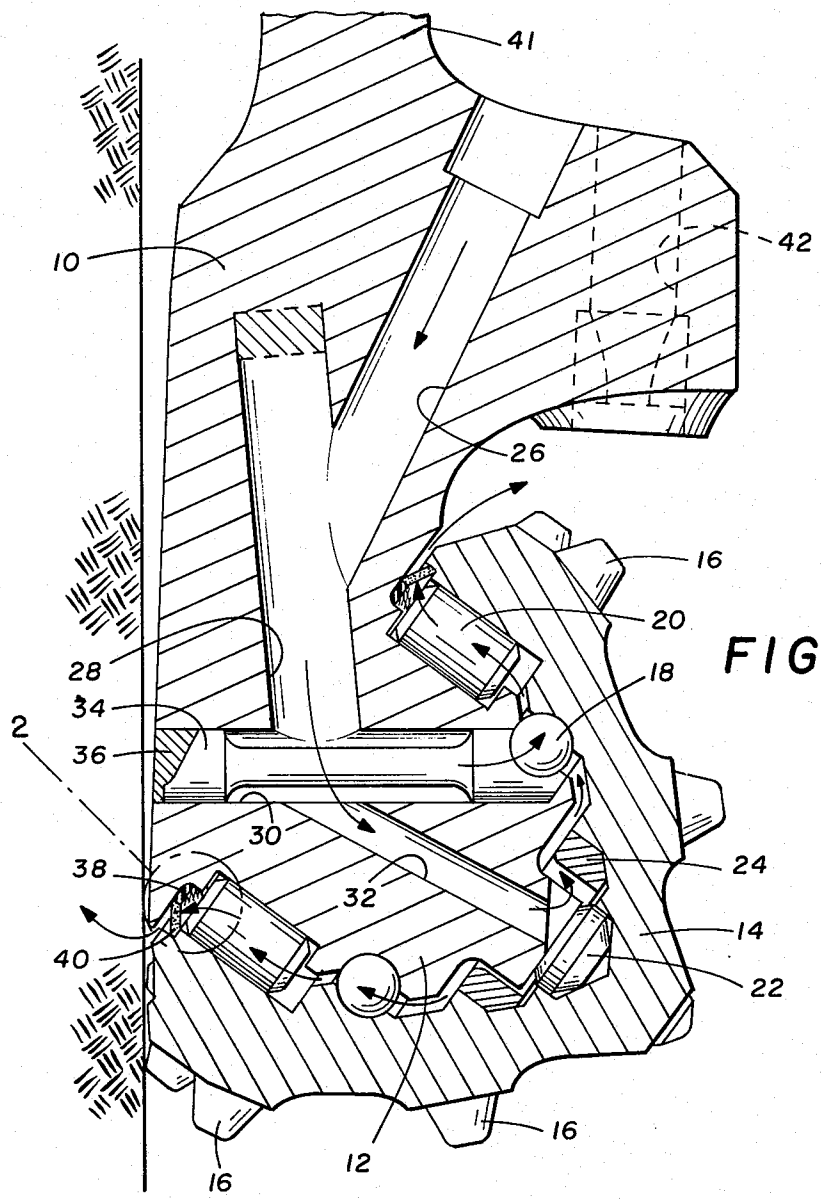


FIG. 1

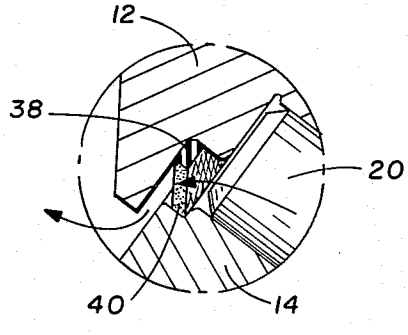


FIG. 2

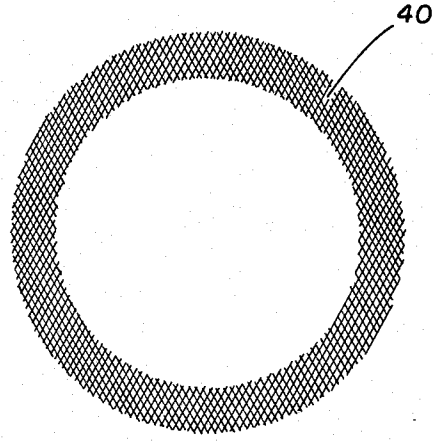


FIG. 3

ROTARY ROCK BIT WITH CONE MOUTH AIR SCREEN

BACKGROUND OF THE INVENTION

The present invention relates to the art of earth boring and more particularly to an improved rotary rock bit for use with a drilling system that utilizes a gaseous drilling fluid.

During certain drilling operations such as the drilling of blast holes, air or other gaseous drilling fluids are circulated through the drill string and the drill bit. The drill bit is attached to a hollow drill string and the gaseous drilling fluid is pumped through the drill string into the bit and thereafter through passages in the bit to the bottom of the borehole, thence upward in the annulus between the drill string and the walls of the borehole to the surface. Some of the passages divert part of gaseous drilling fluid to the bearing spaces between the rolling cutter members and their associated shafts to cool these elements and to keep such spaces cleared from foreign matter and abrasive products.

During drilling operations wherein a gaseous fluid is circulated through the bit with some of the circulating fluid being directed through the bit bearings for cooling and flushing of the bearing components, conditions often exist where the air pressure and volume is inadequate for optimum flushing of the bearings. Under these conditions, the cuttings generated by the bit action on bottom cannot be efficiently lifted off the bottom of the borehole and tend to fall back to the bottom until a time when regrinding by the bit reduces the individual particles to a size small enough to be lifted by the low volume of circulating fluid. It can readily be appreciated that a bit working in a deep bed of cuttings with an insufficiency of fluid flushing through the bearings will be subjected to said cuttings filtering into the bearings. In the bearings, the cuttings will be caught up between the rotating bearing members creating an abrasive grinding-millingwearing action which is extremely detrimental to the entire bearing cluster, and is a major factor in reducing bit bearing life.

The present invention provides a cone mouth air screen which will act as a barrier to the pulverized cuttings, keeping these cuttings from entering the bearing area through the cone mouth opening, thus providing a clean dust-free environment for the metal bearing elements and eliminating the abrasive wearing action mentioned above. The screening out of the dust particles will vastly improve the bearing life by preventing abrasive cuttings from entering the bearings and contributing to wear of the individual bearing components and thereby contributing to the ultimate failure of the full bearing cluster. Abrasive wear is considered a major factor in limiting bearing life in blast hole drilling bit applications and is especially significant in conditions where the air volume is marginal. This latter condition exists when air compressor equipment has been neglected and does not perform up to its rated capacity or as is common with the smaller blast hole drills, the air volume rating of the compressor is marginal to start with.

DESCRIPTION OF PRIOR ART

In U.S. Pat. No. 3,125,175 to J. D. Medlock et al, patented May 17, 1964, and assigned to Hughes Tool Company, a rock bit with a replaceable air course is shown. The rock bit shown in this patent contains

means whereby a portion of the gas stream is diverted into the bearing spaces between the rolling cutters and their shafts thereby flushing and cooling the bearing surfaces. Means are provided within the central body of the bit to prevent the introduction of particular matter into the bearings from the gas being circulated through the drill string.

In U.S. Pat. No. 3,534,823 to Charles R. Frederick, patented Oct. 20, 1970, and assigned to J. W. Murphy Industries, Inc., an improved drill bit is shown. The improved drill bit has a gaseous circulation system for the roller cutters to be used in gas drilling so that a portion of the gas which is circulated through the drill is circulated through the roller cutters to cool the cutter bearings.

SUMMARY OF THE INVENTION

The present invention provides a cone mouth air screen which will act as a barrier to pulverized cuttings in the borehole and prevent the cuttings from entering the bearing area through the cone mouth opening of the cone cutter. The present invention provides a clean dust-free environment for the bearing elements and eliminates abrasive wearing action arising from the entry of solid particles from the borehole into the bearing area. The bit of the present invention includes a bit body having a bearing pin. A cone cutter is mounted on the bearing pin. The cone cutter includes an internal cavity and a cone mouth. Bearing means are located in the bearing area between the cone cutter and the bearing pin for supporting the cone cutter for rotation about the bearing pin. A first passage extends through the bit body to the internal cavity to allow a portion of the circulating fluid to be directed to the bearings. A second passage extends through the bit body to the exterior of the bit to allow a portion of the circulating fluid to be transmitted to the bottom of the bore. Screen means are positioned in the cone mouth between the cone cutter and the bearing pin to prevent the entry of solids into the internal cavity and at the same time allow the circulating fluid passing through the internal cavity to exit into the borehole. The above and other features and advantages of the present invention will become apparent from a consideration of the following detailed description of the invention when taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a sectional view of a portion of a rotary rock bit constructed in accordance with the present invention.

FIG. **2** is an enlarged view of a portion of the bit shown in FIG. **1**.

FIG. **3** shows the cone mouth air screen of the bit shown in FIG. **1**.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings and in particular to FIG. **1**, a rotary rock bit **10** constructed in accordance with the present invention is illustrated. The bit **10** includes a bearing pin **12** depending from the main body of the bit **10**. The body of the bit **10** defines an internal chamber **41** which during drilling is in communication with the interior drilling fluid passage of a rotary drill string (not shown). A gaseous drilling fluid is circulated through the rotary drill string passing into the internal chamber **41** during the drilling operation.

A rotary cone cutter **14** is mounted on the bearing pin **12.** The cone cutter **14** includes an internal cavity for receiving the bearing pin **12.** Bearing means are provided between the cone cutter **14** and bearing pin **12** within the internal cavity. The opening of the internal cavity at the base of the cone cutter **14** constitutes a cone mouth. The bearing means include a system of roller bearings **20,** a system of ball bearings **18,** a friction bearing **24** and a thrust button **22.** A multiplicity of tungsten carbide inserts **16** are embedded in the outer surface of the cone cutter **14** for disintegrating the formations as the bit is rotated and moved downward.

In order to prolong the life of the bit and to cool the bearings a gaseous drilling fluid is circulated through the internal cavity in the cone cutter **14** between the cutter **14** and the bearing pin **12.** Drilling fluid from the rotary drill string (not shown) passes into the internal chamber **41.** A pair of passages **26** and **28** conduct the drilling fluid from the internal chamber **41** to a bore **30** extending through the bearing pin **12.** The drilling fluid passes through the bore **30** and an auxiliary passage **32** into the internal cavity in the cone cutter **14** to cool the bearings. The ball loading bore **30** is filled with a plug **34** to retain the individual ball bearings in the ball bearing system **18.** The plug **34** does not entirely fill the bore **30** and allows free fluid passage. The plug **36** is welded in position in the bore **30** by the weld **36.** The gaseous drilling fluid exits through the cone mouth into the borehole and travels upward in the annulus between the wall of the borehole and the rotary drill string. Drilling fluid is also directed through a passage **42** from the internal chamber **41** directly into the borehole to remove the drill cuttings from the borehole. The passage **42** directs the circulating drilling fluid proximate the cone cutter **14.**

Conditions at times exist where the pressure and volume of the circulating drilling fluid is inadequate for optimum flushing of the bearings. Under these conditions, the cuttings generated by the action of the bit on the bottom of the bore-hole cannot be efficiently lifted off the bottom and they tend to fall back to the bottom until a time when regrinding by the bit reduces the individual particles to a size small enough to be lifted by the low volume of circulating fluid. It can readily be appreciated that a bit working in a deep bed of cuttings with an insufficiency of fluid flushing through the bearings will be subjected to said cuttings filtering into the bearings. In the bearings, the cuttings will be caught up between the rotating bearing members creating an abrasive grinding-milling-wearing action which is extremely detrimental to the entire bearing cluster. Abrasive wear is considered a major factor in limiting bearing life in blast hole drilling bit applications and is especially significant in conditions where the fluid volume is marginal. This latter condition exists when air compressor equipment has been neglected and does not perform up to its rated capacity or as is common with the smaller blast hole drills, the fluid volume rating of the compressor is marginal to start with.

A cone mouth air screen **40** is provided in the cone mouth of the cone cutter **14.** This cone mouth air screen is intended to cover the entire cone mouth area and is of a mesh size such that it will screen out even the smallest particle sizes. For this purpose, a metallic fibermetal screening material is used for the cone mouth air screen **40.** This material lends itself well to this application since it has very low density (high porosity) characteristics while retaining good strength properties. The screen material is selected so that its porous area is such that it will allow passage of all the air needed to cool and clean the bearings with a minimum of back pressure, but still fit satisfactorily into the minimal available space at the constricted cone mouth of a typical cone arm sub-assembly for a three cutter blast hole bit.

The cone mouth air screen **40** is fitted on the bearing pin **12** in the area of the cone mouth. This same area is that area which is utilized on prior art sealed bearing bits for the cone mouth seal recess. The cone mouth air screen **40** may be likened to a cone mouth seal except that the screen **40** will allow the clean fluid in the internal cavity of the cone cutter **14** to escape by offering minimal resistance to fluid flow in one direction while preventing the solid materials in the borehole from entering the internal cavity and by offering maximum resistance to solid materials in the borehole.

Referring now to FIG. **2** an enlarged view of a portion of the cone mouth area of the bit **10** is shown. The cone mouth air screen **40** is positioned between the cone cutter **14** and the bearing pin **12.** The cone mouth air screen **40** is held in place by a rubber ring **38** extending from the air screen **40** that fits around the bearing pin **12.** The screen **40** can be locked in place by gluing the rubber portion or simply by sizing the screen such that it has some interference with the journal boss over which it fits. In prior art blast hole bits, the cone mouth clearance has traditionally been left fairly generous, or (if this backface clearance is designed on the tight side) partially open vent slots of varying configurations have been provided in order to insure minimum restrictions to air flow through the bearings. The cone mouth air screen **40** is the first known attempt to screen out the dust particles at the exit end of the fluid flow passage through the bearing area. The air pressure (and flow) is therefore from the inside toward the outside of the screen and dust particles will be prevented from collecting on the screen by the positive air pressure inside the bearing area.

Referring now to FIG. **3** the cone mouth air screen **40** is shown individually. The cone mouth air screen **40** is intended to cover the entire cone mouth area and should be of a mesh such that it will screen out even the smallest particle sizes. For this purpose, metallic fibermetal screening materials lend themselves well since they have very low density (high porosity) characteristics while retaining good strength properties.

The screen material is selected so that its porous area is such that it will allow passage of all the air needed to cool and clean the bearing area with a minimum of back pressure, but still fit satisfactorily into the minimal available space at the constricted cone mouth of a typical cone arm subassembly for a three cutter blast hole bit.

The material of screen **40** in this preferred embodiment of the invention is a fiber metal of low to medium density (less than 40% density by volume) made as a multi-filament of relatively fine (less than 0.001 inch) filament diameter. The preferred filament material is stainless steel. Other materials such as fiberglass, porous plastic foam, brass or bronze micro beads, etc., may also be used for screen **40** and will perform essentially the same task as the fiber metal. Also, material densities above 40% by volume may be used if a large exit area is designed into the bit, but at no time is a density of more than 75% by volume acceptable for this type of screening application. The preferred filament

material is stainless steel, but other steels, copper or other metallics, plastic, etc. may be utilized satisfactorily. While filament diameters of 0.001 inch or less are preferred, it is to be understood that other filament sizes may be used including filaments of up to 0.010 inch diameter.

The structural details of an earth boring bit constructed in accordance with the present invention having been described, the operation of the bit **10** will now be considered with reference to FIGS. **1, 2** and **3.** The present invention provides a cone mouth air screen **40** which will act as a barrier to the pulverized cuttings, keeping these cuttings from entering the bearing area through the cone mouth opening, thus providing a clean dust-free environment for the metal bearing elements and eliminating the abrasive wearing action of cuttings in the bearing area. The screening out of the dust particles will vastly improve the bearing life by preventing abrasive cuttings from entering the bearings and contributing to wear of the individual bearing components and thereby contributing to the ultimate failure of the full bearing cluster.

The bit **10** is connected as the lowest member of the rotary drill string. A gaseous drilling fluid is circulated through the drill string to the internal chamber **41** in the bit **10.** A portion of the gaseous drilling fluid passes from internal chamber **41** through passage **26,** passage **28** and bores **30** and **32.** This portion of the gaseous drilling fluid is directed into the internal cavity in the cone cutter **14** to cool the bearings and flush any foreign materials from the bearing area. The cone mouth air screen **40** allows the gaseous drilling fluid to exit into the borehole and serves to prevent drill cuttings from building up on the outside of the air screen **40.** The rubber ring **38** locks the air screen in place on the bearing pin **12.** The screening out of drill cuttings from the bearing area vastly improves bearing life by preventing abrasive cuttings from entering the bearing area and contributing to wear of the individual bearing components and thereby contributing to the ultimate failure of the full bearing cluster. Abrasive wear is considered a major factor in limiting bearing life in blast hole drilling bit applications and is especially significant in conditions where the gaseous drilling fluid volume is marginal. Such conditions often exist when air compressor equipment has been neglected and is not performing up to its rated capacity or as is common with the smaller blast hole drills, the fluid volume rating of the compressor is marginal to start with.

The embodiments of an invention in which an exclusive property or privilege is claimed are defined as follows:

1. A drill bit for connection with a drill string that includes a drilling fluid passage, comprising:
- a body;
- a bearing shaft supported from said body;
- a roller cutter adapted to be rotatably mounted on said bearing shaft;
- bearing means supporting said cutter on said bearing shaft;
- a passage within said body adapted to be in communication with the drilling fluid passage in said drill string when said drill bit is connected to the drill string;
- a passage in said bearing shaft communicating between said passage within said body and said bearing means; and
- screen means between said bearing shaft and said roller cutter.

2. A drill bit for use with a circulating fluid, comprising:
- a head defining an internal chamber;
- a leg depending from said head;
- said leg terminating in a bearing shaft;
- a roller cutter adapted to be mounted on said bearing shaft;
- bearing means supporting said roller cutter for rotation about said bearing shaft;
- a first passage through said leg and said bearing shaft, communicating from said internal chamber to a position between said shaft and said cutter;
- a second passage extending through said bit communicating from said internal chamber to the exterior of said bit, whereby a first portion of the fluid being circulated through said internal chamber is circulated through said first passage, between said shaft and said cutter to cool said bearing means and a second portion of the fluid being circulated through said internal chamber is circulated through said second passage proximate said roller cutter; and
- screen means positioned between said cutter and said shaft for preventing entry of solids to said bearing means and allowing said first portion of the fluid being circulated through said internal chamber to exit from said bit.

3. A rolling cutter rock bit for use with a drilling system that utilizes a gaseous flushing media for removing materials from the borehole, comprising:
- a body;
- a bearing shaft supported by said body;
- a rolling cutter adapted to be rotatably mounted on said bearing shaft;
- bearing means supporting said cutter on said bearing shaft;
- a chamber within said body and adapted to be in communication with said gaseous flushing media;
- a passage in said bearing shaft communicating between said chamber and said bearing means to divert said gaseous flushing media to said bearing means; and
- screen means between said bearing shaft and said rolling cutter for preventing materials from the borehole from contacting said bearing means and allowing said gaseous flushing media to pass from said bearing means into the borehole.

4. A rotary rock bit suitable for use with a gaseous drilling fluid, comprising:
- a head defining an internal chamber;
- a bearing pin depending from said head;
- a cone cutter adapted to be mounted on said bearing pin, said cone cutter having a concave cavity projecting from a cone mouth, said cavity and cone mouth positioned over said bearing pin;
- bearing means located in said cavity supporting said cone cutter for rotation about said bearing pin;
- a first passage through said head and said bearing pin communicating from said internal chamber to said cavity;
- a second passage extending through said head communicating from said internal chamber to the exterior of said bit, whereby a first portion of the fluid being circulated through said internal chamber is circulated through said first passage to said cavity to cool said bearing means and a second portion of

the fluid being circulated through said internal chamber is circulated through said second passage proximate said cone cutter; and

screen means positioned in said cone mouth between said cone cutter and said bearing pin for preventing entry of solids into said cavity and allowing said first portion of the fluid being circulated through said internal chamber to exit from said cavity.

5. A rolling cutter rock bit for use with a drilling system that utilizes a gaseous flushing media for removing materials from the borehole, comprising:

a body;

a bearing shaft supported by said body;

a rolling cutter adapted to be rotatably mounted on said bearing shaft;

bearing means supporting said cutter on said bearing shaft;

a chamber within said body and adapted to be in communication with said gaseous flushing media;

a passage in said bearing shaft communicating between said chamber and said bearing means to divert said gaseous flushing media to said bearing means;

screen means between said bearing shaft and said rolling cutter for preventing materials from the borehole from contacting said bearing means and allowing said gaseous flushing media to pass from said bearing means into said borehole; and

an elastic means for positioning said screen means between said bearing shaft and said rolling cutter.

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