

Aug. 25, 1964

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3,145,784

UNDERGAGE HOLE INDICATOR

Filed Dec. 22, 1961

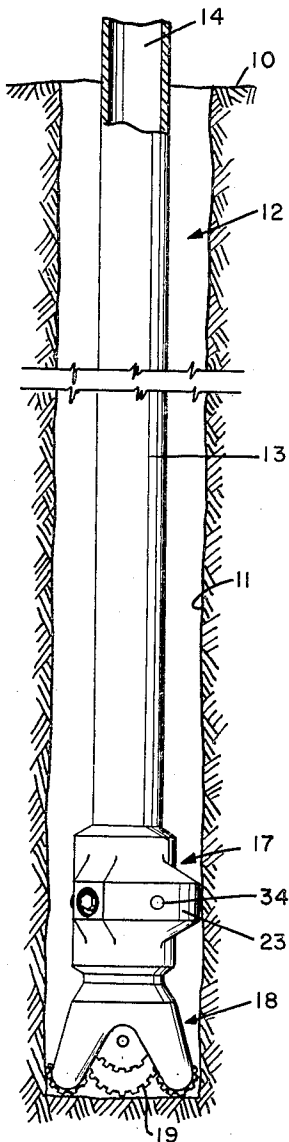


FIG. I

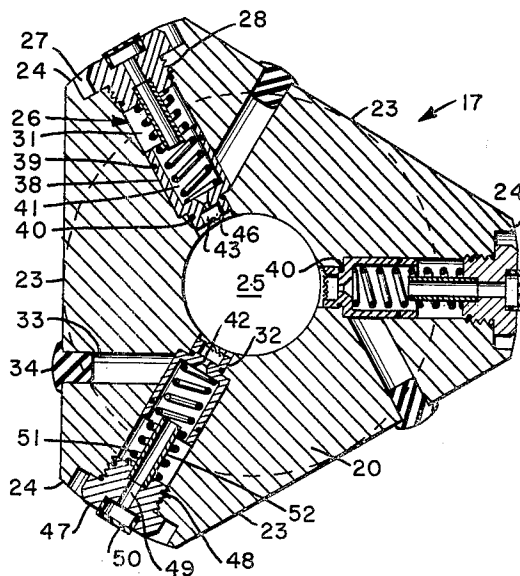


FIG. III

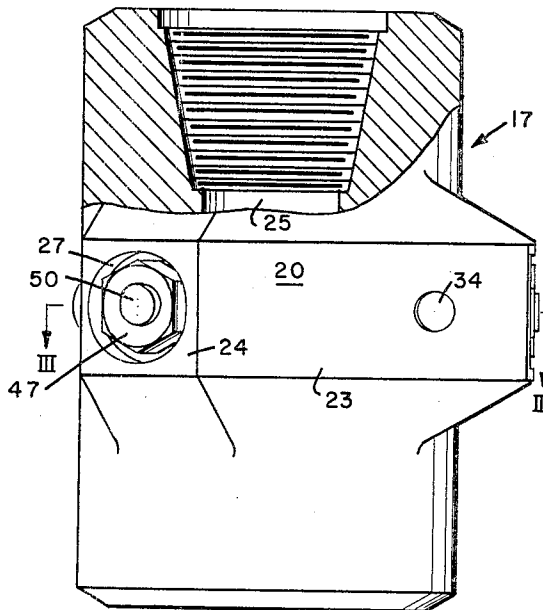


FIG. II

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3,145,784

UNDERGAGE HOLE INDICATOR

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Filed Dec. 22, 1961, Ser. No. 161,668
7 Claims. (Cl. 175—40)

The present invention relates to an apparatus for indicating when the diameter of a hole is undersized. More particularly, the invention pertains to a device to be used when drilling to determine when an undersized hole is being formed.

The problems encountered when a well hole is drilled undersized have long been recognized. Thus, it is known that undersized holes require removal of the drilling apparatus and subsequent reaming of the hole to design size. Maintenance of the design size is essential in order to assure that new bits or other tools may be lowered into the drilled hole without jamming, distortion or breakage. Reaming, particularly of considerable amounts at great depths, presents an expensive and difficult, if not impossible, operation.

For these reasons drilling apparatus is pulled frequently in order to assure that the bits are in condition to drill to design size. As a result, bits are often pulled unnecessarily with resultant delays and expenses. Drilling apparatus is often pulled too late, resulting in undersized holes that are difficult to correct and are hazardous with respect to binding of subsequent drill bits.

In order to prevent unnecessary pulling of the well drilling apparatus drill bits have been provided with various devices to indicate bit wear and transmit the indication to the surface of the earth. Such devices generally are incorporated into the drill bit and rely on wear of the bit for the indication.

Indication devices relying on drill bit wear have the disadvantage that the device is generally incorporated in the bit and, therefore, requires replacement with the bit. Furthermore, incorporating the indicating devices into the expendable parts of the drill bit makes the necessary accurate machining of the indicating device a difficult and expensive process.

Indicating devices relying on drill bit wear also have the disadvantage that the indication thereof may not accurately reflect the diameter of the hole being drilled. For example, wear of the gage cutting surface of the drill may not be indicated by wear of the end cutting faces of the drill. Bearing wear that may allow the cones of a cone type drill to cut undersize is also not necessarily indicated by cutter wear. Furthermore, pinched bit shanks or extreme formation conditions that result in undersized holes are not generally indicated by drill wear.

An object of the present invention is, therefore, to provide an apparatus to accurately and reliably detect undersized holes.

Another object of the invention is to provide an apparatus to indicate undergage drilling independent of drill bit wear.

A further object of the invention is to provide an under gage hole indicator capable of being separated from and used with successive drill bits.

Yet another object of the invention is to provide an undergage hole indicator which may be accurately manufactured and subsequently maintained at a minimum of expense.

Other and further objects of the invention will be apparent from the following description of the invention.

Basically, the apparatus of the present invention consists of an under gage hole indicator for use in combination with a drill string having a bore therein through which fluid is conveyed. The indicator comprises a hous-

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ing secured to the drill string and having an axially extending duct therein through which fluid from the drill string is conveyed. First passages extend between the duct and the periphery of the housing and second passages extend between the first passages and the periphery of the housing. Sealing elements are disposed in the first passages at the periphery of the housing, said sealing elements being adapted to open upon contact with the walls of a hole into which the drill string is lowered. Valves are disposed between the first and second passages to prevent flow therebetween when the sealing elements are closed, said valves being adapted to admit flow between the first and second passages upon opening of the sealing elements. Through this arrangement the fluid within the drill string can flow through the first and second passages when the sealing elements contact the sides of an undersized hole, thereby causing a drop in pressure within the drill string, which drop can be sensed by the drill operator.

The invention will now be described with reference to an embodiment thereof shown in the drawings, in which:

FIGURE I is an elevational view of the indicator in combination with a drill string and bit positioned in a drill hole.

FIGURE II is an enlarged view of the indicator shown in FIGURE I, with parts thereof broken away to show interior details.

FIGURE III is a cross-sectional view taken on line III—III of FIGURE II.

Referring now to the combination shown in FIGURE I. The numeral 10 designates a portion of the earth into which a hole 11 is being drilled. The drilling apparatus in the hole includes a drill string 12 having a collar 13 with a bore 14 therein through which drilling fluid may pass. The lower end of the collar 13 is secured to an indicator 17 to which the present invention is directed. A cone type drill bit 18 having cones 19 is secured to the lower end of the indicator 17. It is to be understood that the indicator of the present invention is not limited to use with the specific drill string and bit illustrated in FIGURE I.

The indicator 17, illustrated in detail in FIGURES II and III, includes a housing 20 of generally triangular cross section having a periphery including flat sides 23 and rounded apices 24. A duct 25 extends axially through the center of the housing and provides a passage through which drilling fluid may be conveyed from the drill string 12 to the bit 18. Identical passages 26 extend radially within the housing between the duct 25 and the apices 24. Each of the passages 26 include an enlarged recess 27 at the apex of the housing and a threaded section 28 extending therefrom toward the center of the housing. The passages 26 each further include an intermediate section 31 of substantially the same diameter as the threaded section 28 and a narrow section 32 extending between the intermediate section 31 and the duct 25.

The housing also has disposed therein identical relief passages or ports 33 extending between the intermediate sections 31 of the passages 26 and the flat sides 23. In order to prevent dirt and drill cuttings from entering the passages 33 resilient plugs 34 are received in the ends thereof at the periphery of the housing 20. Plugs 34 are adapted to be ejected from the passages 33 by fluid pressure within said passages. The sections of the passages 35 interior of the plugs 34 may be filled with a light grease or soap to assure that foreign matter will not enter the passages. When grease or soap is used in the passages 33, the plugs 34 are provided with relief grooves (not shown) cut along the outer sides thereof to accommodate for expansion and contraction of the grease or wax.

FIGURE III shows the internal structure of the indi-

cator in condition to be lowered into a drill hole. In this figure identical valve assemblies are received in the passages 26 to prevent drill fluid from passing from the duct 25 through the passages 26 and 33. Each valve assembly includes a piston or cylindrical member 38 slidably received in the passage 26. The piston 38 includes enlarged and narrow sections adapted to be received in the intermediate and narrow sections, respectively, of the passage 26. The enlarged section of the piston 38 is of sufficient length to close the entrance of the passage 33 into the passage 26. Annular seal elements 39 and 40 are disposed around the piston 38 adjacent the ends thereof to assure that the piston seals the passage 26 from the passage 33. The enlarged section of the piston 38 has a cavity 41 therein in communication with an orifice 42 disposed in the narrow section of the piston. The orifice 42 communicates with the duct 25 through an enlarged passage 43 in the piston 38. A screen 46 is secured to the passage 43 to assure that foreign particles passing through the duct 25 will not foul the orifice 42.

Each valve assembly further includes a bolt 47 received in the threads 28 of the passage 26. Plastic buttons 48 lock the bolt 47 in engagement with the threads 28. The bolt 47 has an axial passage 49 extending therethrough and a diaphragm or sealing element 50 closing the end of said passage disposed at the head of the bolt. Diaphragm 50 is fabricated of material (such as rubber) adapted to be abraded away by contact with the walls of a hole into which the apparatus is lowered. The drill-hole diameter at which the diaphragm is abraded away may be controlled by selecting a bolt having a head of a desired thickness. In order to facilitate selection of a bolt having a head of a desired thickness, bolts may be marked according to the diameter of the drill-hole in which they are to be used.

In each valve assembly a coil spring 51 is interposed between the bolt 47 and the piston 38 to bias the piston to the position shown in FIGURE III. It is noted that the spring 51 is of a diameter to fit within the cavity 41 of the piston 38 and that, therefore, the spring does not interfere with movement of the piston toward the bolt 47. A tube 52 is secured to the bolt 47 and extends into the coil spring 51 to maintain the spring in axially aligned position with respect to the cavity 41 of the piston 38.

In operation the indicating apparatus of the present invention is generally interposed between a drill string and a bit as shown in FIGURE I. The selection of bolts 47 to be used in the apparatus is determined by the diameter of the drill bit used in combination therewith. After the apparatus is in the condition shown in FIGURE I, drilling is commenced in the conventional manner. The drill string 12 is rotated as it is lowered against and into the earth. During the drilling operation drilling fluid, such as mud or gas, is continually fed to the bit 18 through the bore 14 of the drill string collar and the duct 25 of the indicating apparatus.

As long as the bit is drilling to design size the diaphragms 50 will remain intact and out of contact with the walls of the drill hole 11. In this condition the orifices 42 in the pistons 38 permit drilling fluid to pass into the cavities 41 and equalize the pressure on both sides of the pistons so that the springs 51 hold the pistons in seated position as shown in FIGURE III. With the pistons in seated position drilling fluid may only leave the housing through the end of the duct 25 in communication with the drill bit 18.

When the bit begins to form an undersized hole the diaphragms 50 come into contact with the walls of the drill hole and are thereby abraded away. At this point, due to the large openings of the abraded away diaphragms relative to the orifices 42, pressure drops occur in the cavities 41 and the spaces thereabove and the pistons 38 are forced toward the bolts 47 by the pressure of the fluid within the duct 25. The movement of the pistons 38 allows drilling fluid to enter the passages 33 and eject

the plugs 34 therefrom. The ejection of the plugs 34 permits drilling fluid to leave the housing through the passages 33 and, thereby, reduces the pressure of drilling fluid within the drill string. After one, two or three plugs have been ejected, the reduction in pressure will be sufficient to alert the drill operator at the surface of the earth. The reduction in drilling fluid pressure will also decrease bit circulation and, thereby, lower the penetration rate of the bit and further alert the drill operator.

Upon being alerted of the condition of the drill hole the operator removes the drill string and prepares for further drilling. In preparation the indicating unit may be re-used by inserting new bolt and diaphragm units in place of the abraded units and inserting new plugs in the passages 33. The bit may also be replaced if the wear thereof is found to be the cause of the undersized drilling. Therefore, it can be seen that a single indicator apparatus may be used with many successive drill bits.

For the sake of clarity, reference numerals have not been applied to all of the passages and valve assemblies shown in FIGURE III. It is to be understood that the numerals apply equally to the passages and valve assemblies at each of the apexes 24.

The foregoing description of the invention is merely intended to be explanatory thereof. Various changes in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

I claim as my invention:

1. An undergage hole indicator for use in combination with a drill string having a bit at the lower end thereof and a bore through which fluid is conveyed to said bit, said indicator comprising, a housing secured to and interposed between said drill string and said bit and having axially extending duct means therein through which drilling fluid is conveyed from the drill string to the bit, said housing having passage means extending between the duct means and the periphery of the housing; sealing means disposed in said passage means at the periphery of the housing, said sealing means having the outer extremity thereof spaced from the longitudinal center line of said housing by a distance substantially equal to the cutting radius of the bit and wherein said sealing means is adapted to open upon contact of said outer extremity with the walls of a hole into which the drill string is being lowered; and valve means disposed in said passage means to prevent flow therethrough when the sealing means is closed, said valve means being adapted to admit flow through said passage means upon opening of the sealing means.

2. An indicator according to claim 1 wherein the sealing means comprise diaphragm means disposed over the passage means and adapted to be abraded away by contact with the walls of a hole into which the drill string is lowered.

3. An indicator according to claim 1 wherein the valve means comprise cylindrical means slidably and sealingly received within the passage means, said cylindrical means being adapted to slide to a position opening said passage means upon opening of the sealing means.

4. An undergage hole indicator for use in combination with a drill string having a bit at the lower end thereof and a bore through which fluid is conveyed to said bit, said indicator comprising, a housing secured to and interposed between said drill string and said bit and having axially extending duct means therein through which drilling fluid is conveyed from the drill string to the bit, said housing having first passage means extending between the duct means and the periphery of the housing, said housing having second passage means extending between the first passage means and the periphery of the housing; sealing means disposed in said first passage means at the periphery of the housing, said sealing means having the outer extremity thereof spaced from the longitudinal center line of said housing by a distance substantially equal to the cutting radius of the bit and wherein said sealing

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means is adapted to open upon contact of said outer extremity with the walls of a hole into which the drill string is lowered; valve means disposed between said first and second passage means to prevent flow therebetween when the sealing means is closed, said valve means being adapted to admit flow between the first and second passage means upon opening of the sealing means; and plug means disposed in the second passage means at the periphery of the housing, said plug means being adapted to be ejected from said second passage means upon admission of flow between the first and second passage means.

5. An undergage hole indicator for use in combination with a drill string having a bit at the lower end thereof and a bore therein through which fluid is conveyed to said bit, said indicator comprising, a housing secured to and interposed between said drill string and said bit and having axially extending duct means therein through which fluid from the drill string is conveyed to the bit, said housing having first passage means extending between the duct means and the periphery of the housing, said housing having second passage means extending between the first passage means and the periphery of the housing; sealing means disposed in said first passage means at the periphery of the housing, said sealing means being adapted to open upon contact with the walls of a hole into which the drill string is being lowered; cylindrical

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drical valve means slidably and sealingly received within the first passage means; spring means biasing said valve means to a position sealingly disposed between said first and second passage means to prevent flow therebetween when the sealing means is closed; and wherein said valve means is adapted to admit flow between the first and second passage means upon opening of the sealing means.

6. An indicator according to claim 5 wherein the sealing means comprises diaphragm means disposed over the first passage means and adapted to be abraded away by contact with the walls of a hole into which the drill string is lowered.

7. An apparatus according to claim 5 including releasable plug means disposed in the second passage means at the periphery of the housing, said plug means being adapted to be ejected from said second passage upon admission of flow between the first and second passage means.

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