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(54) A rotating bit with junk slots in its gage.

(57) An improved rotating drag bit for cutting plastic, sticky, water reactive and shale formations is devised by providing a plurality of large diamond cutters having a circular cutting face in excess of a three quarter inch in diameter. Each large cutter is provided with at least one hydraulic nozzle which in turn provides a directed hydraulic flow at the corresponding cutter face. The directed hydraulic flow is positioned to apply a force to the chip which tends to peel the chip away frog the cutter face. In addition, the hydraulic flow is positioned with respect to the chip so as to apply an off-center torque to the chip which is used to peel the chip away from the cutter face and toward the gage of the bit. In particular, the nozzle defines a jet which is characterized by a direction and velocity of hydraulic fluid determined by the jet characteristics. The core is generally symmetric about its longitudinal axis and has a length along the longitudinal axis and width perpendicular thereto. The point of the jet most distant from the nozzle defines an impact point of the jet against the chip and cutter face. The longitudinal axis of the jet is chosen so that at least a portion of the jet axis lies between the cutter face and the chip as it is being peeled from the cutter. Hydraulic removal of the chips is further facilitated by a plurality of junk slots having a contained compound surface. The jug slot is characterized by having at least two distinct cross-sectional profiles, namely an asymmetric profile at its lower portion nearest the bit face and a symmetric profile along its upper portion. The asymmetric and symmetric profiles are connected by a surface providing a smooth hydrodynamic transition.

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The invention relater to a rotating bit as set forth in the preamble of claim 1.

A bit of the kind referred to is known from US-A-4 098 363 including junk slots which have a single profile throughout their longitudinal length.

What is needed is a bit having substantially improved hydraulic flow within its junk slots.

To this end the invention provides a rotating bit as claimed in Claim 1. Further embodiments are included in claims 2 - 4.

By reason of the junk slot design according to the invention reverse flow, turbulent or unstable flows and eddies which have been observed in conventional junk slots, can be avoided or at least substantially diminished.

The invention is more graphically depicted in the drawing illustrating a top plan view of a mold from which a matrix bit incorporating the invention is fabricated.

What is shown in the drawing is a plan view of the settings of the large diamond compact cutters on the face of a bit as seen looking into a mold in which such a diamond bit would be made by matrix infiltration. Thus the bit, generally denoted by reference numeral 10, is characterized by an exterior cylindrical surface or gage 12 terminated on its lowermost portion by a bit face, generally denoted by reference numeral 14. Defined within gage 12 is a plurality of junk slots 16 and 18. Junk slots 16 are distinguishable from junk slots 18 in that junk slots 16 have uniform contour as opposed to a contoured or compound surface within junk slots 18 as will be described below.

In the embodiment illustrated a 12 1/4 inch diameter bit is illustrated in which nine large cutters 21-29 will be formed, each comprising a substrate 45, a slug 44 and a diamond table 46 as shown at cutter 24, which is brazed into a pocket 48 of the mold at positions 1 - 9. For the sake of clarity of illustration each cutter is shown in midline cross-sectional view with the diamond cutter in place. In actuality the diamond slugs may be fixed or brazed into the bit in a later step, and would not be seen in place in the mold as depicted in the drawings. See generally US-A-4 098 363 for background information concerning the casting of the bit body, cutter shapes and materials, and various methods of attachment of the cutters. However for ease of conceptualization, the drawings illustrates the diamond cutters in place as would be seen looking downward through the diamond bit toward the rock formation. In reality in a top plan view of a mold, only the pockets into which the diamond slugs were later brazed would be seen.

Corresponding to each cutter is a nozzle 31-39 which provides a directed flow to the cutter. Nozzle 31 thus provides directed flow for cutter 21, nozzle 32 for cutter 22 and so forth through nozzle 39 and cutter 29. In addition to cutters 21-29, a plurality of gage cutters 40 are defined within the shoulder and gage of bit 10 which are also illustrated in a sometimes overlying relationship. The depiction of gage cutters 40 appears to be overlying since the cutters, which may be vertically separated, are superimposed in the diagrammatic view of the drawing.

In addition to junk slots 16 and 18, a plurality of collectors 42 are similarly provided within gage 12. These are provided to enhance the cleaning and cooling of gage cutters 40. Gage defining cutters 40 are comprised of conventionally fabricated Stratapax or Compax cutters and can, by virtue of their relative scale to cutters 21-29, provide a relative feel for the sizes of cutters 21-29.

Generally, cutters 21-29 of the illustrated embodiment have a predetermined rake angle of diamond table 46. In the illustration, however, each cutter 21-29 has been shown only in a midline section for the sake of clarity. Therefore it must be kept in mind that portions of the face of diamond table 46 actually extend both in front of and behind the midsection line shown in the illustration for each cutter 21-29 by an amount depending on the rake angle of each cutter.

The cutter can have different shapes, e.g. triangular, hexagonal, square, or octagonal. The cutter can be composed of thermally stable diamond or some other material such as silicon carbide, tungsten carbide, or baron carbide. During manufacture of the bit, the cutter can be furnaced with the bit body in order to attach it to the bit.

The junk slot 18 is characterized by having at least two distinct cross-sectional profiles, namely a symmetric profile at its upper portion farthest from the bit face and an asymmetric profile along its lower portion. The asymmetric and symmetric profiles are connected by a surface providing a smooth hydrodynamic transition.

Consider specifically the contoured junk slots 18 as depicted in the drawing. Junk slot 18 is a longitudinal cavity defined within gage 12 to facilitate removal of cut material. In the lower portion of junk slot 18, nearest bit face 14, junk slot 18 is characterized by a first asymmetric profile shown in dotted outline as portion 80. The upper portion of junk slot 18, furthest away from the face 14, has a distinct second profile 82 as depicted in solid outline. Thus, the lower section of junk slot 18 has a nonuniform asymmetric profile 80 while the upper section has a substantially uniform symmetric profile 82. The transition between profiles 80 and 82 within the middle region of junk slot 18 is smoothed so that cross sections (not shown) would reflect a smooth hydrodynamic transition between the dramatically different profiles 80 and 82.

In the illustrated embodiment the first profile 80 has been shown with a wedge shaped leading

portion, which transitions to a full depth, following portion which is equivalent to second profile 82. It is entirely within the scope of the invention that profile 80 may be reversed, namely having a full depth leading profile transitioning to a wedged-shaped following portion. Furthermore, any junk slot profile known in the art, in addition to illustrated profiles 80 and 82 may be used or variously combined with each other as may be desired. Similarly, the longitudinal relationship of the portions may be reversed if desired. For example, asymmetric profile 80 may characterize the upper section of junk slot 18, while full portion 82 would characterize the lower section nearest bit face 14.

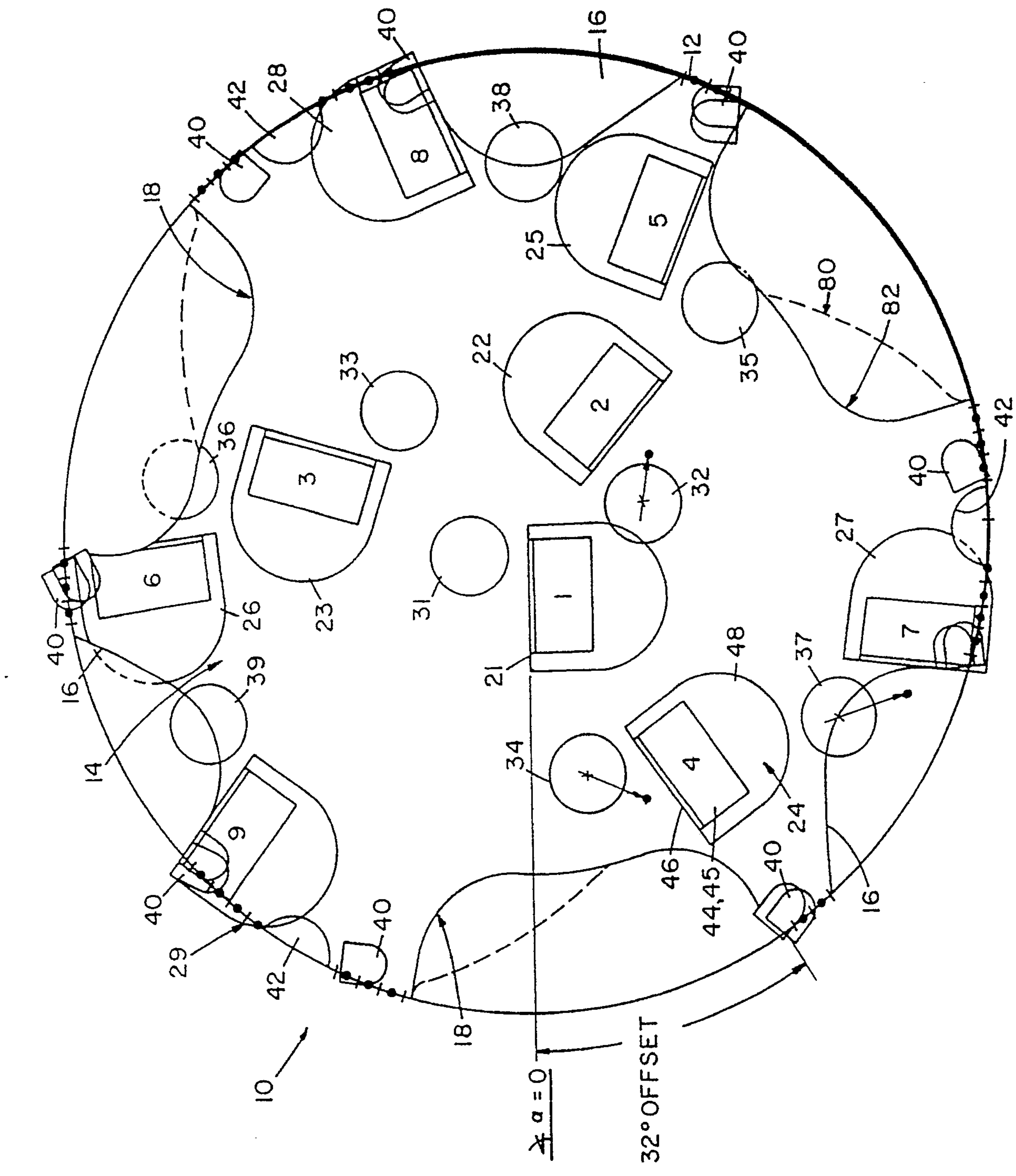
Claims

1. In a rotating bit (10) having a bit face (14) and a gage (12), and at least one junk slot (18) defined in and extending substantially longitudinally along said gage (12) of said bit (10), the improvement characterized in that said junk slot (18) includes a compound profile along its longitudinal extent, said compound profile including at least two distinct substantially longitudinally superimposed regions (80;82) of differing cross-sectional configuration connected by a hydrodynamically smooth transitional region.

2. The improvement of Claim 1 wherein said at least two profiles of said junk slot (18) comprise a symmetric profile (82) and an asymmetric profile (80).

3. The improvement of Claim 2 wherein said asymmetric profile (80) is longitudinally defined within said junk slot (18) nearer said bit face (14) than said symmetric profile (82).

4. The improvement of Claim 3 wherein at least one portion of said asymmetric profile (80) is identical to said symmetric profile (82).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