DRILL BIT WITH FACETED PROFILE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of application Ser. No. 07/523,235, filed on May 11, 1990, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to earth boring drill bits and, more particularly, it concerns an improved drag bit having a faceted profile.

Typically, earth boring drill bits and particularly those commonly known as drag bits have cutting surfaces made up of a number of polycrystalline diamond compact (PDC) cutters such as STRATAPAX TM cutting elements from General Electric Company. Each of the PDC cutters is normally mounted on a tungsten carbide stud or cylinder which is received within a corresponding aperture in the drill bit body during bit fabrication. Conventional PDC drag bits such as STRAT-X® bits produced by Security Division, Dresser Industries, Inc., Dallas, Tex., have either a steel or a matrix bit body and come in a variety of bit profiles, such as, blade, conical, frustrum, concave or stepped, for use in differing drilling conditions and for penetrating different types of formations.

The drill bit design and manufacturing industry has made a significant effort to distribute the individual cutters about the drill bit to provide the most efficient operation. In particular, a variety of methods and techniques have been developed so as to produce a cutter distribution which provides for uniform cutter wear in order to maximize the service life of the drill bit. However, cutter distributions developed, for example, by a computer program are often difficult to implement given existing bit fabrication techniques.

Accurate placement of stud mounted PDC cutters during steel body bit manufacture is relatively easy in that each of the stud receiving cylindrical openings in the steel bit body is drilled separately. On the other hand, accurate placement of PDC cutters during matrix body bit manufacture is more difficult using conventional molding processes. This is especially true in producing matrix body bits having curved profiles. As such, the most efficient matrix body drag bit designs will not be realized until the PDC cutters are accurately positioned during bit fabrication.

Generally, matrix body PDC drag bits are produced by adhering a hard metal matrix to a steel head blank using an infiltration process, securing a number of PDC cutters to the bit body by brazing each of the cutter support studs or cylinders into a corresponding opening in the matrix body, and, then, securing a pin section or top sub to the head blank by, for example, arc welding. Typically, the infiltration process is a casting technique in which a porous skeleton, such as tungsten carbide or another hard metal powder, is filled by a liquid binder alloy, such as a copper alloy, having a lower melting temperature than the skeleton. The infiltration process requires the use of a bit mold to conform the porous powder skeleton to the desired bit profile during infiltration.

Bit mold making requires considerable expertise and involves precision work. Hard molds which are machined from graphite give excellent reproduction. Soft molds which are pressed from bit patterns are better suited for reproducing bits with complex geometries and provide the best bit-to-bit reproduction.

Since a matrix bit body is very hard and somewhat brittle and, as such, extremely difficult to machine, the openings in the matrix body adapted to receive the support studs or cylinders of the PDC cutters cannot be drilled separately as is done with steel body bits. Instead, these openings are formed by placing cores or plugs in the bit mold prior to the addition of the hard metal powder skeleton. These cores or plugs are formed from a material, such as graphite, which is easily removed following the infiltration process.

Usually, these cores or plugs have planar ends which do not conform to the curved inner surfaces of the bit mold. This mismatch between the planar ends of the cores and the curved inner surface of the mold leads to inexact placement and angular orientation of the cores which in turn leads to inaccurate location and angular disposition of the PDC cutters.

Moreover, this geometric incongruity between the cores and the curved mold surface allows the hard powdered metal skeleton and alloy material to leak between the core and mold, and, thereby form an undesirable sprue or flash of hard powdered metal or matrix material in the resultant opening in the matrix bit body. Removal of this sprue or flash of hard powdered metal and matrix material is very difficult and time consuming clean-up work which requires the use of expensive tooling and which adds to the cost of bit production.

In light of the foregoing, there is a need for an improved drag bit design and method which facilitates accurate cutter placement and simplifies bit manufacturing.

SUMMARY OF THE INVENTION

In accordance with the present invention, the problems associated with conventional drag bit designs of the type described are addressed by a drag bit with a faceted profile and method of its manufacture by which the facets provide for planar mold surfaces upon which cores or plugs having planar ends can completely contact the surface of the mold.

The invention is particularly though not exclusively adapted to matrix body drag bits incorporating PDC cutters having tungsten carbide studs which are mounted in wings, ribs or blades of the bit body. In accordance with a preferred embodiment of the present invention, the wings, ribs or blades have a small planar surface or facet at each PDC cutter location. The facets are created by flat mold surfaces which facilitate the accurate positioning and angular disposition of the cores or plugs which form the openings in the matrix for receiving the PDC cutters. In the practice of the present invention, the facets or flats are formed in a hard mold during machining or in a soft mold by using a bit pattern having corresponding facets.

Accordingly, a principal object of the present invention is to provide an improved drag bit design and method incorporating a faceted profile which facilitates accurate cutter location and angular orientation and which reduces clean-up time and tooling costs. Another and more specific object of the invention is the provision of a matrix body drag bit mold having a faceted inner surface which makes provision for attaching cores or plugs having planar ends. Yet another and more specific object of the present invention is to provide a bit pattern having a faceted profile for forming a soft