ROCK BIT WITH HARDFACING MATERIAL INCORPORATING SPHERICAL CAST CARBIDE PARTICLES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of provisional patent applications Ser. Nos. 60/014,731, filed Mar. 12, 1996, and 60/014,225, filed Mar. 27, 1996.

FIELD OF THE INVENTION

This invention relates to improved fracture- and wear-resistant hardfacing compositions applied to wear surfaces on teeth on bits for drilling oil wells or the like.

BACKGROUND OF THE INVENTION

Bits for drilling oil wells and the like commonly have a steel body which is connected at the bottom of a drill string. Steel cutter cones are mounted on the body for rotation and engagement with the bottom of a hole being drilled to crush, gouge, and scrape rock for drilling the well. One important type of rock bit referred to as a milled tooth bit has roughly triangular teeth protruding from the surface of the cone for engaging the rock. The principal faces of such a milled tooth that engage the rock are usually dressed with a layer of hardfacing material to resist wear. The specific tooth geometry forms no part of this invention.

Conventional hardfacing usually comprises particles of tungsten carbide bonded to the steel teeth by a metal alloy. In effect, the carbide particles are embedded in a matrix of metal forming a layer on the surface. Most hardfacing on rock bits employs steel alloys containing nickel and cobalt as the matrix, although other alloys may also be used.

It is quite common in referring to the particulate material in the hardfacing merely as "carbide" without characterizing it as tungsten carbide. The metal carbide principally used in hardfacing is tungsten carbide. Small amounts of tantalum carbide and titanium carbide may be present, although considered to be deleterious. It will be understood that as used herein, reference merely to "carbide" means tungsten carbide.

Three types of tungsten carbide have been employed for hardfacing. Possibly the most common is crushed cast carbide. Tungsten forms two carbides, WC and W_2C and there can be an essentially continuous range of compositions therebetween. Cast carbide is typically a eutectic mixture of the WC and W_2C compounds, and as such is substoichiometric, that is, it has less carbon than the more desirable WC form. Cast carbide is solidified from the molten state and comminuted to the desired particle size.

Another type of tungsten carbide is so-called macrocrystalline tungsten carbide. This material is essentially stoichiometric WC in the form of single crystals. Most of the macrocrystalline tungsten carbide is in the form of single crystals but some bicrystals of WC may form in larger particles.

The third type of tungsten carbide used in hardfacing comprises cemented tungsten carbide, sometimes referred to as sintered tungsten carbide. Cemented tungsten carbide comprises small particles of tungsten carbide (e.g., 1 to 15 microns) bonded together with cobalt. Cemented tungsten carbide is made by mixing tungsten carbide and cobalt powders, pressing the mixed powders to form a green compact, and "sintering" the composite at temperatures near the melting point of cobalt. The resulting dense cemented carbide can then be comminuted to form particles of cemented tungsten carbide for use in hardfacing.

A typical technique for applying hardfacing to the teeth on a rock bit is by oxyacetylene welding. A welding "rod" or stick is formed of a tube of mild steel sheet enclosing a filler which is primarily carbide particles. The filler may also include deoxidizer for the steel, flux, and a resin binder to retain the particles in the tube during welding. The hardfacing is applied by melting the rod on the face of the tooth. The steel tube melts to weld to the steel tooth and provides the matrix for the carbide particles in the hardfacing. The deoxidizer alloys with the mild steel of the tube.

Although mild steel sheet is used when forming the tubes, the steel in the hardfacing as applied to a rock bit is a hard, wear resistant, alloy steel. This occurs by the dissolution of tungsten, carbon, and possibly cobalt, into the alloy steel from the tungsten carbide during welding. There may also be some mixing with the alloy steel from the teeth on the cone.

It is important to provide as much wear resistance as possible on the teeth of a rock bit cutter cone. The effective life of the cone is enhanced as wear and fracture resistance of the hardfacing is increased. It is desirable to keep the teeth protruding as far as possible from the body of the cone since the rate of penetration of the bit into the rock formation is enhanced by longer teeth (however, unlimited length is infeasible since teeth may break if too long for a given rock formation). As wear occurs on the teeth, they get shorter and the drill bit may be replaced when the rate of penetration decreases to an unacceptable level. It is desirable to minimize wear so that the footage drilled by each bit is maximized. This not only decreases direct cost, but also decreases the frequency of having to "round trip" a drill string to replace a worn bit with a new one.

U.S. Pat. No. 4,944,774 discloses a hardfacing material for use with the teeth of rock bits that comprises a mixture of crushed cemented tungsten carbide having a particle size in the range of from 20–30 mesh, and macrocrystalline tungsten carbide having a particle size in the range of from 40–80 mesh. Such a hardfacing material is known to provide a good degree of wear resistance and abrasion protection of the inner teeth, and somewhat improved wear resistance of the gage surfaces of the cone and gage row of teeth.

Advances in wear resistance of hardfacing on the teeth and gage surfaces of the cone are desirable to increase the duration during which a hole diameter can be maintained, to enhance the footage a drill bit can drill before becoming dull, and to enhance the rate of penetration of such drill bits. Such improvements translate directly into reduction of drilling expense.

BRIEF SUMMARY OF THE INVENTION

There is, therefore, provided in practice of this invention according to a presently preferred embodiment, a hardfacing material for both an inner row of rock bit teeth, and gage surfaces of a rock bit cone and gage row of rock bit teeth. The hardfacing material includes spherical cast carbide particles alone or in a mixture including other carbide particles such as spherical or crushed cemented carbide, macrocrystalline carbide, carburized carbide, or the like. The carbide particles are in a matrix of alloy steel welded to the steel of the teeth of the cutter cone.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features and advantages of the present invention will be appreciated as the same becomes better