

Description

BACKGROUND OF THE INVENTION

5 1. Field of the Invention.

The present invention relates generally to earth boring bits of the type used to drill oil and gas wells and particularly to improvements in the bearing regions of rolling cutter bits achieved by applying titanium carbide modified hardfacing compositions to the friction bearing surfaces thereof.

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2. Description of the Prior Art.

As a bit bores through the earth, it experiences increasingly higher pressures and temperatures, while the abrasives that surround the bit create extremely destructive conditions. In order to improve bit life expectancy, continuing effort is directed toward improving the bearing surfaces of the rolling cutter bit.

At the present time, the bearing surfaces of rotatable cutters in earth boring drill bits are commonly carburized, hardened and tempered to increase their wear resistance. Gas carburizing is a known technique which has been used in the past to produce a uniform case on the head section bearings of earth boring drill bits. Pack carburizing is another technique used at the present time to treat the bearing areas of earth boring drill bits. A particulate carburizing compound is packed in a container which surrounds the drill bit bearing area which is to be treated. Other surface treatments of the bearing surfaces which have been used in the past include boronizing and a combination of carburizing and boronizing.

Although surface treatments of the above type have prolonged the useful life of rolling cutter rock bits, each method has associated disadvantages. For instance, the boronized "case" was typically very hard and thin. As a result, the boronized surfaces could not be ground after heat treatment to achieve dimensional accuracy. Carburized bearing surfaces tend to wear fairly quickly, although they can be ground after heat treatment.

Another prior art technique for improving the wear resistance of the bearing surfaces of rolling cutter rock bits was the application of "hard-metal alloy" hardfacing materials. In such processes, a hardfacing such as an iron-based alloy was supplied as a cast rod which was applied to the bearing surface by welding with an oxyacetylene torch. These hardfacings allowed precision grinding to achieve dimensional accuracy but did not provide the improved wear resistance which was desired. Because of the disadvantages associated with surface treatment of the friction bearing surfaces, attention is again being directed to developing an improved hardfacing for the friction bearing surface of a rotary rock bit.

Document FR-A-2 482 627 discloses hardfacing alloys having enhanced resistance to erosive wear. These hardfacing alloys comprise the matrix of an iron-, cobalt- or nickel-based alloy. Further, the hardfacing alloy comprises titanium carbide in a concentration in the range of 5 to 60 wt.-%, as well as a chromium content of about 13 % by weight only. This chromium content is insufficient to provide the basis for an enhanced resistance against erosive wear, since the chromium will not be available in solid solution after application. It is therefore not possible to subject the bearing surface to any further process, like carburization in order to react with the portion of an element in the bearing surface.

Document EP-A-82 122 reveals a method of manufacturing a rotary drill bit in which a wear resistant material forming a hardfacing deposit is applied on to the bearing surface of the shaft supporting the rotary cutter. This wear resistant deposit that has a higher wearability than the surface hardened bearing surface can be stellite, according to the cited document.

Finally document GB 2 128 633 is known. This document discloses a wear resistant stainless steel, consisting of a matrix metal alloy composition used for matrix metal-hard particles-composite hardfacings. These hardfacings do not show a chromium content high enough to enhance the resistance against abrasion, and the alloys described therein are not mentioned in connection with a bearing surface of a boring bit.

The object of the present invention is, to provide an improved hardfacing composition, which has an improved abrasion, adhesion and fatigue resistance, and which can be applied to the friction bearing surface of a boring bit of the type having a rotatable cutter secured to a boring shaft on a head of the bit.

This object is fulfilled by the characterizing features of patent claim 1, while further embodiments of the present invention are disclosed by the characterizing features of the dependent claims.

In the method of manufacturing an earth boring bit of the type having a rotatable cutter secured to a bearing shaft on a head of the bit and at least one friction bearing surface, a hardfacing composition is first formed by combining titanium carbide with a hard metal alloy. The hardfacing composition is then applied

to the friction bearing surface of the earth boring bit.

The hard-metal alloy is an iron-based hard-metal alloy. Most preferably, the iron-based hard-metal alloy consists essentially of the following composition, excluding impurities:

- from about 3 to 35 % by weight chromium,
- 5 approximately 10 % by weight nickel,
- approximately 12 % by weight cobalt,
- approximately 5 % by weight silicon,
- from about 1 to 3 % by weight carbon, and
- the balance being iron, all weight percents being based on the total weight of the hard-metal alloy.
- 10 The hardfacing composition is formed by combining about 5 to 15 % by volume titanium carbide with the hard-metal alloy. Preferably, the iron-based, hard-metal alloy is supplied as a powder mixture. Powdered titanium carbide is then combined with the hard-metal alloy powders and the powder blend is applied to the bearing surface of the rock bit by gas plasma arc welding.

Additional objects, features and advantages will be apparent in the written description which follows.

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BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view, partially in longitudinal section, of a earth boring bit of the rolling cutter type showing the friction bearing surfaces which are the subject of the hardfacing method of the present invention.

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DETAILED DESCRIPTION OF THE INVENTION

The numeral 11 in the drawing designates an earth boring bit which consists of three identical head sections 13, each of which supports a rotatable cutter 15 having a plurality of earth disintegrating teeth 17, here depicted as being inserts of sintered tungsten carbide.

Thus, the three head sections 13 together form a head or body having a hollow interior 19 which terminates at the lower end in usually three passages, each containing a nozzle 21 used to direct drilling fluid or mud against the borehole bottom (not shown).

30 A lubricant passage 23 in each head section extends between the bearing means 25 of a cantilevered bearing shaft 26 and a lubricant pressure compensator and relief means 27.

Lubricant is maintained in the bearing means 27 by a seal means 29, here an O-ring. Each rotatable cutter 15 is retained to the bearing shaft 26 by suitable means such as a snap ring 31. The friction bearing surface regions of the shaft 26 have been darkened for emphasis, it being understood that the bearing surfaces also comprise the mating surfaces on the interior of the rotatable cutter 15. These surfaces will be understood by those skilled in the art to include generally the journals, thrust faces, retaining ring grooves and pilot pins.

The bits manufactured in accordance with the present invention utilize an improved hardfacing composition which is formed by adding titanium carbide within a desired range to a selected, "hard-metal alloy" type hardfacing. By hard-metal alloy hardfacing is meant a commercially available wear resistant alloy which in this case is iron-based. A suitable hard-metal alloy of the iron-based family which is suitable for the purpose of the present invention is commercially available under the trademark "TRISTELLE" from Cabot Stellite Division, Santa Fe Springs, California. These alloys are conveniently supplied in powder form making them well adapted for application by plasma transfer arc methods. Three preferred compositions are shown in Table I.

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TABLE I

TRISTELLE Hard Metal Alloys			
	TS-1 Wt.%	TS-2 Wt.%	TS-3 Wt.%
Cr	30	35	35
Ni	10	10	10
Co	12	12	12
Si	5	5	5
C	1	2	3
Fe	Bal.	Bal.	Bal.

In order to form the hardfacing compositions of the invention, the hard-metal alloy has added thereto about 5 to 15 volume percent titanium carbide, preferably supplied as a powder. Titanium carbide is commercially available from a number of sources and is useful in particle sizes ranging from smaller than 44 μm up to 74 μm .

A preferred hardfacing composition based on an iron-based hard-metal alloy comprises a hard-metal alloy consisting essentially of the following composition, excluding impurities:

from about 30 to 35 % by weight chromium,
approximately 10 % by weight nickel,
approximately 12 % by weight cobalt,
approximately 5 % by weight silicon,
from about 1 to 3 % by weight carbon, and

the balance being iron, all weight percents being based on the total weight of the hard-metal alloy; the hardfacing composition having combined therewith about 5 to 15 % by volume titanium carbide.

The hard-metal alloy is preferably provided as a mixture of powders and the titanium carbide is preferably combined therewith by blending as a powder. The powder blend can then be applied to the selected metal surface by any convenient technique. Most preferably, the powder blend is applied by powder feed, gas plasma arc welding. Gas plasma arc welding is a technique familiar to those in the bit manufacturing industries and provides a convenient method for applying a hardfacing which is supplied as a blend of powders.

With the iron family of hard-metal alloys described above the chromium is available after application, in solid solution. Accordingly, the bearing surfaces so treated can be advantageously carburized in order to react with a portion of the chromium in solid solution and improve wear performance further. Gas and pack carburizing techniques are known in the art and are described, for instance, in U.S. Patent No. 4,643,051, "Pack Carburizing Process For Earth Boring Drill Bits" issued February 17, 1987.

In order to test the effectiveness of the hardfacings of the invention, laboratory bearing parts were loaded at 2721,6 kg and rotated at 168 RPM at temperatures of 93,2 - 120 °C. The laboratory invention parts demonstrated low wear characteristics when compared to similar parts with standard treatments.

The effectiveness of the hardfacings of the invention was further tested by manufacturing six 200 mm ATJ22S bits in which the journal bearing surface of the cones was brush-plated with silver 0,214 mm $\pm$ 0,036 mm over a carburized quenched and tempered surface. The journal bearing surface of the heads was hardfaced with a composition made up of a blend of Stellite 6 powder and titanium carbide. The diametral bearing clearance was 0,995 mm $\pm$ 0,426 mm. These bits, as predicted by the laboratory tests, demonstrated low wear characteristics when compared with bits of standard manufacture.

An invention has been provided with several advantages. The improved hardfacing composition of the invention provides improved abrasion, adhesion and fatigue resistance in rotary earth boring bits. The bearing surfaces can be precision ground after application to ensure dimensional accuracy. The wear resistance of the resulting bearing structure is greatly improved over the prior art technique of carburizing and then boronizing the bearing pin.

Claims

1. A method of manufacturing an earth boring bit of the type having a rotatable cutter secured to a bearing shaft on a head of the bit and at least one friction bearing surface comprising:
forming a hardfacing composition by combining titanium carbide with an iron-based hard-metal alloy containing from about 30 to 35 % by weight chromium;



applying the hardfacing composition to the friction bearing surface of the earth boring bit and carburizing the previously hard-faced friction bearing surface of the earth boring bit.

2. The method of claim 1, comprising the steps of:
- 5 selecting a hard-metal alloy having the following composition, apart from impurities:
- from 30 to 35 % by weight of chromium,
 - 10 % by weight of nickel,
 - 12 % by weight of cobalt,
 - 5 % by weight of silicon,
 - 10 from 1 to 3 % by weight of carbon and
 - the balance being iron, all weight percents being based on the total weight of the hard-metal alloy;
- forming a hardfacing composition by combining 5 to 15 % by volume titanium carbide with a hard-metal alloy; and applying the hard-facing composition to the friction bearing surface of the earth boring bit.
- 15 3. The method of claim 1, comprising the steps of: selecting a hard-metal alloy powder mixture having the following composition, apart from impurities:
- 35 % by weight of chromium,
 - 10 % by weight of nickel,
 - 20 12 % by weight of cobalt,
 - 5 % by weight of silicon,
 - 2 % by weight of carbon, and
 - the balance being iron, all weight percents being based on the total weight of the hard-metal alloy powder;
- 25 forming a powder hardfacing composition by blending 5 to 15 % by volume powder to titanium carbide with the hard-metal alloy powder mixture; and applying the powdered hardfacing composition to the friction bearing surface of the earth boring bit.

Patentansprüche

- 30 1. Verfahren zur Herstellung eines Erdbohrers mit einem rotierenden Meißel, der an einer Lagerwelle an einem Kopf des Bohrers befestigt ist und mit zumindest einer Gleitlagerfläche, **gekennzeichnet durch** das Bilden einer Hartauftraglegierung durch die Kombination von Titankarbid mit einer eisenbasierten Hartmetalllegierung, die zwischen 30 und 35 Gewichts-% Chrom enthält;
- 35 Auftragen der Hartauftraglegierung auf die Gleitlagerfläche des Erdbohrers und Einsatzhärten der vorhergehend hartauftraglegierten Gleitlagerfläche des Erdbohrers.
2. Verfahren nach Anspruch 1, **gekennzeichnet durch** die Schritte:
- Auswahl einer Hartmetalllegierung mit der folgenden Zusammenstellung, abgesehen von Unreinheiten:
- 40 von 3 bis 35 Gewichts-% Chrom,
- 10 Gewichts-% Nickel,
 - 12 Gewichts-% Kobalt,
 - 5 Gewichts-% Silikon,
 - von 1 bis 3 Gewichts-% Kohlenstoff und einem Ausgleich von Eisen, wobei alle Gewichtsprozent
- 45 auf dem Gesamtgewicht der Hartmetalllegierung basieren;
- Bildung einer Hartauftraglegierung durch die Kombination von 5 bis 15 Volumen-% Titankarbid mit einer Hartmetalllegierung; und Auftragen der Hartauftraglegierung auf die Gleitlagerfläche des Erdbohrers.
- 50 3. Verfahren nach Anspruch 1, **gekennzeichnet durch** die Schritte:
- Auswahl einer Hartmetalllegierungspulvermischung mit der folgenden Zusammenstellung, abgesehen von Unreinheiten:
- 35 Gewichts-% Chrom,
 - 10 Gewichts-% Nickel,
 - 55 12 Gewichts-% Kobalt,
 - 5 Gewichts-% Silikon,
 - 2 Gewichts-% Kohlenstoff, und
 - dem Ausgleich an Eisen, wobei alle Gewichtsprozent auf dem Gesamtgewicht des Hartmetalllegie-



rungspulvers basieren;

Bildung einer Pulverhartauftraglegierung durch Mischen von 5 bis 15 Volumen-% Titankarbidpulver mit der Hartmetalllegierungpulvermischung; und Auftragen der pulverigen Hartauftraglegierung auf die Gleitlagerfläche des Erdbohrers.

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Revendications

1. Procédé pour fabriquer un trépan de forage du sol du type ayant un couteau rotatif solidaire d'un arbre support sur une tête du trépan et au moins une surface de frottement de palier comprenant les étapes consistant:
- à former une composition de rechargement dur en combinant du carbure de titane avec un alliage de métal dur à base de fer contenant d'environ 30 à 35% en poids de chrome;
 - à appliquer la composition de rechargement dur à la surface de frottement des paliers du trépan de forage du sol et à cémenter la surface de frottement des paliers précédemment rechargée de métal dur du trépan de forage du sol.
2. Procédé selon la revendication 1, comprenant les étapes consistant:
- à choisir un alliage de métal dur ayant la composition suivante, excepté les impuretés:
de 30 à 35% en poids de chrome,
10% en poids de nickel,
12% en poids de cobalt,
5% en poids de silicium,
de 1 à 3% en poids de carbone, et
le complément étant du fer, tous les pourcentages en poids étant par rapport au poids total de l'alliage de métal dur;
 - à former une composition de rechargement dur en combinant 5 à 15% en volume de carbure de titane avec un alliage de métal dur; et
 - à appliquer la composition de rechargement dur à la surface de frottement des paliers du trépan de forage du sol.
3. Procédé selon la revendication 1, comprenant les étapes consistant:
- à choisir un mélange de poudre d'alliage de métal dur ayant la composition suivante, excepté les impuretés:
35% en poids de chrome,
10% en poids de nickel,
12% en poids de cobalt,
5% en poids de silicium,
2% en poids de carbone, et
le complément étant du fer, tous les pourcentages en poids étant par rapport au poids total de la poudre d'alliage de métal dur;
 - à former une composition de rechargement dur en poudre en combinant 5 à 15% en volume de poudre de carbure de titane avec le mélange de poudre d'alliage de métal dur; et
 - à appliquer la composition de rechargement dur en poudre à la surface de frottement des paliers du trépan de forage du sol.

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