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(54) **Rock bit cutter cones having metallurgically bonded cutter inserts.**

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Description

The present invention is directed to improvements in the construction of rock bits. More particularly, the present invention is directed to cutter cones of rock bits having metallurgically bonded cutting inserts.

Rock bits used for drilling in subterranean formations when prospecting for oil, gas or minerals, have a main body which is connected to a drill string, and a plurality, typically three, cutter cones rotatably mounted on journals. The journals extend at an angle from the main body of the rock bit.

As the main body of the rock bit is rotated either from the surface through the drill string, or by a downhole motor, the cutter cones rotate on their respective journals. During their rotation, teeth provided in the cones come into contact with the subterranean formation, and provide the drilling action.

As is known, the subterranean environment is often very harsh. Highly abrasive drilling mud is continuously circulated from the surface to remove debris of the drilling, and for other purposes. Furthermore, the subterranean formations are composed of rock with a wide range of compressive strength and abrasiveness.

Generally speakong, the prior art has provided two types of cutter cones to cope with the above-noted conditions and to perform the above-noted drilling operations. The first type of drilling cone is known as "milled-tooth" cone because the cone has relatively sharp cutting teeth obtained by appropriate milling of the cone body. Milled tooth cones, generally have a short life and are used for drilling in low compressive strength (soft) subterranean formations.

A second type of cutter cone, used for drilling in higher compressive strength (harder) formations, has a plurality of very hard cermet cutting inserts which are typically comprised of tungsten carbide and are mounted in the cone to project outwardly therefrom. Such a rock bit having cutter cones containing tungsten carbide cutter inserts is shown, for example, in United States Patent No. 4,358,384 wherein the general mechanical structure of the rock bit is also described.

The cutter inserts, which typically have a cylindrical base, are usually mounted through an interference fit into matching openings in the cutter cone. This method, however, of mounting the cutter inserts to the cone is not entirely satisfactory because the inserts are often dislodged from the cone by excessive force, repetitive loadings or shocks which unavoidably occur during drilling.

Another problem encountered in the manufacture of rock bits, relates to the number of machining and other steps required to fabricate the cutter cone. Conventional cutter cones are fabricated in several machining operations, which are, generally speaking, labour intensive and expensive.

Furthermore, the internal portion of the cutter cone includes a friction bearing wherethrough the cone is mounted to the respective journal. It also includes bearing races for balls to retain the cone on the journal. These internal bearing surfaces of the cone must be sufficiently hard to avoid undue wear and to support the loads encountered in drilling. To accomplish this, it has been customary in the prior art to selectively carburize certain pre-machined internal surfaces of the cone.

None of the prior art processes are entirely satisfactory from the standpoint of providing rock bit cutter cones in sufficiently simple (and therefore inexpensive) procedures with sufficient ability to retain the cutter inserts under severe load conditions.

According to the present invention there is provided a cutter cone to be mounted on a journal of a rock bit comprising: a solid core including an interior opening wherethrough the cutter cone may be rotatably mounted to a journal of the rock bit, said core also including on its exterior surface a plurality of cavities; and a plurality of hard cutter inserts in the cavities in the core characterized in that the inserts fit into respective cavities with a non-interference fit and further characterized by a powder metallurgy cladding metallurgically bonded to the outer surface of the core and to the cutter inserts for retaining the cutter inserts in the core.

According to the present invention there is further provided a process for making a cutter cone for a rock bit of the type having at least one journal on which the cutter cone is rotatably mounted, the cutter cone having a plurality of tungsten carbide cutter inserts, the process being characterised by the steps of: placing a plurality of cutter inserts into cavities formed in the outer surface of a solid core of the cutter cone without an interference fit, depositing a powder composition on the outer surface of the core so as to partially embed the cutter inserts pressing the powder in a mould to substantially conform to the desired final exterior configuration of the cutter cone; and heating the powder to a temperature below its melting point to metallurgically bond said powder to the cone and thereby provide an exterior cladding of the cutter cone for retaining the cutter inserts in the cavities.

According to the present invention there is still further provided a process for securing at least one cemented carbide insert to a steel core comprising the steps of: placing such a carbide insert into a cavity formed in the outer surface of a solid core of steel, the cavity being dimensioned to accept the cemented carbide insert without substantial interference; applying a powder composition on the outer surface of the steel core so as to partially embed the cemented carbide insert pressing the powder in a mould to substantially conform to a desired final exterior configuration; and heating the powder to metallurgically bond said powder to the steel core and thereby provide an exterior cladding of the steel core for retaining the carbide insert in the cavity.

The cutter cone has a tough shock resistant core, and hard, cutting inserts fitted in cavities provided in the core. A hard cladding is disposed on the outer surface of the cone, having been metallurgically bonded thereto in a suitable mould by a powder metallurgy process.

Preferably, metallurgical bonding of the cladding occurs through hot isostatic pressing. The cutting inserts are also metallurgically bonded to the core and to the cladding as a result of the formation of the cladding through hot isostatic pressing or like powder metallurgy processes.

The interior of the cone incorporates conventionally machined bearing surfaces and races for attachent of the cutter cone to a respective journal of the rock bit. As a preferred alternative, however, the bearing surfaces and bearing races are formed in the interior of the cone from a metal powder or cermet in the same or similar powder metallurgical bonding process wherein the exterior cladding is bonded and hardened. As still another alternative, the bearing surfaces are formed in a separate piece which is subsequently affixed into a bearing cavity provided in the core.

In order to prevent degradation of the cutting inserts into undesirable "eta" phase, by diffusion of carbon from the insert into the underlying core during the powder metallurgical bonding process, and to accommodate the mismatch in thermal expansion coefficients between the cutting insert and the ferrous core body, a thin coating of a suitable material is deposited on the inserts prior to placement of the inserts into corresponding cavities in the core. Examples of such materials are copper, copper alloys, silver, silver alloys, cobalt, cobalt alloys, tantalum, tantalum alloys, gold, gold alloys, palladium, palladium alloys, platinum, platinum alloys, and nickel or nickel alloys.

Another alternative to prevent degradation of the cutting inserts is to provide an alternate source of carbon such as a graphite layer, in the vicinity of the cutting inserts.

The features of the present invention can be best understood, together with further objects and advantages, from the following description taken together with the appended drawings wherein like numerals indicate like parts.

Figure 1 is a perspective view of a rock bit incorporating the cutter cone of the present invention.

Figure 2 is a cross-sectional view of a journal leg of a rock bit with the cutter cone of the present invention mounted thereon;

Figure 3 is a schematic cross-sectional view of an intermediate in the fabrication of the cutter cone of the present invention, the intermediate having a solid core;

Figure 4 is a schematic cross-sectional view of an intermediate in the process of fabricating another embodiment of the cutter cone of the present invention;

Figure 5 is a schematic cross-sectional view of a tungsten carbide cobalt (cermet) insert coated with a layer of nickel, which is incorporated in the cutter cone of the present invention, and

Figure 6 is a schematic representation of a Scanning Electron Microscope (SEM) micrograph of the boundary layers between the tungsten carbide cobalt insert and a nickel coating on the one hand, and the nickel coating and underlying mild steel core, on the other hand.

Referring now to the drawing figures, the perspective view of Figure 1 shows a rock bit 8 wherein a cutter cone of the present invention is mounted. The cross-sectional view of Figure 2, shows mounting of a first embodiment of the cutter cone 10 of the present invention to a journal leg or journal 12 of the rock bit 8.

It should be noted at the outset, that the mechanical configurations of the rock bit 8, the journal 12 and of the cutter cone 10 are conventional in many respects, and therefore need to be disclosed here only to the extent they differ from well known features of conventional rock bits. For a description of the conventional features of a rock bit, the specification of United States Patent No. 4,358,384 is incorporated herein by reference.

For the purpose of explaining the several features of the cutter cone it is deemed sufficient to note that, in conventional rock bit construction internal friction bearing surfaces 14 and ball races 16 are lubricated by an internal supply of a lubricant (not shown). The bearing surfaces 14 and ball races 16 are sealed from extraneous material, such as drilling mud and drilling debris, by a suitable seal, such as an elastic O-ring seal 20. The conventional internal bearings are usually of the "hard-on-soft" type; e.g. a hard metal bearing surface of the journal 12 engages a bronze bearing surface 14 of the cutter cone 10.

Furthermore, in conventional cutter cone construction, a plurality of tungsten carbide cobalt (cermet) cutter inserts 26 are interference fitted into corresponding circular holes which are drilled individually in the cutter cone 10. This procedure is not only labour intensive, but provides a cutter cone which may have, under severe drilling conditions, less than adequate retention of the cutter inserts 26.

Referring now principally to Figure 3, a solid core 28 of the cutter cone 10 is shown in a first embodiment. The core 28 comprises tough, shock resistant steel, such as mild steel, for example AISI 9315 steel, or AISI 4815 steel. In alternative embodiments, the core 28 itself, may be made by powder metallurgy techniques.

A plurality of cavities 30 are provided in the outer surface 32 of the core 28 to receive, preferably by a sliding fit, a plurality of cutter inserts 26. The cavities 30 may be configured as circular apertures, shown in Figure 3, but may also comprise circumferential grooves (not shown) on the exterior surface 32 of the core 28. Furthermore, the cutter inserts 26 may be of other than cylindrical configuration. They may be tapered, as is shown in Figure 5, or may have an annulus (not shown) comprising a protrusion. Alternatively, the inserts may be tapered and oval in cross-section. What is important in this regard is that the cutter inserts 26 are positioned into the cavities 30 without force fitting, or without the need for precision fitting each individual insert 26 into a precisely matching hole, thereby eliminating significant labour and cost.

The cutter inserts 26 are typically made of hard cermet material. In accordance with usual practice in the art, the cutter inserts comprise tungsten-carbide cobalt cermet. However, other cermets which have the required hardness and mechanical properties, may be used. Such alternative cermets are tungsten-carbide in iron, iron-nickel, and tungsten-carbide in iron-nickel cobalt. In fact, tungsten-carbide-iron based metal cermets often match better the thermal expansion coefficient of the underlying steel core 28, than tungsten-carbide-cobalt cermets.

Subsequent to positioning the cutter inserts 26 into the cavities 30, a powdered metal or cermet composition is applied to the exterior surface 32 of the core 28, to eventually become a hard exterior cladding of the cutter cone 10.

The metal or cermet composition is schematically shown in Figure 3 as a layer of cladding bearing the reference numeral 34. As is explained below, one function of the cladding is to retain the insert 26 in the core 28.

The metal or cermet composition comprising the cladding, should satisfy the following requirements. It should be capable of being hardened and metallurgically bonded to the underlying core 28 to provide a substantially one hundred per cent dense cladding of a hardness of at least 50 Rockwell C units. Many tool steel, and cermet compositions satisfy these requirements. For example, commercially available, well known, AISI D2, M2, M42, and S2 tool and high strength steels are suitable for the cladding. An excellent cladding for the present invention is the tool steel composition which comprises 2.45 weight percent carbon, 0.5 percent manganese, 0.9 percent silicon, 5.25 percent chromium, 9.0 percent vanadium, 1.3 percent molybdenum, 0.07 percent sulphur, with the remainder of the composition being iron. This composition is well known in the metallurgical arts under the CPM 10V designation of the Crucible Metals Division of Colt Industries. Still another excellent cladding material is a proprietary alloy of the above-noted Crucible Metals Division, known under the developing number 516,892.

Instead of powdered steel compositions, such powdered cermets as tungsten carbide cobalt (WC-Co), titanium-carbide-nickel-molybdenum, (TiC-Ni-Mo) or titanium-carbide-iron alloys (Ferro-TiC alloys) may also be used for the cladding 34.

The application of the powdered material of the cladding 34 and metallurgical bonding to the underlying core 28 and its subsequent hardening are performed in accordance with well known powder metallurgy processes and conventional heat treatment practices. Although these well known processes need not be disclosed here in detail, it is noted that the powder metallurgy processes suitable for use include the use of a mould (not shown) which determines the exterior configuration of the cutter cone 10.

Furtheremore, the powder metallurgy process involves application of high pressure to compact the powder, and a step of heating the powdered cladding in the mould (not shown) at a high temperature, but below the melting temperature of the powder, to transform the powder into dense metal, or cermet, and to metallurgically bond the same to the underlying core 28. Thus, the cladding 34 incorporated in the cutter cone 10 may be obtained by cold pressing or cold isostatic pressing the powdered layer 34 on the core 28, followed by a step of sintering.

A preferred process for obtaining the hard cladding 34 for the cutter cone 10 is, however, hot isostatic pressing (HIPping). Details of this process, including the preparatory steps to the actual hot pressing of the cutter cone 10, are described in United States Patent Nos. 3,700,435 and 3,804,575, the specifications of which are hereby expressly incorporated by reference. When the Crucible CPM-10V powdered steel composition is used for the cutter cone 10, the hot isostatic pressing step is preferably performed between approximately 1900 to 2200°F (1038°C to 1204°C), for approximately 4 to 8 hours, at approximately 15000 to 30000 PSI (2×10^6 to 2×10^6Pa).

After the hot isostatic pressing step, certain further heat treatment steps, well known in the art, such as quenching and tempering, are performed on the cutter cone 10. The conditions for quenching and tempering are preferably those recommended by the suppliers of the powdered steel composition which is used for the cladding 34.

Referring still principally to Figures 2 and 3, the cutter cone 10 obtained in the above-described manner has an exterior configuration which corresonds to the final, desired configuration of the cutter cone 10 usable in a rock bit. In other words, little, if any, machining is required on the exterior of the cutter cone 10. Thickness of the cladding is not critical; the cladding may, for example, be 1/8 inch (3.2 mm) thick.

A further, very significant advantage is that the cutter inserts 26 are affixed to the core 28 and to the cladding 34 by metallurgical bonds. Experience has shown that a tungsten carbide cobalt insert (of the size normally used for rock bits, having 0.5″ (12.7 mm) in diameter and a 0.310″ (7.9 mm) "grip") affixed to the cutter cone 10 as described herein requires on the average a pulling force in excess of 21000 lbs (9534 Kg) to dislodge the insert from the cone 10. In contrast, conventional, interference fitted inserts are dislodged from the cone 10 by a force of approximately 7000 to 10000 lbs (3178 to 4540 Kgs).

The cladding 34 of the cone 10 is substantially one hundred per cent (99.995%) dense, and has a surface hardness of at least 50 Rockwell C Units.

The interior of the solid intermediate cutter cone 10 shown in Figure 3 may be machined independently of the hot isostatic pressing process, to provide the cutter cone interior shown in Figure 1. Alternatively, the core 28 itself may be formed by powder metallurgy in steps separate from the above-described steps. Furthermore, conventional, bearing surfaces, for example, aluminium-bronze, or hard metal bearings, for example, cobalt based hard facing alloys may be applied into the interior of the cone 10 in accordance with the state of the art.

As still another alternative, the bearing surfaces may be formed separately from the fabrication of the core 28. In this case, a separate bearing insert piece (not shown) is fitted into the hollow core.

Referring now to Figure 4, a second embodiment of the cutter cone 36 is shown. This embodiment has interior bearing surfaces 38 and races 40 obtained by a powder metallurgy process, preferably a processing including a hot isostatic pressing step. Thus, in order to obtain the cutter cone 36 shown in Figure 4, a forged mild steel core is provided by a machined interior cavity, or opening 42, and a plurality of exterior cavities or apertures 30. The exterior apertures 30 receive cutter inserts 26 in a sliding fit, as it was described in connection with the first embodiment. The exterior cladding 34 is applied to the core 10 in the manner described in connection with the first embodiment.

However, simultaneously with, or subsequent to the powder metallurgy process wherein the cladding 34 (not separately shown in Figure 4) is bonded, a powdered metal or cermet composition is also bonded in the interior cavity 42 through a powder metallurgy process, to provide the bearing races 40 and bearing surfaces 38. In this case, the interior surfaces of the cutter cone 36 emerge from the hot isostatic pressing process in a "near-net" shape, and therefore do not require extensive finish machining.

There is a significant advantage of obtaining very hard bearing surfaces 38 and races 40, such as tungsten-carbide cobalt, in the cutter cone 36. Namely, when such bearing surfaces and races have "hard" counterparts on the rock bit journal 12, then external lubrication and cooling may be affected by circulating drilling mud, rather than by an internal supply of a lubricant. This, of course, eliminates the need for a sealing device such as an O-ring seal 20 (shown in Figure 2) and eliminates problems associated with degradation or wear of the seal 20. Rock bits having no seal, but rather bearings open to the ambient environment, are known in the art as "open bearing" bits.

Referring now to Figure 5, still another feature of the improved cutter cone 10 is disclosed. In accordance with this feature, the tungsten carbide cobalt cutter inserts 26 have a thin coating or layer 44 of a material which prevents diffusion of carbon from the tungsten carbide into the underlying steel core 28 during the high temperature hot isostatic pressing or sintering process. As is known, such diffusion has a significant driving force because the carbon content of the steel core 28 typically is low. Loss of carbon from the tungsten carbide results in formation of "eta" phase of the tungsten carbide, which has significantly less desirable mechanical properties than the original tungsten carbide insert.

It was discovered, however, that the above-noted diffusion, undesirable "eta phase" formation, and degradation of mechanical properties of the tungsten carbide inserts 26 may be prevented by providing a layer of copper, copper alloys, silver, silver alloys, cobalt, cobalt alloys, tantalum, tantalum alloys, gold, gold alloys, palladium, palladium alloys, platinum, platinum alloys, and nickel or nickel alloys on the cutter inserts 26 before the inserts 26 are incorporated into the core 28.

Alternatively, a layer of graphite (not shown) also prevents degradation because it provides an alternate source of carbon. A layer of graphite is readily placed on or near the insert 26 for example, by applying a suspension of graphite in a volatile solvent, such as ethanol, on the insert 26. The graphite prevents or reduces diffusion of carbon from the tungsten carbide because it eliminates the driving force of the diffusion.

The other metals noted above, prevent or reduce diffusion of carbon by virtue of the limited solubility of carbon in these metals at the temperatures and pressures which occur during the hot isostatic pressing process.

The metal coatings may be applied to the cutter inserts 26 by several methods, such as electroplating, electroless plating, chemical vapour deposition, plasma deposition and hot dipping. The metal layer or coating 44 on the cutter inserts is preferably approximately 25 to 100 microns (0.001 to 0.004") thick.

The metal layer 44 deposited on the cutter insert preferably should not melt during the hot isostatic pressing or sintering process. It certainly must not boil during said processes. Nickel or nickel alloys are most preferred materials for the coating or layer 44 used in the present invention.

The metal coating 44 on the inserts 26 not only prevents the undesirable "eta" phase formation in the insert 26, but also provides a transition layer of intermediate thermal expansion coefficient between the tungsten carbide inserts 26 and the surrounding ferrous metal cladding 34 and core 28. In the absence of such a transition layer the boundary cracks readily. Nevertheless, as it was noted above, test results in the absence of such a metal coating still show significant improvement over non-metallurgically bonded inserts with regards to the force required to dislodge the inserts 26. Figure 6 schematically illustrates a Scanning Electron Microscope (SEM) micrograph of the boundary layers between the tungsten carbide cutter insert 26 and a nickel layer 44 on the one hand, and the nickel layer 44 and the underlying core 28, on the other hand.

Claims

1. A cutter cone (10) to be mountd on a journal of a rockbit (8) comprising: a solid core (28)

including an interior opening wherethrough the cutter cone may be rotatably mounted to a journal of the rock bit (8), said core (28) also including on its exterior surface a plurality of cavities (30); and a plurality of hard cutter inserts (26) in the cavities (30) in the core (28) characterized in that the inserts (26) fit into respective cavities with a non-interference fit and further characterized by a powder metallurgy cladding (34) metallurgically bonded to the outer surface of the core and to the cutter inserts (26) for retaining the cutter inserts (26) in the core (28).

2. The cutter cone of Claim 1 characterised in that the cladding (34) has a different composition from the core (28) and/or is harder than the core (28).

3. The cutter cone of Claim 1 or Claim 2 characterised in that the cladding (34) has a hardness of at least 50 Rockwell C hardness units.

4. The cutter cone of any preceding claim characterised in that the core (28) is a solid steel core or comprises mild steel.

5. The cutter cone of Claim 4 characterised in that the material of the core (28) is selected from a group consisting of AISI 9315 steel and AISI 4815 steel.

6. The cutter cone of any preceding claim characterised in that the cladding (34) comprises tool steel or is of a material selected from a group consisting of D2, M2, M42, S2 tool steel; a tool steel composition consisting essentially of 2.45 percent carbon, 0.5 percent manganese, 0.9 percent silicon, 5.25 percent chromium, 1.3 percent molybdenum, 9 percent vanadium, 0.07 percent sulfur and 80.53 percent iron; a tungsten carbide-cobalt cermet, a titanium carbide-nickel-molybdenum cermet and titanium carbide-ferro alloy cermets.

7. The cutter cone of any preceding claim characterised in that the cladding (34) has been metallurgically bonded to the core (28) by a hot isostatic pressing process.

8. The cutter cone of any preceding claim further characterised by means disposed on the cutter inserts (26) for substantially preventing diffusion of carbon from the cutter inserts (26) into the core (28) and the cladding (34) during heating of the cladding (34) for metallurgically bonding the same to the core (28).

9. The cutter cone according to any preceding claim characterised by a layer (44) disposed between cutter inserts (26) and the core (28), the material of which is selected from a group consisting of graphite, copper, copper alloys, silver, silver alloys, cobalt, cobalt alloys, tantalum, tantalum alloys, gold, gold alloys, palladium, palladium alloys, platinum, platinum alloys, nickel and nickel alloys.

10. The cutter cone of Claim 9 characterised in that the layer (44) is approximately 25 to 100 microns thick.

11. The cutter cone according to any preceding claim characterised by a lining incorporated within the interior opening, said lining comprising a bearing surface for rotatably mounting the cone on the journal and being harder than the core.

12. The cutter cone of Claim 11 characterised in that the hard lining has been deposited on the core by a powder metallurgy process.

13. A process for making a cutter cone (10) for a rock bit (8) of the type having at least one journal (14) on which the cutter cone (10) is rotatably mounted, the cutter cone (10) having a plurality of tungsten carbide cutter inserts (26), the process being characterised by the steps of: placing a plurality of cutter inserts (26) into cavities (30) formed in the outer surface of a solid core (28) of the cutter cone without an interference fit, depositing a powder composition on the outer surface of the core so as to partially embed the cutter inserts (26); pressing the powder in a mould to substantially conform to the desired final exterior configuration of the cutter cone; and heating the powder to a temperature below its melting point to metallurgically bond said powder to the cone and thereby provide an exterior cladding (34) of the cutter cone for retaining the cutter inserts (26) in the cavities.

14. The process of Claim 13 characterised by the step of depositing a thin layer (44) of a material selected from a group consisting of graphite, copper, copper alloys, silver, silver alloys, cobalt, cobalt alloys, tantalum, tantalum alloys, gold, gold alloys, palladium, palladium alloys, platinum, platinum alloys, nickel and nickel alloys on the cutter inserts before placing the cutter inserts into the cavities of the core.

15. The proces of Claim 14 characterised in that the step of depositing a thin layer (44) of material on the cutter inserts comprises electroplating.

16. The process of Claim 14 or of Claim 15 characterised in that the material of the thin layer (44) is selected from a group consisting of nickel and nickel alloys.

17. The process of any one of Claims 13 to 16 characterised in that the powder composition of the cladding (34) is selected from a group consisting of tungsten carbide-cobalt cermet, titanium carbide-nickel-molybdenum cermet, titanium carbide-ferro alloy cermet, D2, M2, M42, S2 tool steels and a tool steel composition consisting essentially of 2.45 percent carbon, 0.5 percent manganese, 0.9 percent silicon, 5.25 percent chromium, 9.0 percent vanadium, 1.3 percent molybdenum, 0.07 percent sulfur and 80.53 percent iron.

18. The process of any one of Claims 13 to 17 characterised in that the steps of heating and pressing are conducted as hot isostatic pressing in the range of 15000 to 30000 PSI (2×10^6 to 4×10^6 Pa).

19. The process of any one of Claims 13 to 17 characterised by the step of placing a second powder composition within an interior opening of the solid core (28), and pressing and heating the second powder composition to metallurgically bond the same to the core to provide a hard

interior bearing surface within said core (28).

20. A process for securing at least one cemented carbide insert (26) to a steel core (28) comprising the steps of: placing such a carbide insert (26) into a cavity (30) formed in the outer surface of a solid core of steel, the cavity (30) being dimensioned to accept the cemented carbide insert (26) without substantial interference; applying a powder composition on the outer surface of the steel core (28) so as to partially embed the cemented carbide insert (26); pressing the powder in a mould to substantially conform to a desired final exterior configuration; and heating the powder to metallurgically bond said powder to the steel core (28) and thereby provide an exterior cladding (34) of the steel core (28) for retaining the carbide insert (26) in the cavity (30).

21. The process of Claim 20 further comprising the step of depositing a thin layer (44) of a material selected from a group consisting of graphite, copper, copper alloys, silver, silver alloys, cobalt, cobalt alloys, tantalum, tantalum alloys, gold, gold alloys, palladium, palladium alloys, platinum, platinum alloys, nickel and nickel alloys on the carbide insert (26) before placing the carbide insert (26) into the cavity (30).

22. The process of Claim 21 wherein the step of depositing a thin layer (44) of material on the carbide insert (26) comprises electroplating.

23. The process of Claim 21 wherein the material of the thin layer (44) is selected from a group consisting of nickel and nickel alloys.

24. The process of any one of Claims 20 to 23 wherein the powder composition is selected for also metallurgically bonding to the carbide insert (26).

25. The process of any one of Claims 20 to 23 wherein the powder composition of the cladding is selected from a group consisting of tungsten carbide-cobalt cermet, titanium carbide-nickel-molybdenum cermet, titanium carbide-ferro alloy cermet, D2, M2, M42, S2 tool steels and a tool steel composition consisting essentially of 2.45 percent by weight of carbon, 0.5 percent by weight of manganese, 0.9 percent by weight of silicon, 5.25 percent by weight of chromium, 9.0 percent by weight of vanadium, 1.3 percent by weight of molybdenum, 0.07 percent by weight of sulfur and 80.53 percent by weight of iron.

26. The process of any one of Claims 20 to 25 further comprising the step of hardening the cladding to a hardness of at least 50 Rockwell C.

27. The process of any one of claims 20 to 27 wherein the steps of heating and pressing are conducted as hot isostatic pressing in the range of 15,000 to 30,000 PSI (2×10^6 to 4×10^6 Pa).

Patentansprüche

1. Schneidkonus (10) zum Befestigen auf dem Achszapfen eines Gesteinsbohrers (8) mit einem massiven Kern (28), der eine innere Öffnung aufweist, durch die der Schneidkonus drehbar auf dem Achszapfen des Gesteinsbohrers (8) angeordnet werden kann, wobei der Kern (28) auf seiner äußeren Oberfläche eine Vielzahl von Eintiefungen (30) aufweist; und mit einer Vielzahl von harten Schneideinsätzen (26) in den Eintiefungen (30) im Kern (28), dadurch gekennzeichnet, daß die Einsätze (26) in die jeweiligen Eintiefungen in einem Nicht-Preßsitz eingefügt sind und weiterhin dadurch, daß eine Sintertechnikeinhüllung (34) vorgesehen ist, die metallisch an die äußere Oberfläche des Kerns und an die Schneideinsätze (26) gebunden ist, um die Schneideinsätze (26) in dem Kern (28) zu halten.

2. Schneidkonus nach Anspruch 1, dadurch gekennzeichnet, daß die Einhüllung (34) eine andere Zusammensetzung als der Kern (28) hat und/oder härter als der Kern (28) ist.

3. Schneidkonus nach Anspruch 1 oder Anspruch 2, dadurch gekennzeichnet, daß die Einhüllung (34) eine Härte von mindestens 50 Rockwell-C-Härteeinheiten (HRC) hat.

4. Schneidkonus nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der Kern (28) ein Massivstahlkern ist oder Weichstahl enthält.

5. Schneidkonus nach Anspruch 4, dadurch gekennzeichnet, daß das Material des Kerns (28) aus einer Gruppe ausgewählt wird, die 9315- und 4815-Stahl nach AISI-Norm enthalten (Amerikanisches Eisen- und Stahl-Institut).

6. Schneidkonus nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Einhüllung (34) aus Werkzeugstahl besteht oder aus einem Material hergestellt ist, das aus einer Gruppe ausgewählt ist, die aus D2-, M2-, M42- und S2-Werkzeugstahl besteht; aus einer Werkzeugstahlmischung aus im wesentlichen 2,45 Prozent Kohlenstoff, 0,5 Prozent Mangan, 0,9 Prozent Silizium, 5,25 Prozent Chrom, 1,3 Prozent Molybdän, 9 Prozent Vanadium, 0,07 Prozent Schwefel und 80,53 Prozent Eisen; aus einem Wolfram Kobalt-Karbid Keramik-Metall-Verbundwerkstoff, einerm Titan Nickel-Molybdän-Karbid Keramik-Metall-Verbundwerkstoff und Titan Eisenlegierung-Karbid Keramik-Metall-Verbundwerkstoffen.

7. Schneidkonus nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Einhüllung (34) metallurgisch durch einen heißen isostatischen Druckprozeß mit dem Kern (28) gebunden ist.

8. Schneidkonus nach einem der vorhergehenden Ansprüche, weiterhin dadurch gekennzeichnet, daß Mittel auf den Schneideinsätzen (26) angebracht sind, um im wesentlichen die Diffusion von Kohlenstoff von den Schneideinsätzen (26) in den Kern (28) und die Einhüllung (34) zu verhindern, während die Einhüllung (34) zum metallurgischen Verbinden desselben mit dem Kern (28) aufgeheizt wird.

9. Schneidkonus nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß eine Schicht (44) zwischen den Schneieinsätzen (26) und dem Kern (28) angeordnet ist, deren Material aus einer Gruppe ausgewählt ist, die Graphit, Kupfer, Kupferlegierungen, Silber, Silberlegierungen, Kobalt, Kobaltlegierungen, Tantal, Tantallegierungen, Gold, Goldlegierungen,

Palladium, Palladiumlegierungen, Platin, Platinlegierungen, Nickel und Nickellegierungen umfaßt.

10. Schneidkonus nach Anspruch 9, dadurch gekennzeichnet, daß die Schicht (44) ungefährt 25 bis 100 Mikrometer dick ist.

11. Schneidkonus nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß in der inneren Öffnung eine Ausfütterung vorgesehen ist, wobei die besagte Ausfütterung eine Lagerfläche, die härter als der Kern ist, aufweist, um den Konus drehbar auf dem Achszapfen anzuordnen.

12. Schneidkonus nach Anspruch 11, dadurch gekennzeichnet, daß die harte Ausfütterung auf dem Kern durch einen Sinterprozeß abgelagert ist.

13. Verfahren zur Herstellung eines Schneidkonus (10) für einen Gesteinsbohrer (8) von dem Typ, der mindestens einen Achszapfen (14) aufweist, auf dem der Schneidkonus (10) drehbar angeordnet ist, und bei dem der Schneidkonus (10) über eine Vielzahl von Wolfram-Karbid-Schneideinsätzen (26) verfügt, wobei das Verfahren die Verfahrensschritte umfaßt: Einsetzen einer Vielzahl von Schneideinsätzen (26) in die Eintiefungen (30), die in der äußeren Oberfläche eines massiven Kerns (28) des Schneidkonus angeordnet sind, ohne einen Preßsitz, Ablagern einer Pulvermischung auf der äußeren Oberfläche des Kerns, so daß die Schneideinsätze (26) teilweise eingebettet sind, Pressen des Pulvers in einer Form, um im wesentlichen die gewünschte fertige äußere Gestaltung des Schneidkonus anzupassen; und Aufheizen des Pulvers zu einer unter seinem Schmelzpunkt liegenden Temperatur, um das besagte Pulver mit dem Konus metallurgisch zu verbinden und dadurch eine äußere Umhüllung (34) des Schneidkonus zu schaffen, damit die Schneideinsätze (26) in den Eintiefungen gehalten werden.

14. Verfahren nach Anspruch 13, gekennzeichnet durch den Verfahrensschritt des Ablagerns einer dünnen Schicht (44) eines Materials, das aus der Gruppe ausgewählt wird, die Graphit, Kupfer, Kupferlegierungen, Silber, Silberlegierungen, Kobalt, Kobaltlegierungen, Tantal, Tantallegierungen, Gold, Goldlegierungen, Palladium, Palladiumlegierungen, Platin, Platinlegierungen, Nikkel und Nickellegierungen umfaßt, auf den Schneideinsätzen, bevor die Schneideinsätze in die Eintiefungen des Kerns eingebracht werden.

15. Verfahren nach Anspruch 14, dadurch gekennzeichnet, daß der Verfahrensschritt des Ablagerns einer dünnen Schicht (44) Materials auf den Schneideinsätzen Galvanisieren umfaßt.

16. Verfahren nach Anspruch 14 oder Anspruch 15, dadurch gekennzeichnet, daß das Material der dünnen Schicht (44) aus einer Gruppe ausgewählt wird, die Nickel und Nickellegierungen umfaßt.

17. Verfahren nach einem der Ansprüche 13 bis 16, dadurch gekennzeichnet, daß die Pulvermischung der Einhüllung (34) aus einer Gruppe ausgewählt wird, die aus Wolfram Kobalt-Karbid Keramik-Metall-Verbundwerkstoff, Titan Nickel-Molybdän-Karbid Keramik-Metall-Verbundwerkstoff, Titan Eisenlegierung-Karbin Keramik-Metall-Verbundwerkstoff, D2-, M2-, M42-, S2-Werkzeugstählen und einer Werkzeugstahlmischung aus im wesentlichen, 2,45 Prozent Kohlenstoff, 0,5 Prozent Mangan, 0,9 Prozent Silizium, 5,25 Prozen Chrom, 9 Prozent Vanadium, 1,3 Prozent Molybdän, 0,07 Prozent Schwefel und 80,53 Prozent Eisen besteht.

18. Verfahren nach einem der Ansprüche 13 bis 17, dadurch gekennzeichnet, daß die Verfahrensschritte des Aufheizens und Pressens als heißes isostatisches Pressen in einem Bereich von 15.000 to 30.000 Pfund pro Quadratzoll ($2*10^6$ bis $4*10^6$ Pascal) durchgeführt werden.

19. Verfahren nach einem der Ansprüche 13 bis 17, durch den Verfahrensschritt gekennzeichnet, daß eine zweite Pulvermischung innerhalb einer inneren Öffnung des massiven Kerns (28) angeordnet wird und daß die zweite Pulvermischung gepreßt und aufgeheizt wird, um dieselbe mit dem Kern metallurgisch zu verbinden, um eine harte innere Lagerfläche innerhalb des Kerns (28) zu schaffen.

20. Verfahren um mindestens einen Sinterkarbideinsatz (26) mit einem Stahlkern (28) zu verbinden, das die Verfahrensschritte umfaßt: Anordnen eines solchen Karbideinsatzes (26) in einer Eintiefung (30), die in der äußeren Oberfläche eines massiven Kerns aus Stahl eingeformt ist, wobei die Eintiefung (30) dimensioniert ist, um den Sinterkarbideinsatz (26) ohne wesentliche Pressung aufzunehmen; Aufbringen einer Pulvermischung auf der äußeren Oberfläche des Stahlkerns (28), so daß die gesinterten Schneideinsätze (26) teilweise eingebettet sind; Pressen des Pulvers in einer Form, um im wesentlichen die gewünschte fertige äußere Gestaltung anzupassen; und Aufheizen des Pulvers, um das besagte Pulver mit dem Stahlkern (28) metallurgisch zu verbinden und dadurch eine äußere Einhüllung (34) des Stahlkerns (28) zu schaffen, um den Schneideinsatz (26) in der Eintiefung (30) zu halten.

21. Verfahren nach Anspruch 20, weiterhin gekennzeichnet durch den Verfahrensschritt des Ablagerns einer dünnen Schicht (44) eines Materials, das aus einer Gruppe ausgewählt ist, die Graphit, Kupfer, Kupferlegierungen, Silber, Silberlegierungen, Kobalt, Kobaltlegierungen, Tantal, Tantallegierungen, Gold, Goldlegierungen, Palladium, Palladiumlegierungen, Platin, Platinlegierungen, Nickel und Nickellegierungen umfaßt, auf dem Karbideinsatz (26), bevor der Karbineinsatz (26) in die Eintiefung (30) eingebracht wird.

22. Verfahren nach Anspruch 21, dadurch gekennzeichnet, daß der Verfahrensschritt des Ablagerns einer dünnen Schicht (44) von dem Material auf dem Schneideinsatz (26) Galvanisieren umfaßt.

23. Verfahren nach Anspruch 21, dadurch gekennzeichnet, daß das Material der dünnen Shicht (44) aus einer Gruppe ausgewählt wird, die Nickel und Nickellegierungen umfaßt.

24. Verfahren nach einem der Ansprüche 20 bis 23, bei dem die Pulvermischung so gewählt wird,

daß sie auch mit dem Karbineinsatz (26) metallurgisch verbunden wird.

25. Verfahren nach einem der Ansprüche 20 bis 23, bei dem die Pulvermischung der Umhüllung aus einer Gruppe ausgewählt wird
die aus Wolfram Kobalt-Karbin Keramik-Metall-Verbundwerkstoff, Titan Nickel-Molybdän-Karbid Keramik-Metall-Verbundwerkstoff, Titan Eisenlegierung-Karbid Keramik-Metall-Verbundwerkstoff, D2-, M2-, M42-, S2-Werkzeugstählen und eine Werkzeugstahlmischung aus im wesentlichen 2,45 Gewichtsprozent Kohlenstoff, 0,5 Gewichtsprozent Mangan, 0,9 Gewichtsprozent Silizium, 5.25 Gewichtsprozent Chrom, 9 Gewichtsprozent Vanadium, 1,3 Gewichtsprozent Molybdän, 0,07 Gewichtsprozent Schwefel und 80,53 Gewichtsprozent Eisen besteht.

26. Verfahren nach einem der Ansprüche 20 bis 25, weiterhin gekennzeichnet durch den Verfahrensschritt des Härtens der Einhüllung zu einer Härte von mindestens 50 Rockwell-C-Härteeinheiten (HRC).

27. Verfahren nach einem der Ansprüche 20 bis 26, bei dem die Verfahrensschritte des Aufheizens und Pressens als heißes isostatisches Pressen in einem Bereich von 15.000 bis 30.000 Pfund pro Quadratzoll ($2*10^6$ bis $4*10^6$ Pascal) durchgeführt werden.

Revendications

1. Outil conique de coupe (10) destiné à être monté sur un tourillon d'un trépan à cônes (8) comportant un noyau solide (28) incluant une ouverture intérieure grâce à laquelle l'outil conique de coupe peut être monté rotatif sur un tourillon du trépan à cônes (8), ledit noyau (28) comportant également sur sa surface extérieure une pluralité de cavités (30), et une pluralité d'inserts durs de coupe (26) dans les cavités (30) du noyau (28), caractérisé en ce que les inserts (26) s'adaptent dans les cavités respectives avec un ajustement qui ne soit pas serré et caractérisé en outre par un revêtement métallique pulvérulent (34) relié métalliquement à la surface externe du noyau et aux inserts de coupe (26) pour maintenir les inserts de coupe (26) dans le noyau (28).

2. Outil conique de coupe selon la revendication 1, caractérisé en ce que le revêtement (34) a une composition différente du noyau (28) et/ou est plus dur que le noyau (28).

3. Outil conique de coupe selon la revendication 1 ou la revendication 2, caractérisé en ce que le revêtement a une dureté de au moins 50 unités, en dureté Rockwell C.

4. Outil conique de coupe selon l'une quelconque des revendications précédentes, caractérisé en ce que le noyau (28) est un noyau solide en acier ou comporte de l'acier doux.

5. Outil conique de coupe selon la revendication 4, caractérisé en ce que le matériau du noyau (28) est choisi dans le groupe consistant en acier AISI 9315 et AISI 4815.

6. Outil conique de coupe selon l'une quelconque des revendications précédentes, caractérisé en ce que le revêtement (34) comporte de l'acier à outils ou est un matériau choisi dans un groupe comprenant l'acier à outil D2, M2, M42, S2; une composition d'acier à outil consistant essentiellement en 2,45 pour cent de carbone, 0,5 pour cent de manganèse, 0,9 pour cent de silicium, 5,25 pour cent de chrome, 1,3 pour cents de molybdène, 9 pour cent de vanadium, 0.07 pour cent de soufre et 80,53 pour cent de fer; un cermet de carbure de tungstène et de cobalt, un cermet de carbure de titane, de nickel et de molybdène et des cermets de carbure de titane et de ferro-alliages.

7. Outil conique de coupe selon l'une quelconque des revendications précédentes, caractérisé en ce que le revêtement (34) a été relié métalliquement au noyau (28) par un procédé de pressage isostatique à chaud.

8. Outil conique de coupe selon l'une quelconque des revendications précédentes, caractérisé en outre par des moyens disposés sur les inserts de coupe (26) pour éviter substantiellement la diffusion de carbone des inserts de coupe (26) vers le noyau (28) et le révétement (34) pendant le chauffage du revêtement (34) pour lier métalliquement celui-ci au noyau (28).

9. Outil conique de coupe selon l'une quelconque des revendications précédentes, caractérisé par une couche (44) disposée entre les inserts de coupe (26) et le noyau (28), dont le matériau est choisi dans un groupe comprenant le graphite, de cuivre, les alliages de cuivre, l'argent, les alliages d'argent, le cobalt, les alliages de cobalt, le tantale, les alliages de tantale, l'or, les alliages d'or, le palladium, les alliages de palladium, le platine, les alliages de platine, le nickel et les alliages de nickel.

10. Outil conique de coupe selon la revendication 9, caractérisé en ce que la couche (44) a approximativement une épaisseur de 25 à 100 microns.

11. Outil conique de coupe selon l'une quelconque des revendications précédentes, caractérisé par un garnissage incorporé dans l'ouverture intérieure, ledit garnissage comprenant une surface de palier pour monter à rotation le cône sur le tourillon et étant plus dure que le noyau.

12. Outil conique de coupe selon la revendication 11, caractérisé en ce que le garnissage dur a été disposé sur le noyau par un procédé de pulvérisation métallique.

13. Procédé pour la réalisation d'un outil conique de coupe (10) pour un trépan à cônes (8) du type ayant au moins un tourillon (14) sur lequel l'outil conique de coupe (10) est monté à rotation, l'outil conique de coupe (10) ayant une pluralité d'inserts de coupe (26) en carbure de tungstène, procédé caractérisé par les étapes consistant à:

—disposer une pluralité d'inserts de coupe (26) dans des cavités (30) formées dans la surface externe d'un noyau solide (28) de l'outil conique de coupe avec un ajustement non serré;

—déposer une composition de poudre sur la surface externe du noyau de manière à enrober partiellement les inserts de coupe (26);

—presser la poudre dans un moule de manière à correspondre substantiellement à la configuration finale extérieure désirée pour l'outil conique de coupe, et

—chauffer la poudre à une température inférieure à son point de fusion pour lier métalliquement ladite poudre au cône et ainsi réaliser un revêtement extérieur (34) de l'outil conique de coupe pour retenir les inserts de coupe (26) dans les cavités.

14. Procédé selon la revendication 13, caractérisé en ce qu'il comporte l'étape consistant à déposer une couche mince (44) d'un matériau choisi dans un groupe consistant en le graphite, le cuivre, les alliages de cuivre, l'argent, les alliages d'argent, le cobalt, les alliages de cobalt, le tantale, les alliages de tantale, l'or, les alliages d'or, le palladium, les alliages de palladium, le platine, les alliages de platine, le nickel et les alliages de nickel sur les inserts de coupe avant de disposer les inserts de coupe dans les cavités du noyau.

15. Procédé selon la revendication 14, caractérisé en ce que l'étape de dépose d'une couche mince (44) de matériau sur les inserts de coupe fait intervenir l'électro-déposition.

16. Procédé selon la revendication 14 ou la revendication 15, caractérisé en ce que le matériau de la couche mince (44) est choisi dans un groupe consistant en le nickel et les alliages de nickel.

17. Procédé selon l'une quelconque des revendications 13 à 16, caractérisé en ce que la composition de poudre du revêtement (34) est choisie dans un groupe consistant en cermet carbure de tungstène-cobalt, cermet carbure de titane-nickel-molybdène, cermet carbure de titane-ferro-alliage, aciers à outils D2, M2, M42, S2 et une composition d'acier à outil se composant essentiellement de 2,45 pour cent de carbone, 0,5 pour cent de manganèse, 0,9 pour cent de silicium, 5,25 pour cent de chrome, 9,0 pour cent de vanadium, 1,3 pour cent de molybdène, 0,07 pour cent de soufre et 80,53 pour cent de fer.

18. Procédé selon l'une quelconque des revendications 13 à 17, caractérisé en ce que les étapes de chauffage et de pressage sont conduites en pressage isostatique à chaud dans le domaine de 15 000 à 30 000 PSI (2×10^6 à 4×10^6 Pa).

19. Procédé selon l'une quelconque des revendications 13 à 17, caractérisé en ce qu'il comporte l'étape consistant à placer une seconde composition de poudre dans une ouverture intérieure du noyau solide (28), et à presser et chauffer la seconde composition de poudre pour lier métalliquement celle-ci au noyau afin de réaliser une surface de palier intérieure dure à l'intérieur dudit noyau (28).

20. Procédé pour fixer au moins un insert (26) en carbure cémenté à un noyau (28) en acier comprenant les phases consistant à:

—placer un tel insert (26) en carbure dans une cavité (30) formée dans la surface externe d'un noyau solide en acier, la cavité (30) étant dimensionnée pour accepter l'insert (26) en carbure cémenté sans ajustment substantiellement serré,

—appliquer une composition de poudre sur la surface externe du noyau d'acier (28) pour enrober partiellement l'insert (26) en carbure cémenté,

—presser la poudre dans un moule pour correspondre substantiellement à la configuration finale extérieure désirée et,

—chauffer la poudre pour lier métalliquement ladite poudre au noyau en acier (28) et ainsi réaliser un revêtement extérieur (34) du noyau d'acier (28) pour retenir l'insert en carbure (26) dans la cavité (30).

21. Procédé selon la revendication 20, caractérisé en ce qu'il comporte en outre l'étape consistant à déposer une couche mince (44) d'un matériau choisi dans un groupe consistant en le graphite, le cuivre, les alliages de carbure, l'argent, les alliages d'argent, le cobalt, les alliages de cobalt, le tantale, les alliages de tantale, l'or, les alliages d'or, le palladium, les alliages de palladium, le platine, les alliages de platine, le nickel et les alliages de nickel sur les inserts de carbure (26) avant de disposer les inserts de carbure (26) dans la cavité (30).

22. Procédé selon la revendication 21, caractérisé en ce que l'étape de dépose d'une couche mince (44) de matériau sur l'insert de carbure (26) fait intervenir l'électro-déposition.

23. Procédé selon la revendication 21, caractérisé en ce que le matériau de la couche mince (44) est choisi dans un groupe consistant en le nickel et les alliages de nickel.

24. Procédé selon l'une quelconque des revendications 20 à 23, dans lequel la composition de poudre est choisie pour également se lier métalliquement à l'insert de carbure (26).

25. Procédé selon l'une quelconque des revendications 20 à 23, dans lequel la composition de poudre du revêtement est choisie dans un groupe consistant en cermet carbure de tungstène-cobalt, cermet carbure de titane-nickel-molybdène, cermet carbure de titane-ferro-alliage, aciers à outils D2, M2, M42, S2 et une composition d'acier à outil se composant essentiellement de 2,45 pour cent de carbone, 0,5 pour cent de manganèse, 0,9 pour cent de silicium, 5,25 pour cent de chrome, 9,0 pour cent de vanadium, 1,3 pour cent de molybdène, 0,07 pour cent de soufre et 80,53 pour cent de fer.

26. Procédé selon l'une quelconque des revendications 20 à 25, comprenant en outre l'étape de durcissement du revêtement à une dureté d'au moins 50 Rockwell C.

27. Procédé selon l'une quelconque des revendications 20 à 26, dans lequel les phases de chauffage et de pressage sont conduites sous forme d'un pressage isostatique à chaud dans la zone de 15 000 à 30 000 PSI (2×10^6 à 4×10^6 Pa).

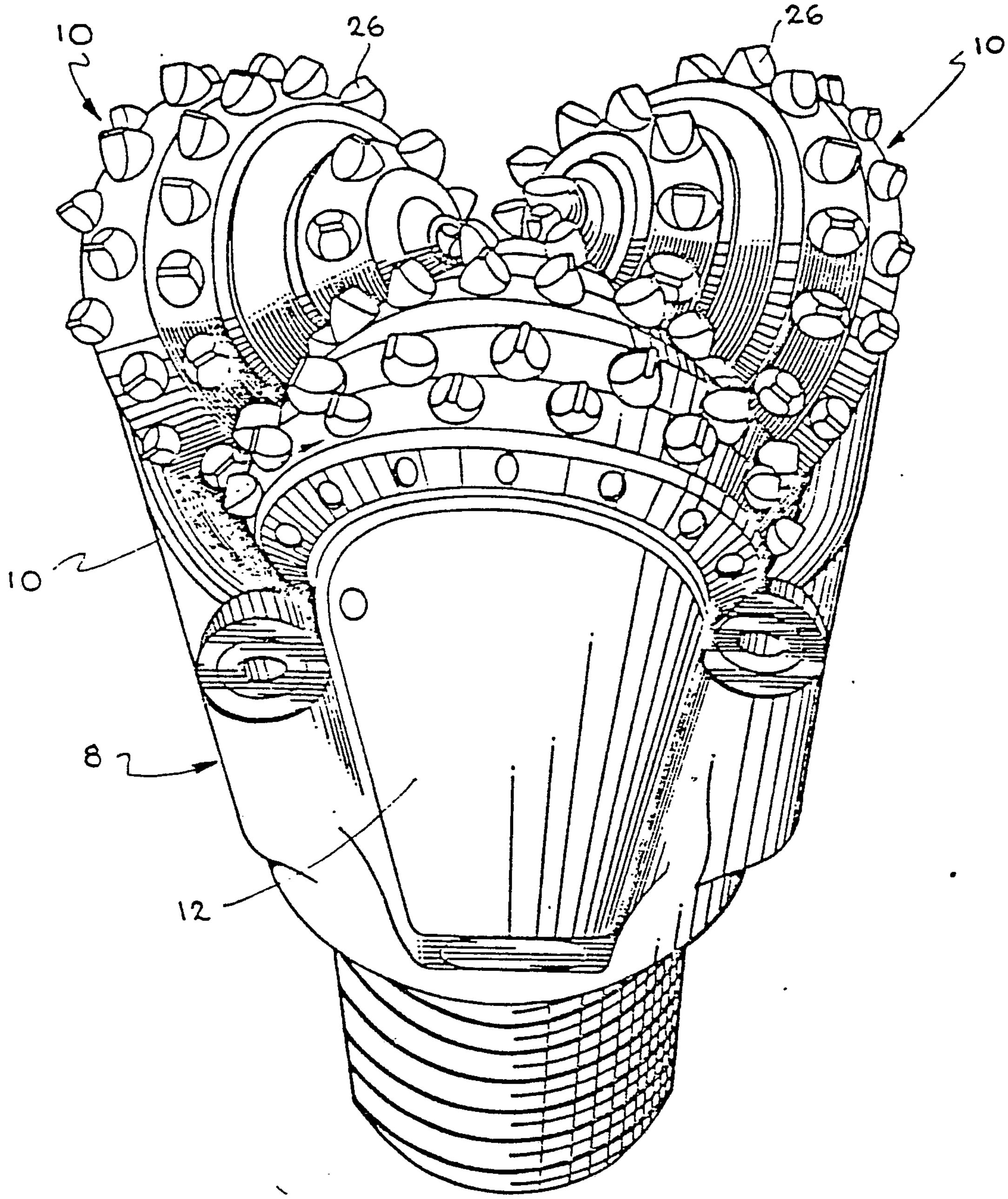

Fig. 1

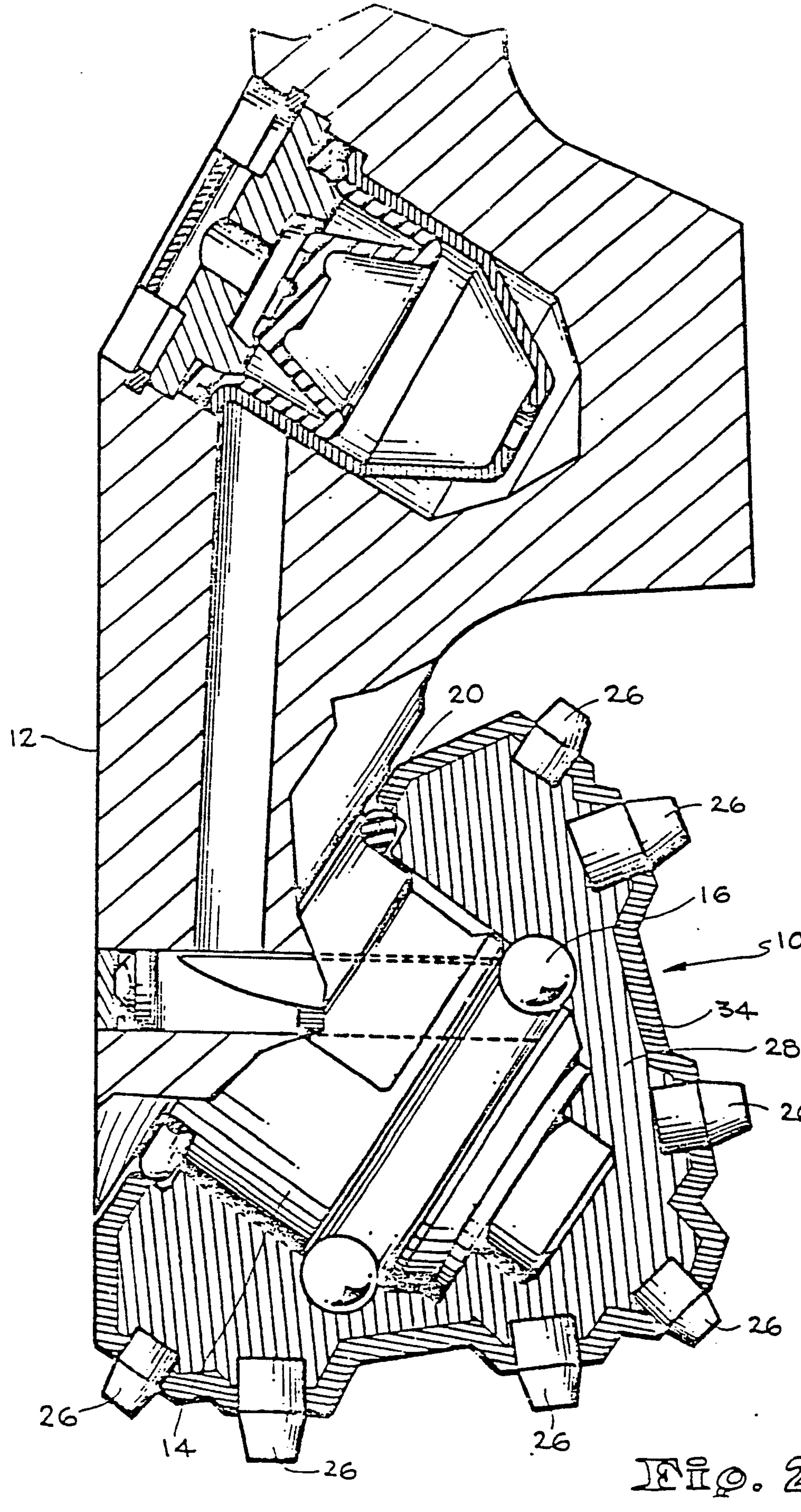

Fig. 2

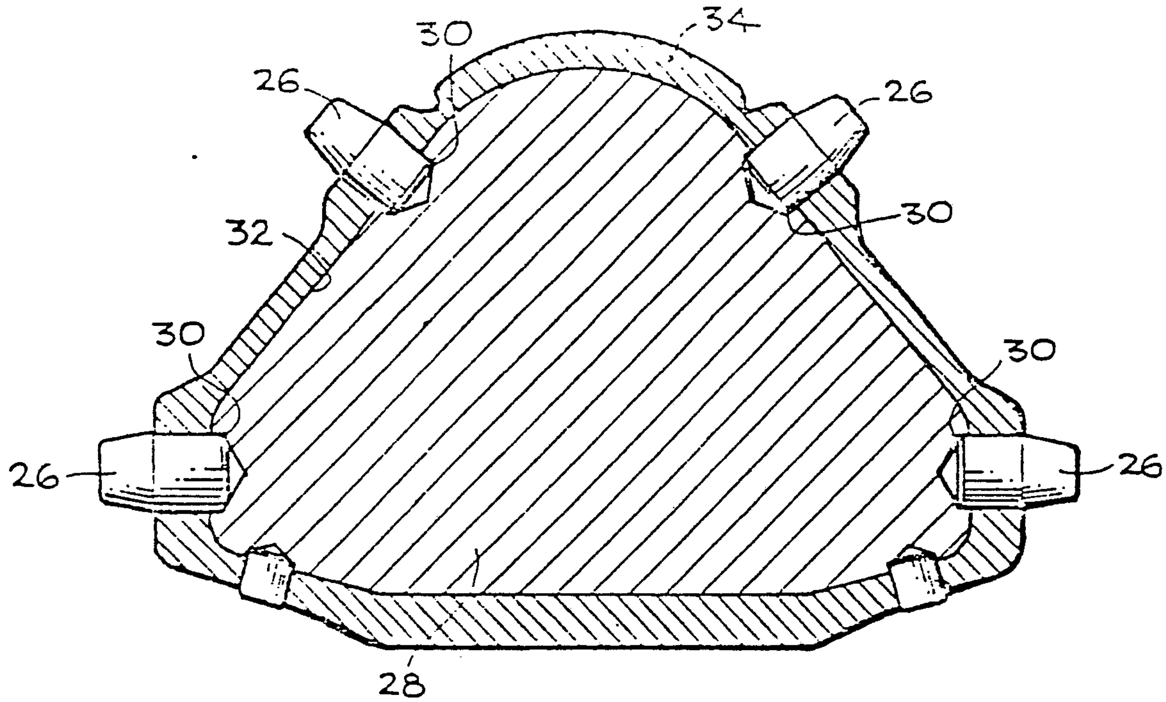

Fig. 3

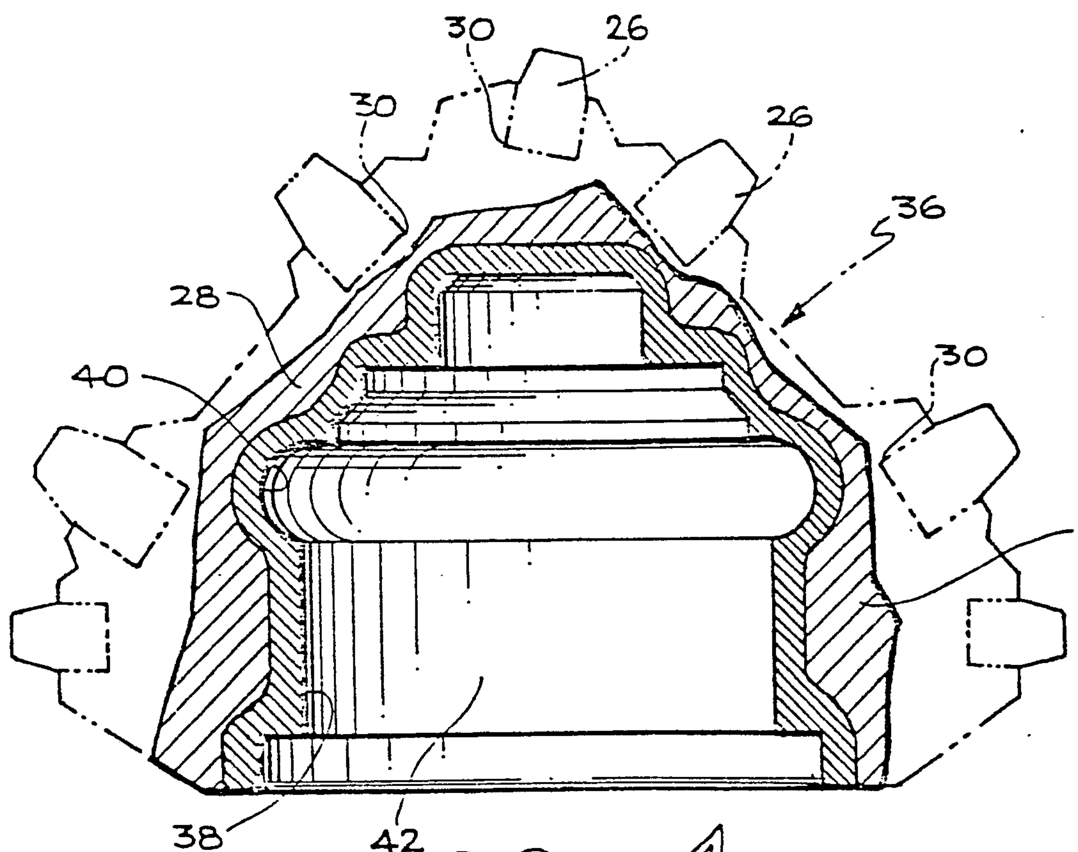

Fig. 4

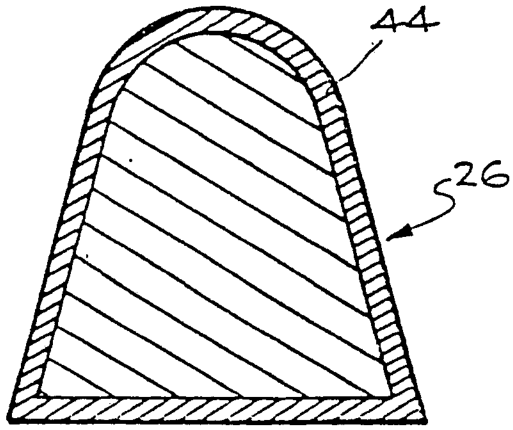

Fig. 5

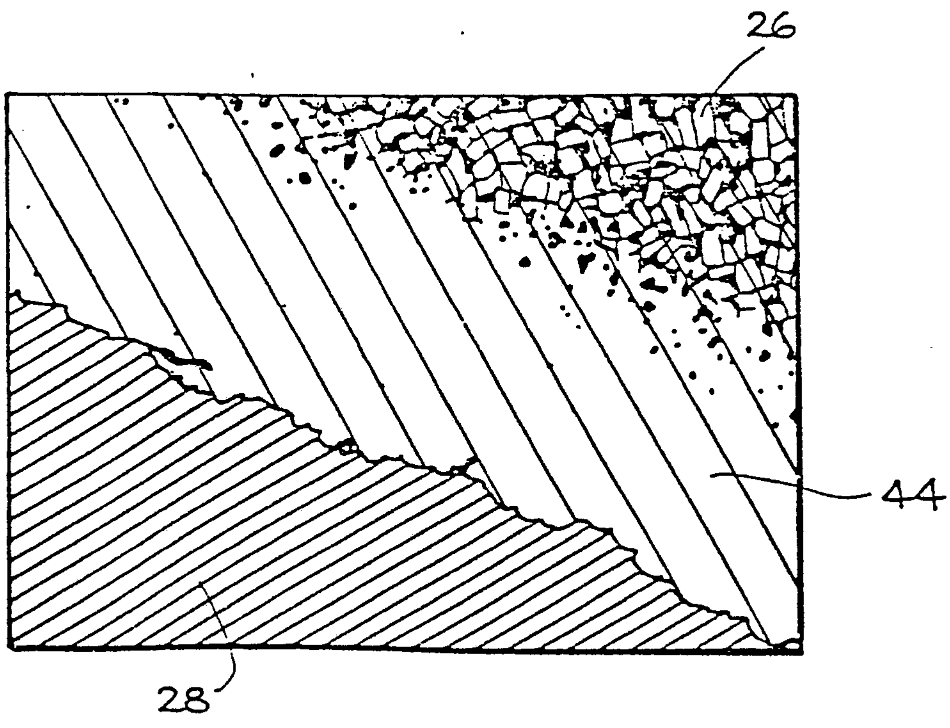

Fig. 6