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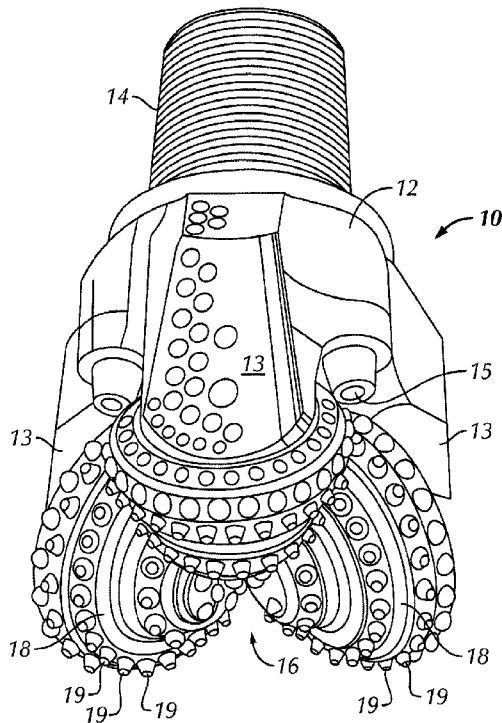


FIG. 1

(57) Abstract: A rock bit including a bit body having an upper end adapted to be detachably secured to a drill string; at least one roller cone; at least one cutting element disposed on the at least one roller cone; and a wear resistant weld overlay on at least a portion of an external surface of the rock bit, wherein the wear resistant weld overlay comprises a steel nanocrystalline material having at least one metal borocarbide precipitant dispersed therein is disclosed.

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WEAR RESISTANT WELD OVERLAY ON DOWNHOLE MINING COMPONENTS

BACKGROUND OF INVENTION

Field of the Invention

[0001] Embodiments disclosed herein relate generally to an improved rotary mining bit for boring a borehole in an earthen formation. In particular, the present disclosure relates to an improved weld overlay material for use in mining bits or other earth boring cutting tools, or downhole equipment.

Background Art

[0002] In mining a borehole for minerals or in search of oil or gas, earth-boring drill bits (or rock bits) are commonly used. Typically, an earth-boring drill bit is mounted on the lower end of a drill string and is rotated by rotating the drill string at the surface. With weight applied to the drill string, the rotating drill bit engages an earthen formation and proceeds to form a borehole along a predetermined path toward a target zone.

[0003] The borehole environment in which a rotary rock bit is operated is extremely harsh and may decrease the life of the bit. Pressurized air, although there is usually some water present, may be circulated downwardly through passages in the bit to the load bearing areas to cool or lubricate or otherwise condition the bearings and also through jetting ports in the bit to remove cuttings from the borehole.

[0004] Rotary bits typically include three cone-shaped members adapted to connect to the lower end of a drill string. Roller cone bits include one or more roller cones rotatably mounted on steel journals or pins integral with the bit body. These roller cones are generally formed of a relatively soft metal (*e.g.*, steel) and have a plurality of relatively hard cutting elements attached thereto that crush, gouge, and scrape rock at the bottom of a hole being drilled. Several types of roller cone drill bits are available for drilling wellbores through earth formations, including insert bits (*e.g.*, tungsten carbide insert bit (“TCI bit”)) and “milled tooth” bits.

[0005] When drilling a hard formation, a TCI bit is generally used due to the inserts’ relative hardness. The carbide inserts are normally mounted in the relatively soft

metal (*e.g.*, steel) that forms the body of the rolling cone. While steel body bits may have toughness and ductility properties which make them resistant to cracking and failure due to impact forces generated during drilling, steel is more susceptible to erosive wear or abrasion caused by contact with the formation and by high-velocity drilling fluids and formation fluids which carry abrasive particles, such as sand, rock cuttings, and the like. Generally, steel body bits are coated with a more erosion-resistant material, such as tungsten carbide, to improve their erosion resistance. However, tungsten carbide and other erosion-resistant materials are relatively brittle. During use, a thin coating of the erosion-resistant material may crack, peel off or wear, exposing the softer steel body which is then rapidly eroded. When the material supporting the inserts is substantially eroded away, the drilling forces may either break the inserts or may force them out of the cone body. As a result the bit is no longer effective in cutting the formation. Moreover, the inserts that break off from the rolling cone may further damage other inserts, the rolling cones, or other parts of the bit, eventually leading to a catastrophic failure.

[0006] Typically, a hardfacing material is applied, such as by arc or gas welding, to the exterior surface of the drill bit to protect the bit against erosion and abrasion. The hardfacing material typically includes one or more metal carbides, which are bonded to the steel body by a metal alloy (“binder alloy”). In effect, the carbide particles are suspended in a matrix of metal forming a layer on the surface of the bit. The carbide particles give the hardfacing material hardness and wear resistance, while the matrix metal provides fracture toughness to the hardfacing.

[0007] Various hardfacing materials and methods are known in the art for minimizing wear on various parts of a drill bit. For example, U.S. Patent Nos. 4,836,307 issued to Keshavan et al., and 5,944,127 and 6,659,206 both issued to Liang et al. disclose various hardfacing material compositions and particle size distributions suitable for use in hardfacing inserts, teeth, or roller cones. In addition, various methods have been developed for applying hardfacing coatings to wear prone surfaces on rock bits or inserts. These methods, for example, include thermal spraying, plasma arc welding, laser cladding, or other conventional welding methods.

[0008] Many factors affect the effectiveness and durability of a hardfacing composition in a particular application. These factors include the chemical composition and physical structure (size, shape, and particle size distribution) of the carbides, the chemical composition and microstructure of the matrix metal or alloy, and the relative proportions of the carbide materials to one another and to the matrix metal or alloy. In addition, the chemical compositions of the hardfacing materials also affect the strength of the bonding between the hardfacing layers and the underlying substrates. The metal carbide most commonly used in hardfacing is tungsten carbide. Small amounts of tantalum carbide and titanium carbide may also be present in such material, although these other carbides may be considered to be deleterious.

[0009] Generally, altering a composition to enhance the wear resistance of the hardfacing overlay, typically results in a decrease of the fracture toughness of the overlay and reduction in the bonding strength between the hardfacing and the substrate. On the other hand, altering a composition to enhance the fracture toughness and bonding strength between the hardfacing and the substrate, typically results in a decrease in the wear resistance of the hardfacing overlay. Thus, the hardfacing materials used in the protection of drill bits or roller cones often represent a compromise between the desired properties, i.e., wear resistance, fracture toughness, and bonding strength.

[0010] Regardless of the type of hardfacing material used, designers continue to seek improved properties (such as improved wear resistance, thermal resistance, etc.) in the hardfacing materials. Unfortunately, increasing wear resistance usually results in a loss in fracture toughness, or vice-versa. Typically, to achieve higher wear resistance (mainly against abrasion or erosion) the hardfacing composition may be designed to have a maximum amount of carbide content in the metallic matrix. However, a hardfacing with higher hardness and higher carbide content is more prone to cracking and delamination.

[0011] Although the prior art hardfacing application techniques are capable of providing improved wear resistance to rock bits, there exists a need for a hardfacing having increased toughness and hardness without increased tendency for cracking or delamination in the hardfacing.

SUMMARY OF INVENTION

- [0012]** In one aspect, embodiments disclosed herein relate to a rock bit, comprising a bit body having an upper end adapted to be detachably secured to a drill string; at least one roller cone; at least one cutting element disposed on the at least one roller cone; and a wear resistant weld overlay on at least a portion of an external surface of the rock bit, wherein the wear resistant weld overlay comprises a steel nanocrystalline material having at least one metal borocarbide precipitant dispersed therein.
- [0013]** In another aspect, embodiments disclosed herein relate to a rock bit, comprising a bit body having an upper end adapted to be detachably secured to a drill string; at least one roller cone; at least one cutting element disposed on the at least one roller cone; and a wear resistant weld overlay on at least a portion of an external surface of the rock bit, wherein the wear resistant weld overlay comprises a steel nanocrystalline material having a hardness of at least 60 HRc.
- [0014]** In another aspect, embodiments disclosed herein relate to a rock bit, comprising a bit body having an upper end adapted to be detachably secured to a drill string; at least one roller cone; at least one cutting element disposed on the at least one roller cone; and a wear resistant weld overlay on at least a portion of an external surface of the rock bit, wherein the wear resistant weld overlay comprises a steel nanocrystalline material having a surface roughness of about 0.8 μm or better (Ra).
- [0015]** In another aspect, embodiments disclosed herein relate to a downhole component, comprising a tubular body comprising upper and lower ends adapted to be detachably secured to adjacent drilling tools or pipe; and a wear resistant weld overlay on at least a portion of an external surface of the downhole component, wherein the wear resistant weld overlay comprises a steel nanocrystalline material having at least one metal borocarbide precipitant dispersed therein.
- [0016]** In another aspect, embodiments disclosed herein relate to a stabilizer, comprising a tubular body comprising upper and lower ends adapted to be detachably secured to adjacent drilling tools or pipe; and a wear resistant weld overlay on at least a portion of an external surface of the stabilizer, wherein the wear

resistant weld overlay comprises a steel nanocrystalline material having at least one metal borocarbide precipitant dispersed therein.

[0017] Other aspects and advantages of the invention will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF DRAWINGS

[0018] FIG. 1 shows an example of a rotary type rock bit according to embodiments of the present disclosure.

[0019] FIG. 2 shows an example of a downhole component according to embodiments of the present disclosure.

[0020] FIG. 3 shows an example of a downhole component according to embodiments of the present disclosure.

[0021] FIG. 4 shows an example of a downhole component according to embodiments of the present disclosure.

[0022] FIG. 5 shows an example of a downhole component according to embodiments of the present disclosure.

[0023] FIG. 6 shows an example of a downhole component according to embodiments of the present disclosure

DETAILED DESCRIPTION

[0024] In one aspect, embodiments disclosed herein relate generally to downhole components having a superior wear resistant weld overlay provided on at least one external surface of a bit or other downhole component. Specifically, providing a wear resistant weld overlay that has improved hot hardness properties and higher wear resistance in comparison with conventional techniques may minimize the wear to the external surfaces of the bit or other downhole component and thus extend the life of the bit or other downhole component. Such a weld overlay, in accordance with the embodiments of the present disclosure, which is applied to external bit (or other downhole component) surfaces, may include a steel nanocrystalline material, *i.e.*, a steel material having nanocrystalline grain sizes.

[0025] “Steel,” as used herein, refers to any iron-based alloy in which no other single element (besides iron) is present in excess of 30 weight percent, and for which the iron content amounts to at least 50 weight percent. Steel generally includes regular arrangements of atoms, with the periodic stacking arrangements forming 3-dimensional lattices which define the internal structure of the steel. The internal structure, also referred to as the microstructure, of conventional steel alloys is always metallic and polycrystalline (consisting of many crystalline grains). Typically, an increase in hardness can be accompanied by a corresponding decrease in toughness.

[0026] Steel is typically formed by cooling a molten alloy. For steel alloys, the rate of cooling will determine whether the alloy cools to form an internal structure that predominately comprises crystalline grains, or, in rare cases a structure which is predominately amorphous (a so-called metallic glass). Generally, it is found that if the cooling proceeds slowly (i.e. at a rate less than about 10^4 K/s), large grain sizes occur, while if the cooling proceeds rapidly (i.e. at rate greater than or equal to about 10^4 K/s, and preferably between 10^4 and 10^5 K/s) microcrystalline (or nanocrystalline) internal grain structures are formed (depending on the composition).

[0027] Some materials may be referred to in the art as metallic glass or an amorphous metallic material. An amorphous material generally has no long-range order of the positions of the atoms. If the cooling rate is faster than the rate at which molecules can organize into a more thermodynamically favorable crystalline state, then an amorphous solid will be formed. However, devitrification of an amorphous material may result in a crystalline (or amorphous) steel material having a nanocrystalline grain size. Such devitrification can be accomplished by heating the metallic glass to a temperature of from about 450 to 700°C. Such heating enables a solid state phase change wherein the amorphous phase of a metallic glass is converted to one or more crystalline (or amorphous) solid phases. The solid state devitrification of an amorphous enables uniform nucleation to occur throughout the metallic glass to form nanocrystalline grains within the glass. The metal matrix microstructure formed via the devitrification may comprise a steel matrix (iron with dissolved interstitials), with an intimate mixture of ceramic precipitates (transition metal

carbides, borides, silicides, etc.). The nanocrystalline scale metal matrix composite grain structure may enable a combination of mechanical properties which are improved compared to the properties which would exist with larger grain sizes or with the metallic glass. Such improved mechanical properties may include, for example, high strength, and high hardness coupled with maintained or improved ductility or toughness. However, it is also within the scope of the present disclosure that such nanocrystalline microstructure (a steel matrix (iron with dissolved interstitials) with an intimate mixture of ceramic precipitates (transition metal carbides, borides, silicides, etc.)) may result without devitrification.

[0028] Desired properties of microcrystalline grains (*i.e.*, grains having a size on the order of 10^{-6} meters) can frequently be improved by reducing the grain size to that of nanocrystalline grains (*i.e.*, grains having a size on the order of 10^{-9} meters). Thus, the steel nanocomposites used as a weld overlay in accordance with the present disclosure include a metallic material having a microstructure with a crystalline grain less than about 10 microns.

[0029] Thus, the steel nanocrystalline materials may be iron based alloys, such as those marketed under the name Superhard Steel Alloys™, available from The Nanosteel™ Company as well as a derivative of such a metallic glass-forming, iron alloy. Additionally, the weld overlay may include other alloys based on iron, or other metals, that are susceptible to forming metallic glass materials at critical cooling rates less than about 10^5 K/s. Accordingly, the alloy may solidify before significant growth of crystalline domains, thereby producing a nanocrystalline microstructure. The nanocrystalline scale metal matrix composite grain structure may advantageously enable a combination of mechanical properties that are improved compared to the properties which would exist with larger grain sizes or a metallic glass. Such improved mechanical properties may include, for example, high strength and high hardness, as well as a maintained or even increased toughness relative to materials comprising larger grain sizes or a metallic glass. Steel nanocrystalline materials that may be used as the weld overlay in embodiments of the present disclosure may include those described in U.S. Patent Nos. 6,689,234 and 6,767,419, and U.S. Patent Publication Nos. 2008/0053274, 2007/0029295, and 2005/0252586, all of which are herein incorporated by reference in their entirety.

[0030] An exemplary alloy may include a steel composition, comprising at least 50% iron and at least one element selected from the group consisting of Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W, Al, and the class of elements called rare earths including Y, Sc, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu; and at least one element selected from the group consisting of B, C, N, O, P and S. An exemplary mixture may comprise at least 55% iron, by weight, and comprise at least one element selected from the group consisting of B, C, Si and P. In particular embodiments, the mixture may comprise at least two of B, C and Si.

[0031] In other particular embodiments, the steel nanocrystalline material may include Cr, Mo, Nb, W, Al, B, C, Mn, Si, Fe, and combinations thereof. In a preferred embodiment, the steel nanocrystalline material may include up to about 20 weight percent Cr, up to about 10 weight percent Mo, up to about 10 weight percent Nb, up to about 10 weight percent W, up to about 5 weight percent Al, up to about 5 weight percent B, up to about 5 weight percent C, up to about 5 weight percent Mn, up to about 2 weight percent Si, and a balance of Fe. In another preferred embodiment, the weld overlay may include up to about 18 weight percent Cr, up to about 6 weight percent B, up to about 5 weight percent Al, up to about 5 weight percent Nb, up to about 2 weight percent C, up to about 2 weight percent Mn, up to about 2 percent Si, and a balance of Fe.

[0032] Additionally, as mentioned above, at least one transition metal carbides, borides, silicides, or borocarbide may precipitate out of the matrix during cooling of the alloy. Additionally, depending on the type of precipitant, it is hypothesized that some precipitants may also function as a grain growth inhibitor, to inhibit grain growth during cooling of the alloy. Such uniform and fine distribution of precipitants within the steels may result in the weld overlay having a smooth finished surface. In a particular embodiment, the weld overlay may have a surface roughness of 3.2 μm or better (Ra), and more preferably of 1.6 μm or better, and even more preferably of 0.8 μm or better.

[0033] Additionally or alternatively, the wear resistant weld overlay may have a porosity of less than about 5%, and more preferably less than 1%. Application techniques such as those described below may allow for the application of the wear resistant weld overlay to be very low in porosity and very high in bond strength. A

low porosity (*i.e.*, less than 1%) may be advantageous because it may reduce or prevent the pores from becoming interconnected, as is seen at higher porosity levels and which may behave similarly to a crack in the overlay. Further, interconnected pores may not be desirable particularly in wear environments as they may facilitate a higher rate of material removal and thus a higher rate of wear on the overlay.

[0034] Conventional rock bits typically have a hardfacing material applied to exterior surfaces to protect against erosion and abrasion. The hardfacing material typically includes one or more metal carbides, which are bonded to the steel body by a binder alloy. The carbide particles are suspended in a matrix of metal forming a layer on the surface of the bit. Although the carbide particles are used increase the hardness and wear resistance of the hardfacing material, enhancing the wear resistance of the hardfacing overlay typically results in a decrease of the fracture toughness of the overlay and reduction in the bonding strength between the hardfacing and the substrate. On the other hand, altering a composition to enhance the fracture toughness and bonding strength between the hardfacing and the substrate, typically results in a decrease in the wear resistance of the hardfacing overlay. Thus, the hardfacing materials used in the protection of conventional rock bits often represent a compromise between the desired properties, *i.e.*, wear resistance, fracture toughness, and bonding strength.

[0035] During application of the steel nanocrystalline material as a weld overlay on various external surfaces of a bit or other downhole component, it may be desirable to pre-heat the bit or other downhole component prior to application. Specifically, in one embodiment, the bit or other downhole component may be pre-heated from about 500 to 850°F, and more preferably to about ~600°F, to facilitate application of the weld overlay to the desired surfaces, as well as to minimize the thermal stress related cracking which typically occurs in the microstructure of the overlay.

[0036] In some embodiments, it may be desirable to use the nanocrystalline steel material as a metallic phase that is used in combination with a hard component phase, *i.e.*, hard particles dispersed in the metallic nanocrystalline steel material. In such an instance, the hard component materials may be selected from, for example, metal oxides, metal nitrides, metal borides, and other metal carbides (and alloys thereof), such as sintered tungsten carbide (*e.g.*, WC-Co), monocrystalline tungsten

carbide, macrocrystalline tungsten carbide, multicrystal or polycrystalline tungsten carbide, and, in some embodiments, the additional component of spherical cast tungsten carbide (*e.g.*, a eutectic of WC-W₂C), each of which may be crushed in form.

[0037] In one embodiment, the wear resistant weld overlay formed from the steel nanocrystalline material may have a hardness greater than that of the surface on which it is disposed. In other embodiments, the wear resistant weld overlay may have a hardness of greater than about 60 HRc; from about 60 to 75 HRc in another embodiment; and greater than about 60, 65, and 70 HRc in various other embodiments.

[0038] The wear resistant weld overlay disclosed herein may be applied to desired surfaces using one of several techniques, including, for example, those described in U.S. Patent No. 6,196,338, as well as other techniques known in the art, including oxyacetylene welding (OXY), atomic hydrogen welding (ATW), gas metal arc welding (GMAW), metal inert gas welding (MIG), gas tungsten arc welding (GTAW), tungsten inert gas welding (TIG), plasma transfer arc welding (PTAW), high velocity oxygen fuel (HVOF), twin wire arc spray (TWAS), laser cladding, or other applicable processes as known by one of ordinary skill in the art.

[0039] The wear resistant weld overlay may be disposed on any desired surface or surfaces of a bit or other downhole component, including, for example, the drill bit body, a drill pipe, a bit adaptor sub, a roller stabilizer, and/or a blade stabilizer. For example, the wear resistant weld overlay may be disposed on steel components of a drill bit or other downhole component, as well as other surface features such as the cones or legs of a drill bit body, as are known in the art. FIG. 1 shows a rotary type rock bit 10 that includes a bit body 12, a cutting end 16, and a threaded pin end 14 for attachment to a drill string (not shown) or other downhole component (*e.g.*, a bit adaptor sub (see FIG. 2)). Each leg 13 supports a roller cone 18 that is rotatably mounted on a journal bearing (not shown) cantilevered from each of the legs 13. Each of the cones 18, for example, support a plurality of tungsten carbide inserts (or cutting elements) 19 extending from the surface of the cones. The rock bit further includes a fluid or air passage through pin end 14 that communicates with a plenum chamber (not shown) formed in the bit body 12. Typically, one or more air nozzles

15 direct air from the plenum chamber toward a borehole bottom. According to embodiments of the present disclosure, the wear resistant weld overlay may be provided on at least one external surface of the bit body 12, including, for example, the legs 13, nozzles 15, cones 18, and/or inserts 19. Additionally, it is within the scope of the invention that the overlay may be applied on the bit body, legs, cone, or teeth of milled tooth bits, which is known to those skilled in the art to have steel teeth integral with the roller cone instead of inserts as compared to the bit shown in FIG. 1.

[0040] In FIGS. 2-5, the wear resistant weld overlay 22 is represented by dark lines and/or bands on the surface of the components; however, one of ordinary skill in the art would recognize that these are only provided as an example and not meant to be limiting on the present disclosure in any way. FIG. 2 shows an embodiment of the present disclosure wherein the wear resistant weld overlay 22 is provided on various external surfaces of a bit adaptor sub 20. As used herein, "bit adaptor sub" means any small component of a drill string having a tubular body with means at both the upper 24 and lower 26 ends for attachment to adjacent drilling tools or pipe, which may, for example, be used to transition a drill bit to a drill string. FIG. 3 shows an embodiment of the present disclosure wherein the wear resistant weld overlay 22 is provided on various external surfaces of a drill pipe 30. As used herein, "drill pipe" means any downhole component having a tubular body with means at both the upper 34 and lower 36 ends for attachment to adjacent drilling tools or pipe.

[0041] FIG. 4 shows an embodiment of the present disclosure wherein the wear resistant weld overlay 22 is provided on various external surfaces of a roller stabilizer 40. A roller stabilizer is a type of stabilizer located in the drilling assembly and used for controlling the trajectory of the drill bit as drilling progresses. Roller stabilizer 40 may have means at both the upper 44 and lower 46 ends for attachment to adjacent drilling tools or pipe. As shown in FIG. 6, a stabilizer 40 may be connected uphole of a rotary rock bit 62. The bit 62 and stabilizer 40, as shown in FIG. 6, may be separated by tubular sub 20; however, the use of sub 20 is optional and the bit 62 and stabilizer 40 may be threaded together directly. FIG. 6 also shows that at least one roller 64 may be rotatably mounted in pockets 66 formed in the stabilizer body 61 with the at least one roller protruding beyond the body's

outer surface. The outer surface of each roller 64 may be studded with buttons 68 that frictionally engage the wall 80 of the borehole which may cause the rollers 64 to rotate in a direction opposite that of the drill bit 62. Additionally, the stabilizer 40 has an axial passageway 70 formed therethrough for the flow of drilling fluid (which may be either liquid or gas, *e.g.*, compressed air). According to embodiments of the present disclosure, the wear resistant weld overlay may be provided on any external surface of the roller stabilizer, including any surface of any component disposed on or protruding from the surface of the stabilizer (*e.g.*, a roller).

[0042] FIG. 5 shows an embodiment of the present disclosure wherein the wear resistant weld overlay 22 is provided on various external surfaces of a blade stabilizer 50. A blade stabilizer may be used to describe another type of stabilizer which may include concentric arms or blades 52 extending radially outwardly from the stabilizer housing 54; the outer edges of the arms or blades may be adapted to contact the wall of a borehole. A blade stabilizer 50 may also have means at both the upper 54 and lower 56 ends for attachment to adjacent drilling tools or pipe. As mentioned above and shown in FIGS. 2-5, the wear resistant weld overlay 22 is represented by the dark lines and/or bands on the surface of the downhole components; however, the wear resistant weld overlay may be further disposed on other external surfaces of the drill string components.

[0043] In preferred embodiments of the present disclosure, the thickness of the wear resistant weld overlay may range from, for example, 0.25 to 3 mm. One of skill in the art would recognize the thickness need not be uniform across all surfaces of a bit or other downhole component; rather, it is within the scope of the present invention that the thickness may be varied to optimize performance. Additionally, during application of the wear resistant weld overlay, multiple layers of the wear resistant weld overlay may be applied to the desired surfaces. If multiple layers of a wear resistant weld overlay are provided, one of ordinary skill in the art would recognize that compositions and resulting properties may be varied across the multiple layers to promote bonding and adhesion of the wear resistant weld overlay to the desired surface.

[0044] Advantageously, embodiments of the present disclosure provide for a wear resistant weld overlay to be disposed upon an external surface of a rock bit or other

downhole component used in drilling or mining operations. An external surface having a wear resistant weld overlay may provide increased wear resistance, fracture toughness, and impact resistance to the bit and/or downhole component.

[0045] While the invention has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments can be devised which do not depart from the scope of the invention as disclosed herein. Accordingly, the scope of the invention should be limited only by the attached claims.

CLAIMS

What is claimed:

1. A rock bit, comprising:
a bit body having an upper end adapted to be detachably secured to a drill string;
at least one roller cone;
at least one cutting element disposed on the at least one roller cone; and
a wear resistant weld overlay on at least a portion of an external surface of the rock bit, wherein the wear resistant weld overlay comprises a steel nanocrystalline material having at least one metal borocarbide precipitant dispersed therein.
2. The rock bit of claim 1, wherein the at least one borocarbide functions as a grain growth inhibitor.
3. The rock bit of claim 1, wherein the wear resistant weld overlay further comprises at least one of chromium, molybdenum, niobium, tungsten, aluminum, boron, carbon, manganese, silicon, and iron.
4. The rock bit of claim 1, wherein the wear resistant weld overlay has a porosity of less than about 5%.
5. The rock bit of claim 1, wherein the matrix has a hardness of at least 60 HRc.
6. The rock bit of claim 1, wherein the steel nanocrystalline material further comprises at least one hard material selected from metal oxides, metal nitrides, metal borides, metal carbides, or combinations thereof dispersed therein.
7. The rock bit of claim 1, wherein the steel nanocrystalline material further comprises sintered tungsten carbide, monocrystalline tungsten carbide, macrocrystalline tungsten carbide, polycrystalline tungsten carbide, spherical cast tungsten carbide, or combinations thereof dispersed therein.
8. A rock bit, comprising:
a bit body having an upper end adapted to be detachably secured to a drill string;
at least one roller cone;

- at least one cutting element disposed on the at least one roller cone; and
a wear resistant weld overlay on at least a portion of an external surface of the rock bit, wherein the wear resistant weld overlay comprises a steel nanocrystalline material having a hardness of at least 60 HRc.
9. The rock bit of claim 8, wherein the wear resistant weld overlay further comprises at least one of chromium, molybdenum, niobium, tungsten, aluminum, boron, carbon, manganese, silicon, and iron.
 10. The rock bit of claim 8, wherein the wear resistant weld overlay has a porosity of less than about 5%.
 11. The rock bit of claim 8, wherein the steel nanocrystalline material further comprises at least one hard material selected from metal oxides, metal nitrides, metal borides, metal carbides, or combinations thereof dispersed therein.
 12. A rock bit, comprising:
a bit body having an upper end adapted to be detachably secured to a drill string;
at least one roller cone;
at least one cutting element disposed on the at least one roller cone; and
a wear resistant weld overlay on at least a portion of an external surface of the rock bit, wherein the wear resistant weld overlay comprises a steel nanocrystalline material having a surface roughness of about 0.8 μm or better (Ra).
 13. The rock bit of claim 12, wherein the wear resistant weld overlay further comprises at least one of chromium, molybdenum, niobium, tungsten, aluminum, boron, carbon, manganese, silicon, and iron.
 14. The rock bit of claim 12, wherein the wear resistant weld overlay has a porosity of less than about 5%.
 15. The rock bit of claim 12, wherein the steel nanocrystalline material further comprises at least one hard component selected from metal oxides, metal nitrides, metal borides, metal carbides, or combinations thereof.

16. A downhole component, comprising:
a tubular body comprising upper and lower ends adapted to be detachably secured to adjacent drilling tools or pipe; and
a wear resistant weld overlay on at least a portion of an external surface of the downhole component, wherein the wear resistant weld overlay comprises a steel nanocrystalline material having at least one metal borocarbide precipitant dispersed therein.
17. The downhole component of claim 16, wherein the downhole component is a bit adaptor sub.
18. The downhole component of claim 17, wherein the lower end of the bit adaptor sub is attached to a drill bit.
19. The downhole component of claim 16, wherein the downhole component is a drill pipe.
20. A stabilizer, comprising:
a tubular body comprising upper and lower ends adapted to be detachably secured to adjacent drilling tools or pipe; and
a wear resistant weld overlay on at least a portion of an external surface of the stabilizer, wherein the wear resistant weld overlay comprises a steel nanocrystalline material having at least one metal borocarbide precipitant dispersed therein.
21. The stabilizer of claim 18, wherein the stabilizer is a roller stabilizer.
22. The stabilizer of claim 18, wherein the stabilizer is a blade stabilizer.

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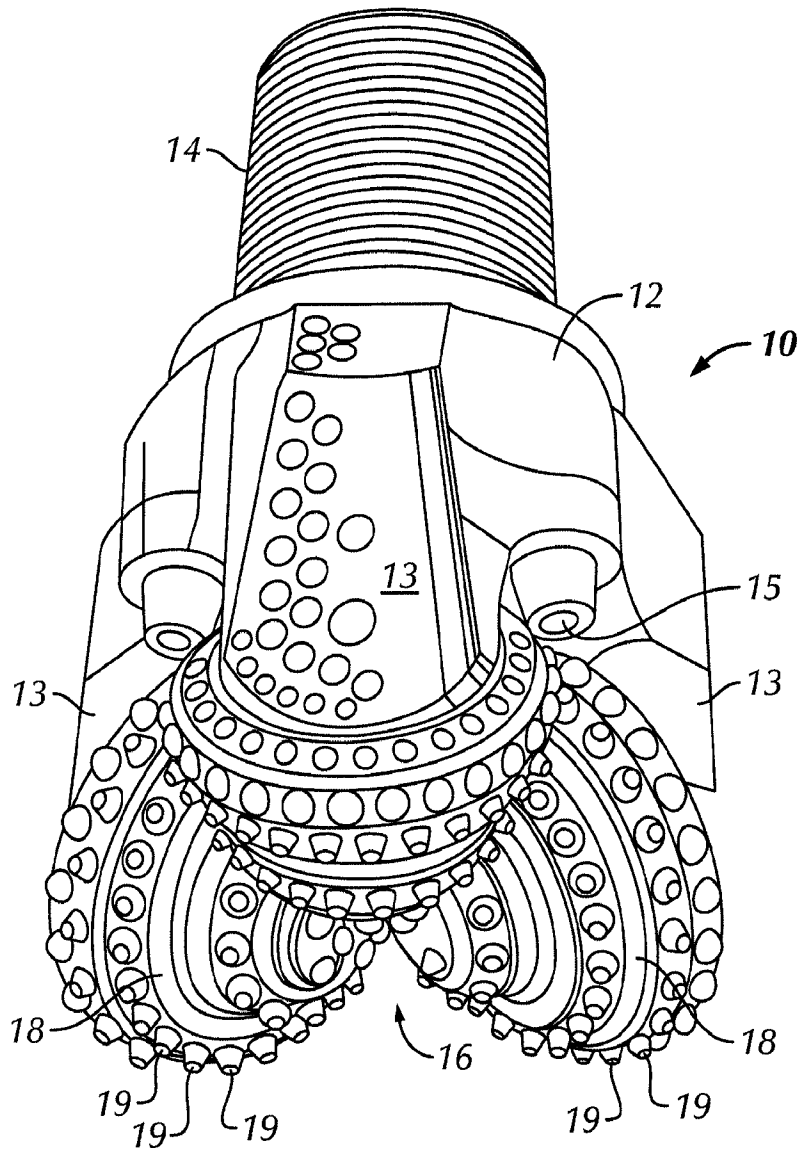


FIG. 1

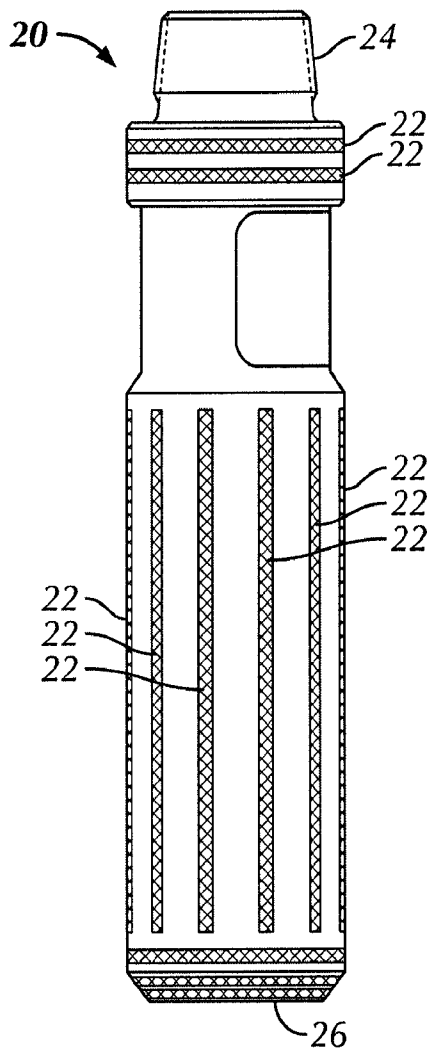


FIG. 2

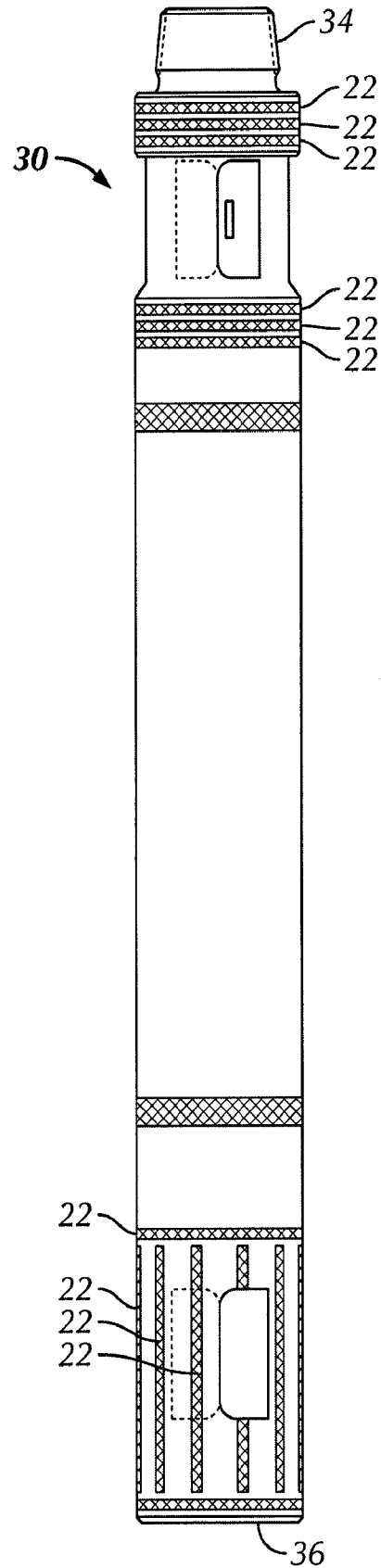


FIG. 3

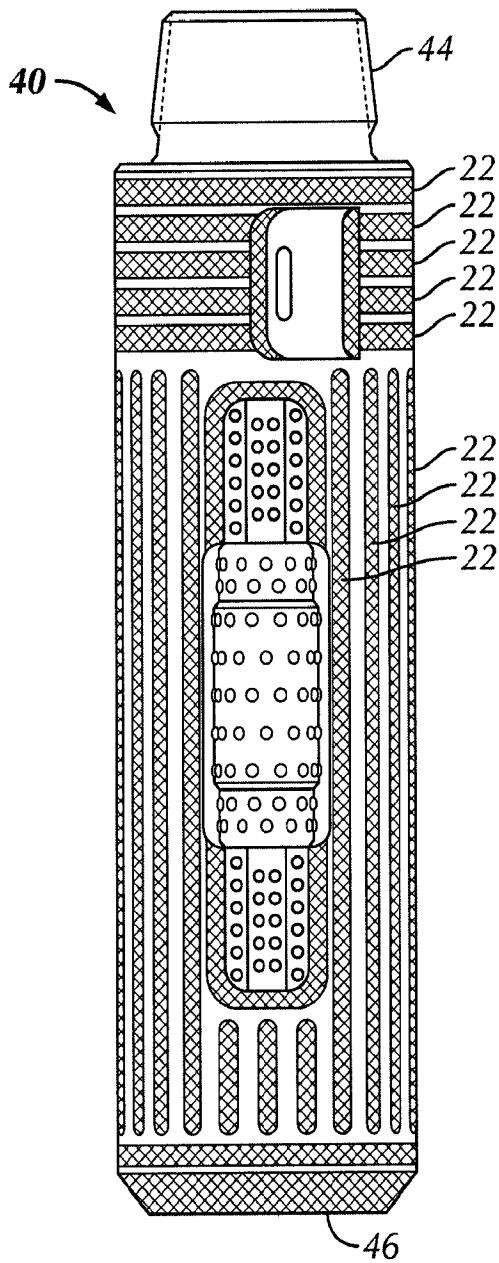


FIG. 4

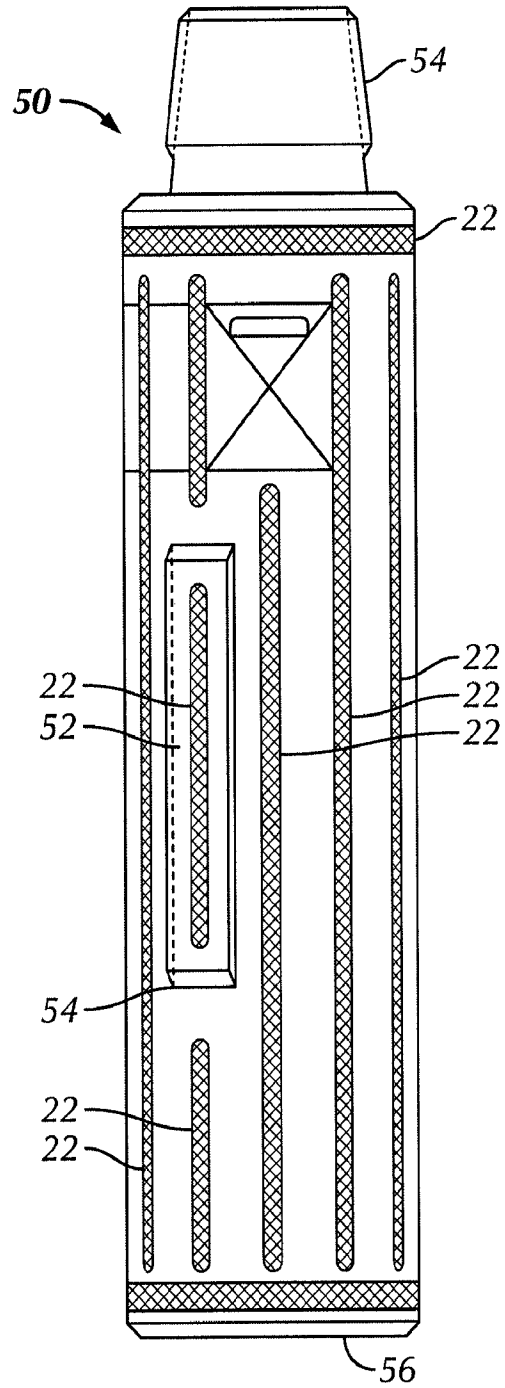


FIG. 5

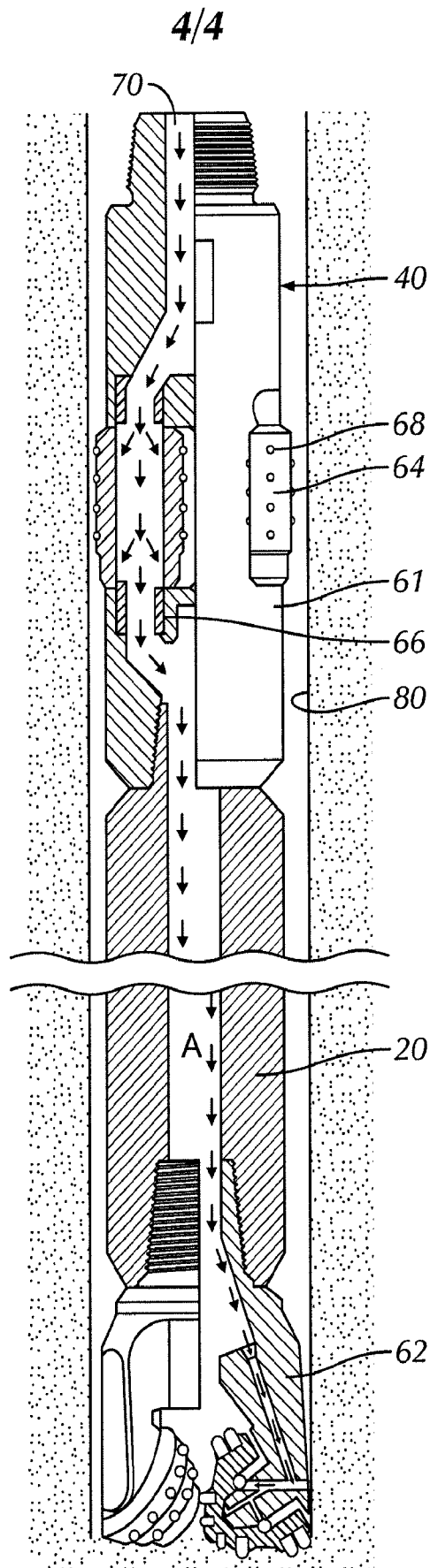


FIG. 6