(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 299 875 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
03.01.2024 Bulletin 2024/01

(21) Application number: **22182130.9**

(22) Date of filing: **30.06.2022**

(51) International Patent Classification (IPC):
E21B 17/042 *(2006.01)* ***E21B 17/10*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
E21B 17/0426; E21B 17/1085

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

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(54) LASER CLADDED RODS OR TUBES FOR PERCUSSIVE DRILLING

(57) A drill rod or tube comprising a hollow elongate main length section having a longitudinal axis extending axially between a male end at an axially forward end and a female end at an axially rearward end; the male end comprising a male connecting means and a radially projecting shoulder that axially separates the main length section and the male connecting means; the shoulder comprising a peripheral surface that may have a greater outer diameter than the outer diameter of the main length section: wherein at least part of the peripheral surface of the rod or tube has at least one laser cladding layer positioned thereon.

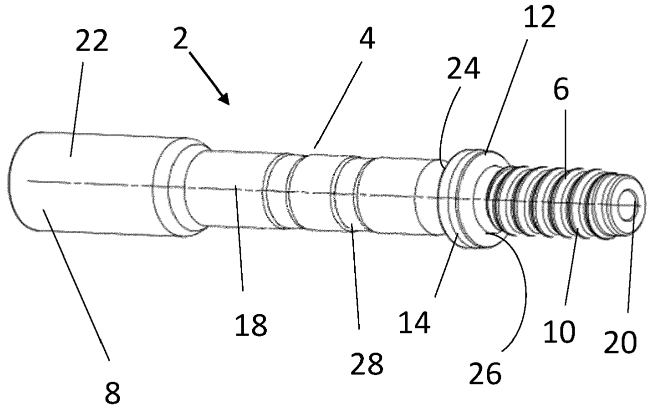

Fig. 1

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Description

Field of invention

[0001] The present invention relates to a rod or tube for percussive drilling having a laser cladded wear protection layer and a method of producing there said.

[0002] Percussion drill bits are widely used both for drilling relatively shallow bores in hard rock and for creating deep boreholes. For the latter application, drill strings are typically used in which a plurality of rods or tubes are interconnected to advance the drill bit and increase the depth of the hole. In 'top hammer drilling' a terrestrial machine is operative to transfer a combined impact and rotary drive motion to an upper end of the drill string whilst a drill bit positioned at the lower end is operative to crush the rock and form the boreholes.

[0003] Drill rods or tubes, that are connectable to neighbouring drill rods or tubes and the drill bit or guide adapter, can have a shoulder. The shoulder is typically formed as a radially flared extension of the main length section of the drill rod to provide increased efficiency in energy transfer between the drill rod and the drill bit or a guide adapter. The shoulder on the first drill string rod or tube that joins to the drill bit or guide adapter and the shoulder on the guide adapter is exposed to high levels of wear as the hole collapses and rock cuttings gather behind the drill bit. The problem with this is that as the shoulder wears the strength of the coupling will weaken prematurely. Additionally, as the shoulder wears away the contact area between the drill string rod and the drill bit or guide adapter or between the guide adapter and the drill bit decreases and therefore the transfer of the energy between the drill bit or guide adapter and rod or tube, or adjacent rods or tubes decreases, if the transfer of energy is not efficient energy will be wasted and the drilling efficiency will be compromised. This premature failure leads to low service life of the rods or tubes.

[0004] One known solution is to hard face the peripheral edge of the shoulder using FCAW, MIG/MAG or thermal spraying methods, however a problem with these methods can be that excessive heat input will create a large heat affected zone (HAZ). The large HAZ in addition to thick layers can create stresses between the substrate and the cladding thereby leading to cracking. Any cracks formed during the deposition will be a possible initiation point for failure. Therefore, the problem to be solved is how to protect the rod or tube from wear without introducing unwanted stresses.

Summary of the Invention

[0005] It is an objective of the present invention to provide a drill rod or tube having increased wear protection. This objective is achieved by providing a drill rod or tube comprising a hollow elongate main length section having a longitudinal axis extending axially between a male end at an axially forward end and a female end at an axially rearward end; the male end comprising a male connecting means and a radially projecting shoulder that axially separates the main length section and the male connecting means; the shoulder comprising a peripheral surface that may have a greater outer diameter than the outer diameter of the main length section: wherein at least part of the peripheral surface of the rod or tube has at least one laser cladding layer positioned thereon.

[0006] Advantageously, the laser cladding provides wear protection to the rod or tube it is applied to, therefore reducing the risk of premature failure which maintains drilling efficiency and prolongs the lifetime of the rod.

[0007] In one embodiment the laser cladding layer is positioned on at least part of the peripheral surface of the shoulder. Advantageously, this provides protection to the shoulder which is especially prone to wear. It is particularly important to protect the shoulder from wear as if it gets worn down too quickly it will no longer be able to effectively transfer energy to the drill bit or adjacent rod or tube that it is connected to meaning that the drilling efficiency would be decreased and accelerated wear of the drill bit or adjacent coupling will occur. Therefore, increased wear protection to the shoulder results in increased drilling efficiency.

[0008] In one embodiment the laser cladding layer extends at least 100 mm along the peripheral surface of the rod or tube from the axially forward side of the shoulder. Advantageously, this provides wear protection to the area of the rod or tube that is most exposed to wear.

[0009] In one embodiment, the laser cladding layer extends over the male end of the drill rod or tube. Advantageously, this provides wear protection to the male end of the drill rod or tube.

[0010] In one embodiment the laser cladding layer extends over the female end of the drill rod or tube. Advantageously, this provides wear protection to the female end of the drill rod or tube.

[0011] In one embodiment the heat affected zone (HAZ) projecting into surface of the rod or tube where the laser cladding layer has been applied is <0.3 mm. Advantageously, this reduces or removes the build-up of unfavourable stresses between the laser cladding layer and the surface of the rod or tube it has been applied to, otherwise known as the substrate. Therefore, reducing the risk of cracking in the laser cladding layer which would have a detrimental effect on the wear resistance of the protective layer. Any cracking in the laser cladding layer may also propagate into substrate it has been applied to which may have a negative impact on the lifetime of the rod or tube.

[0012] In one embodiment the thickness of the laser cladding layer is between 20 - 2000 μm. Advantageously, this thickness range provides an optimal balance between providing sufficient wear protection without adding unnecessary cost and weight.

[0013] In one embodiment the composition of the laser cladding layer comprises a metal matrix composite (MMC). Advantageously, the use of MMC as the cladding material provides high wear resistance.

[0014] In one embodiment the composition of the laser cladding layer comprises a metal alloy. Advantageously, the metal alloy can be selected to have superior corrosion and /or wear resistance to suit the application.

[0015] In one embodiment the laser cladding layer has a hardness of between 500 to 1800 HV10. Advantageously, this provides increased wear resistance.

[0016] Another aspect of the present application is a method of providing wear protection to a drill rod or tube characterised in that: a wear protection layer is applied to at least one part of the peripheral surface of the rod or tube using laser cladding. Advantageously, the application of a laser cladding layer will increase the wear resistance of the drill rod or tube.

[0017] In one embodiment, the laser cladding is performed using extreme high-speed laser material deposition (EHLA). Advantageously, EHLA coatings can be applied on the substrate with minimum HAZ, thereby reducing the build-up of unfavourable stress between the wear protection layer and the peripheral surface of the rod or tube where the laser cladding has been applied consequently resulting increased wear protection which will increase the lifetime of the rod or tube. Additionally, with the EHLA process it is possible to get a wide range of different properties of the coating depending on what type of powder is selected. EHLA provides thinner layers, with a reduced heat effected zone as the dilution between the cladding and the substrate is smaller, with higher power efficiency and faster processing times.

Brief description of drawings

[0018] A specific implementation of the present invention will now be described, by way of example only, and with reference to the accompanying drawings in which:

Figure 1 is a schematic drawing of a drill rod or tube.
Figure 2 is a schematic drawing of the laser cladding layer.

Detailed description

[0019] Figure 1 shows a rod or tube 2 for percussive drilling, comprising a hollow elongate main length section 4 having a longitudinal axis 18 extending axially between a male end 6 at an axially forward end 20 and a female end 8 at an axially rearward end 22 of the rod or tube 2. The male end comprises a male connecting means 10 and a radially projecting shoulder 12 that axially separates the main length section 4 and the male connecting means 10. The shoulder 12 comprises a peripheral surface 14 that may have a greater outer diameter than the outer diameter of the main length section 4.

[0020] Figure 2 shows that there is a laser cladding layer 16 positioned on at least part of the peripheral surface of the rod or tube 2.

[0021] The laser cladding layer 16 is positioned on at least part of the peripheral surface 14 of the shoulder 12. Optionally, the laser cladding layer 16 is positioned on the entire peripheral surface 14 of the shoulder. Optionally, the laser cladding layer 16 is positioned on an axially rearward side face 24 of the shoulder 12. Preferably, the laser cladding layer 16 is not positioned on the axially forward side face 26, otherwise known as the striking face, of the shoulder 12. Optionally, the laser cladding layer 16 extends over a friction weld 28 which is positioned on the main length section 4.

[0022] Optionally, the laser cladding layer 16 extends at least 100 mm, preferably at least 200 mm, more preferably at least 300 mm, even more preferably at least 400 mm, most preferably at least 500 mm along the peripheral surface of the rod or tube 2 from the axially rearward side of the shoulder 12.

[0023] Optionally, the laser cladding layer 16 extends over the male end 6 of the drill rod or tube 2. Optionally, the laser cladding layer 16 extends over the female end 8. It should be understood that the laser cladding layer 16 can be positioned on any combination of the different locations on the rod or tube 2.

[0024] Preferably, the heat affected zone (HAZ) projecting into surface of the rod or tube 2 where the laser cladding layer 16 has been applied, otherwise known as the substrate is <0.3 mm, preferably <0.2 mm, more preferably <0.1 mm.

[0025] In one embodiment the thickness of the laser cladding layer 16 is between 20 - 2000 μm, preferably 20-1000 μm, more preferably between 25-500 μm. The laser cladding layer 16 could have a substantially uniform thickness in all areas where it is applied or could have different thicknesses in different areas as required.

[0026] In one embodiment the composition of the laser cladding layer 16 comprises a metal matrix composite (MMC). The MMC comprises a secondary hard phase, for example this could be tungsten carbide, titanium carbide, tantalum carbide, niobium carbide or any other carbide or nitride or a mixture thereof and a metal alloy as a binder which could for example be cobalt, nickel, iron, chromium or a mixture thereof.

[0027] Alternatively, the composition of the laser cladding layer 16 comprises a metal alloy. The composition of the laser cladding material could for example be, but not limited to, a stainless steel or tool steel, a nickel-based alloy e.g. a Ni-Cr alloy; an Fe based alloy; a Cr-based alloy; stellite or, inconel a mixture thereof or any other suitable material. The material selected can be chosen to suit the specific application and drilling environment, for example stainless steel will provide better corrosion protection, whereas tool steel or hard metal composite will provide better wear resistance.

[0028] In one embodiment the laser cladding layer 16 has a hardness of between 500 to 1800 HV10, preferably between 800 - 1800 HV10, more preferably between 1000 - 1800 HV10. If the cladding layer 16 is a metal matrix composite preferably the hardness of the metal matrix is 500-900 HV10, preferably 600-900 HV10, more preferably 600-900 HV10 and the hardness of the hard metal phase is 1500-3500 HV0.1, preferably 2000-3500 HV0.1 and most preferably 2500-3500 HV0.1.

[0029] The present invention also relates to method of providing wear protection to a drill rod or tube 2 wherein a wear protection layer 16 is applied to at least one part of the peripheral surface of the rod or tube 2 using laser cladding. The peripheral or external surface of the rod or tube 2 can also be considered to be the substrate for the laser cladding. Laser cladding is a melting process where a laser beam is used to fuse a powder alloy with another metallurgical composition onto a substrate. A metallic substrate is exposed to a laser beam while a powder is injected over the melted bath to form, after being solidified, a layer referred to as the cladding on the surface of the substrate. The laser cladding could be applied using any suitable laser.

[0030] Preferably, the laser cladding is performed using extreme high-speed laser material deposition (EHLA). EHLA is a laser cladding method which faster than traditional laser cladding methods in terms of surface coverage rate. The high-speed deposition from EHLA does not only result in a faster processing time, it also makes it possible to apply cladding to a substrate with even lower heat input and smaller distortion, meaning that the heat effected zone will be even less in the substrate. In addition, the small dilution formed by EHLA makes it possible to apply even thinner coatings, the thickness of the laser cladding layers is for example typically only 25-400 μm thick.

[0031] The drill rod or tube as described hereinbefore or hereinafter may form part of a drill string and / or part of a drill rig assembly.

Claims

1. A drill rod or tube (2) comprising a hollow elongate main length section (4) having a longitudinal axis (18) extending axially between a male end (6) at an axially forward end (20) and a female end (8) at an axially rearward end (22);

   the male end (6) comprising a male connecting means (10) and a radially projecting shoulder (12) that axially separates the main length section (4) and the male connecting means (10);
   the shoulder (12) comprising a peripheral surface (14);
   characterised in that:
   at least part of the peripheral surface of the rod or tube (2) has at least one laser cladding layer (16) positioned thereon.

2. The drill rod or tube (2) according to claim 1 wherein the laser cladding layer (16) is positioned on at least part of the peripheral surface (14) of the shoulder (12).

3. The drill rod or tube (2) according to claim 1 or claim 2 wherein the laser cladding layer (16) extends at least 100 mm along the peripheral surface of the rod or tube (2) from the axially rearward side of the shoulder (12).

4. The drill rod or tube (2) according to any of the previous claims wherein the laser cladding layer (16) extends over the male end (6).

5. The drill rod or tub (2) according to any of the previous claims wherein the laser cladding layer (16) extends over the female end (8).

6. The drill rod or tube (2) according any of the previous claims wherein the heat affected zone (HAZ) projecting into surface of the rod or tube (2) where the laser cladding layer (16) has been applied is <0.3 mm.

7. The drill rod or tube (2) according to any of the previous claims wherein the thickness of the laser cladding layer (16) is between 20 - 2000 μm.

8. The drill rod or tube (2) according to any of the previous claims wherein the thickness of the laser cladding layer (16) is between 20 - 1000 μm.

9. The drill rod or tube (2) according to any of the previous claims wherein the thickness of the laser cladding layer (16) is between 25-500 μm.

10. The drill rod or tube (2) according to any of the previous claims wherein the composition of the laser cladding layer (16) comprises a metal matrix composite (MMC).

11. The drill rod or tube (2) according to any of claims 1-8 wherein the composition of the laser cladding layer (16) comprises a metal alloy.

12. The drill rod or tube (2) according to any of the previous claims wherein the laser cladding layer (16) has a hardness of between 500 to 1800 HV10.

13. A method of providing wear protection to a drill rod or tube (2) **characterised in that:** a wear protection layer (16) is applied to at least one part of the peripheral surface of the rod or tube (2) using laser cladding.

14. The method according to claim 13 wherein the laser cladding is performed using extreme high-speed laser material deposition (EHLA).

15. The method according to claim 13 or 14 wherein the laser cladding is applied in a thickness of between 20 - 2000 μm.

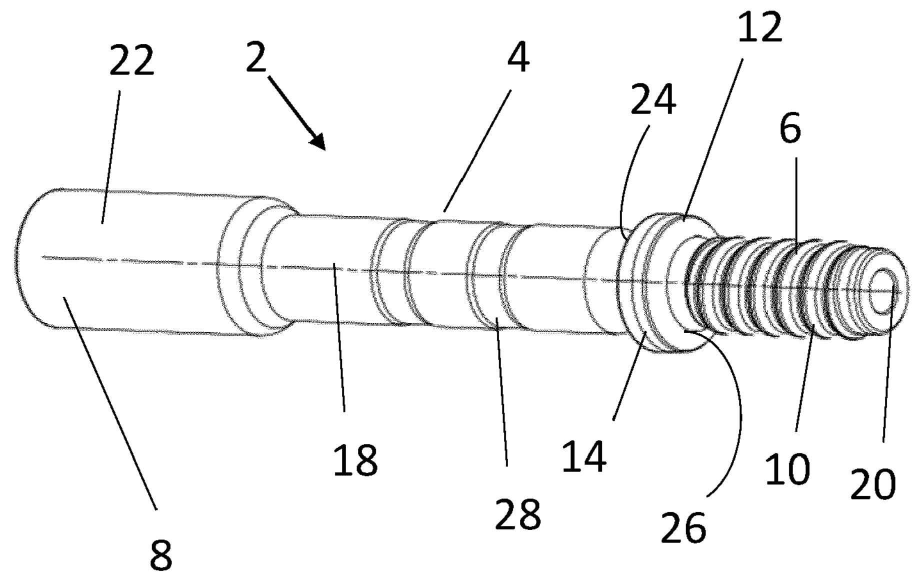

Fig. 1

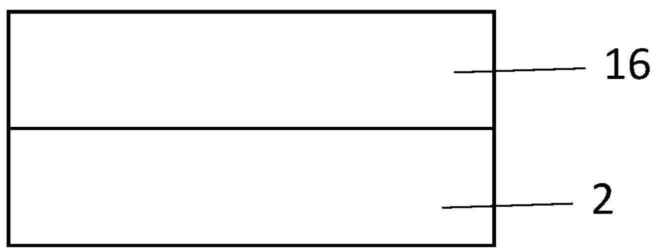

Fig. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 22 18 2130

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The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	15 November 2022	Simunec, Duro

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 18 2130

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