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

(11) **EP 3 751 092 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
16.12.2020 Bulletin 2020/51

(51) Int Cl.:
E21B 10/36 *(2006.01)* ***E21B 17/042*** *(2006.01)*
E21B 17/10 *(2006.01)*

(21) Application number: **19180284.2**

(22) Date of filing: **14.06.2019**

(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

(71) Applicant: **Sandvik Mining and Construction Tools AB**
81181 Sandviken (SE)

(72) Inventors:
- **BJÖRK, Fredrik**
  81134 Sandviken (SE)
- **NORMAN, Andreas**
  81134 Sandviken (SE)
- **YASSERI, Ali**
  81181 Sandviken (SE)

(74) Representative: **Sandvik**
Sandvik Mining and Construction Oy PL 100
Patent Department
33311 Tampere (FI)

(54) GUIDE ADAPTER

(57) The present invention relates to a guide adapter (100) for guiding a drill bit during percusion drilling, said guide adapter is intended to be arranged between the drill bit and an elongated drill string extending along an axis A, said drill bit having a first radius (Rf) transverse to axis A. The guide adapter comprises: a sleeve shaped adapter body (101) intended to extend along axis A and comprising a forward end (102) with a first coupling (104) intended for connecting the guide adapter to the drill bit, and a rear end (103) with a second coupling (105) intended for connecting the guide adapter (100) to the drill string; and a plurality of guiding elements (106) extending substantially radially in relation toaxis A from the sleeve shaped adapter body (101), wherein the guiding elements (106) extend along 60% or less of the adapter body length (L) along axis A and are arranged in the rear end (103) of the adapter body (101), said guiding elements (106) in the rear end (103) has an extension in radial direction from axis A substantially equal to said first radius (Rf) and curved, straight or stepwise reduced radial extension towards the forward end along axis A. The invention furthermore relates to a drill arrangement comprising the guide adapter.

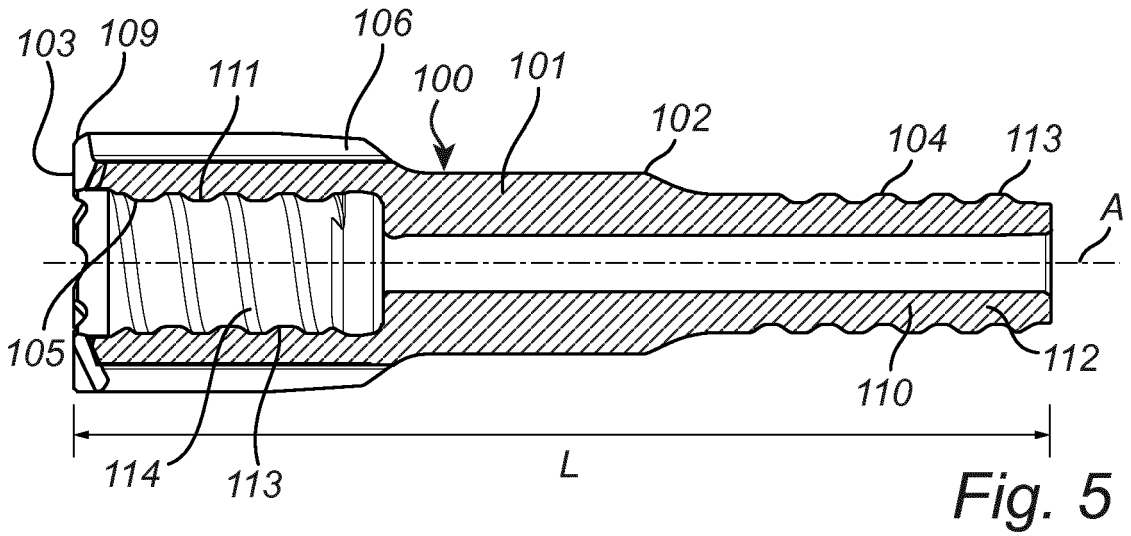

Fig. 5

EP 3 751 092 A1

Description

Field of the invention

[0001] The present invention generally relates to a guide adapter for guiding a drill bit during percussion drilling, and a drill arrangement comprising said guide adapter.

Technical background

[0002] Within the constructional work sector and the mining industry percussion drilling, such as top hammer drilling, is an established method for drilling vertical bore holes with a drill bit arranged in the forward end of an elongated drill string or cable. During drilling, a hammering impact from a hydraulically driven piston is acting on the drill string to exert the required force to break the rock and generate the bore hole.

[0003] The length of the drill string is, during the drilling, increased by adding further drill string rods as the depth of the bore hole increases. When the depth of the bore hole increases also the risk for deviation from the intended straight direction of the bore hole increases. The problem with deviation could be reduced by adding a guide adapter between the drill bit and the drill string or cable to provide additional support to the forward end of the drill string and the drill bit. One example of a guide adapter is disclosed in US8051927B2.

[0004] However, there is always a need to improve the drilling performance without increasing the problem with deviation.

Summary

[0005] It would be advantageous to achieve a guide adapter that fulfills at least some of the needs mentioned above. To better address one or more of these concerns a guide adapter as defined in the independent claims is provided. Preferable embodiments are defined in the dependent claims.

[0006] The guide adapter for guiding a drill bit during percusion drilling, said guide adapter is intended to be arranged between the drill bit and an elongated drill string extending along an axis A, said drill bit having a first radius transverse to axis A. The guide adapter according to the invention comprises:

a sleeve shaped adapter body intended to extend along axis A and comprising a forward end with a first coupling intended for connecting the guide adapter to the drill bit, and a rear end with a second coupling intended for connecting the guide adapter to the drill string; and

a plurality of guiding elements extending substantially radially in relation to axis A from the sleeve shaped adapter body,

wherein the guiding elements extend along 60% or less of the adapter body length along axis A and are arranged in the rear end of the adapter body, said guiding elements in the rear end have an extension in radial direction from axis A substantially equal to said first radius and curved, straight or stepwise reduced radial extension towards the forward end along axis A.

[0007] The guide adapter according to the invention is favorable since the guide elements with the claimed characteristics arranged in the rear end of the guide adapter will provide the desired guiding of the drill bit, and at the same time reduce the weight of the guide adapter which is a considerable advantage to improve the drilling performance. The characteristic design of the guide elements furthermore reduces the friction between the guide elements and the bore hole since only the rear end of the guide elements will be in contact with the side wall of the bore hole which improves the drilling performace further. The guiding elements in the rear end of the guide adapter preferably have an extension in radial direction from axis A substantially equal to the maximum radius, i.e. the first radius of the drill bit such that the guiding elements of the guide adapter will provide support against the side walls of the bore hole and reduce deviation from the desired straight bore hole direction.

[0008] In one embodiment of the guide adapter, the guide adapter comprises at least five guide elements with substantially identical shape and dimension. This embodiment is favourable since the five or more guiding elements will provide very good guiding of the drill bit and prevent deviation.

[0009] In one embodiment of the guide adapter, the guide elements are substantially straight and extending parallel to axis A along the sleeve shaped adapter body. This embodiment could be manufactured in an effective way since the guiding elements are straight and parallell to axis A.

[0010] In one embodiment of the guide adapter, the guide elements, in a plane transverse to axis A, have a base arranged towards the sleeve shaped adapter body, said guide elements have a tapered shape in radial direction from axis A and are ended by an outer end surface. Guiding elements with this design provide excellent support within the bore hole and are very resistant to loads exerted during drilling since the wider base provides a strong bounding to the guide adapter body while the tapered shape reduces the amount of material, and consequently the weight, of the guide adapter which improves the performance of the arrangement.

[0011] In one embodiment of the guide adapter, the outer end surface is shaped like a cirular arc with a radius corresponding to the radius from axis A to the outer end surface. The curved outer end surface provides excellent support against the side walls of the bore hole and are very resistant to wear.

[0012] In one embodiment of the guide adapter, at least an area of the outer end surface of at least one guiding

element is covered by a hard layer. The guide adapter body and the guide elements are made of a metal material and the applied hard layer of a material that is harder and more resistant to wear increases the life time for the guide adapter.

[0013] In one embodiment of the guide adapter, the hard layer is applied on the outer end surfaces along the entire guide elements along axis A to increase the life time of the guide adapter by providing the hard layer on the entire surface of the guide element facing the bore hole side wall. The hard layer is a layer made of a material that is harder and more resistant to wear than the metal material of the guide adapter body. The material is a material including an iron-based alloy, a cobalt-based alloy, a nickel-based alloy, a refractory metal, a cemented carbide, a metal matrix composite and/or a chromium carbide alloy. These different alternative materials provide a protective layer that can withstand wear and increase the intervals between replacement of the guide adapter. The hard layer has a thickness in a direction perpendicular from the outer end surface within the range of 0.1 - 10 mm, and preferably within the range of 0.1 - 4 mm to provide the desired protection of the guiding elements of the guide adapter.

[0014] In one embodiment of the guide adapter, the guide elements comprise a rear end surface and the rear end surface of at least one guide element is covered by a rear end surface hard layer. The rear end surfaces are exposed to wear since the material removed from the rock to form the bore hole remains within the bore hole and due to gravitation tend to land on the rear end surfaces of the guiding elements. The application of the rear end surface hard layer exends the life time of the guide adapter since the rear end of the guide elements are protected by the rear end surface hard layer. The rear end surface hard layer has a thickness in a direction perpendicular from the rear end surface within the range of 0.1 - 10 mm, and preferably within the range of 0.1 - 4 mm and is made of the same type of materials as the hard layer arranged on the outer end surface on the guiding element.

[0015] In one embodiment of the guide adapter, the guiding elements in the rear end has an extension in radial direction from axis A of about 94 - 96 % of said first radius, and a radial extension the forward of the guiding elements of about 89 - 91 % of said first radius. Guiding elements with this design provides excellent guiding of the drill bit and the desired drilling performance.

[0016] In one embodiment of the guide adapter, a wear indicator is arranged in the outer end surface of at least one of the guide elements to indicate when the guide adapter is worn out and needs to be replaced. This embodiment helps the operator to replace the guide adapter in time to ensure the desired guiding of the drill bit.

[0017] In one embodiment of the guide adapter, the wear indicator is a notch, recess or cut out portion arranged in the top end surface, said notch, recess or cut out portion has a depth selected such that when the guide adapter is worn out, the notch is no longer visible in the top end surface. This embodiment makes it easy for the operator to verify the condition of the guide adapter and, if required, replace the guide adapter.

[0018] In one embodiment of the guide adapter, the distance from axis A to the wear indicator is within the range of 80 - 99 % of the guiding element extension in radial direction from axis A in the rear end of the guide adapter, and preferably within the range of 85 - 95 % of the guiding element extension in radial direction from axis A in the rear end of the guide adapter. These ranges are selected to ensure that the guide adapter is preplaced in time to ensure the desired guiding of the drill bit.

[0019] In one embodiment of the guide adapter, the guide elements extend along 50% or less of the adapter body length L along axis A, alternatively 40% or less of the adapter body length L along axis A. These lengths are selected to ensure the desired guiding of the drill bit in combination with excellent drilling performance.

[0020] In one embodiment of the guide adapter, the radial extension of the guiding elements are decreasing in the direction from the rear end towards the forward end such that the guide elements will have a convex shape along axis A, or a substantially straight shape angled in relation to axis A along axis A.

[0021] The invention furthermore relates to a drill arrangement for percussion drilling, said arrangement comprises a drill string, a drill bit having a first radius transverse to axis A and a guide adapter according to claim 1 arranged between the drill string and the drill bit to reduce the risk for deviation.

Brief description of the drawings

[0022] The invention will be better understood through the following illustrative and non-limiting detailed description of preferred embodiments, with reference to the appended drawings, on which:

Figure 1 is a perspective view of a drill arrangement comprising a drill string rod, a guide adapter and a drill bit, and enlarged views of the guide adapter and drill bit arranged in one end of the drill string and the coupling arranged in opposite end of the drill string.

Figure 2 illustrates an exploded view of the forward end of the drill string rod, the guide adapter and the drill bit.

Figure 3 illustrates a perspective view of one embodiment of a guide adapter.

Figure 4 illustrates a cross-sectional view of the guide adapter transverse to a longitudinal axis A. The position of the cross-sectional view is illustrated by arrows IV in figure 3.

Figure 5 illustrates a cross-sectional view of the guide adapter parallel to the longitudinal axis A through the center of the guide adapter. The position of the cross-sectional view is illustrated by arrows V in figure 3.

Figure 6 illustrates a side view of a drill bit and a guide adapter fitted together.

[0023] All figures are schematic, not necessarily to scale, and generally only illustrating parts which are necessary to elucidate the invention, wherein other parts may be omitted or merely suggested.

Detailed description of embodiments

[0024] In figure 1 a perspective view of a drill arrangement according to the invention is illustrated. The drill arrangement comprises a drill string rod 10, a guide adapter according to the invention 100 and a drill bit 20. The drill string rod 10 comprises an elongated intermediate section 11 extending along a longitudinal axis A (shown in figure 3). In the illustrated embodiment, a male coupling 12 is arranged in one end of the intermediate section and a female coupling 13 in the opposite end. The male and female couplings are intended to make it possible to connect the guide adapter and drill bit in the forward end of the drill string rod, and the female coupling in the rear end of the drill string rod is intended for connecting further drill string rods to form a drill string 100 with the desired length by connecting the male coupling of an identical drill string rod to the female coupling of the adjacent drill string rod. During drilling, further drill string rods 10 are connected to extend the length of drill string 100 as the depth of the bore hole increases. In the illustrated embodiment male / female couplings are illustrated but other coupling arrangements could be used to adapt the arrangement for different needs.

[0025] During drilling, the rear end of the drill string 10 is connected to a hydraulically driven piston, not illustrated, arranged to provide the desired axial force and rotation of the drills string, the guide adapter and the drill bit to conduct the percussion drilling. The design of the drill string rod, the guide adapter and the drill bit are adapted to specific needs origin from different types of rock materials and the desired bore hole diameter. Larger bore hole diameters require larger dimensions of the different components to ensure that they are able to withstand the loads during drilling.

[0026] The drill string rod could be embodied in different ways and for example the intermediate section 10 could have a circular, rectangular, pentagonal or hexagonal cross-sectional shape as long as the required strength is ensured. The intermediate section is either solid, or comprising a passage extending in the center of the intermediate section through the drill string rod to allow a of flushing media through the drill string to the drill bit arranged in the forward end of the drill string to remove particles and gravel from the rock during drilling. The flushing media is for example air, water or a mixture of air and water.

[0027] Figure 2 illustrates an exploded view along axis A where the forward end of the drill string rod 10, the guide adapter 100 and the drill bit 20 are illustrated separately from each other to more clearly illustrate the design of the different components. The male coupling 12, arranged in the forward end of the intermediate section 11, comprises a male spigot portion 14 extending co-axially to the intermediate section along axis A. In the illustrated embodiment, the male spigot portion 14 has substantially the same radius as the intermediate section 11, but dimensions could be changed to adapt the spigot portion 14 and intermediate section to different needs. The male spigot portion 14 comprises an external thread 15 extending along the entire length of the spigot portion along axis A. In the opposite end to the male coupling, illustrated in figure 1, a female coupling 13 is permanently fitted to the intermediate section 11. The female coupling 13, illustrated in figure 1, has a shape and dimension corresponding to the dimensions of the male coupling 12, i.e the male spigot portion 14 to make it possible to connect identical drill string rods 10 to each other to form a drill string. The female coupling 13 comprises a sleeve shaped element 16 extending co-axially to the intermediate section. The sleeve shaped element 16 has internal threads 17 corresponding to the external threads 15 on the male spigot portion 14.

[0028] The guide adapter 100 is attached to the forward end of the drill string rod to provide additional guiding of the drill bit 20 during drilling and reduce deviation from the desired straight bore hole direction. Different embodiments of the guide adapter according to the invention will be described in detail further down the detailed description.

[0029] The different embodiments of the guide adapter all comprises a sleeve shaped adapter body 101 intended to extend co-axially to axis A. The adapter body has a forward end 102 with a first coupling 104 intended for connecting the guide adapter 100 to the drill bit 20, and a rear end 103 with a second coupling 105 intended for connecting the guide adapter 100 to the drill string 10.

[0030] The drill bit 20 is fitted to the forward end 102 of the guide adapter 100 by the first coupling element 104. In the illustrated embodiment the first coupling 104 of the guide adapter 100 is a male coupling and in the rear end 28 of the drill bit 20 a corresponding female coupling 22 is arranged within the drill bit body 21. The drill bit body 21 extend co-axially to axis A. The length of the drill bit body 21 along axis A depends on the size and intended use of the drill bit. The front surface 23 of the drill bit is either substantially flat, or convex. In the front surface 23 several buttons 24 are arranged. The buttons are made of a harder and more resistant material and are intended to form the desired bore hole during drilling. The buttons are positioned such that the buttons along the periphery of the front surface define the maximum radius of the drill bit, i.e. the first radius, and consequently the radius of the bore hole of the drill bit will form when the drilling is initiated. There are different well-known suitable materials for the buttons as well as a number of different layouts and designs of the front surface and button known in the art. Behind the front surface 24 of the

drill bit the drill bit body has a narrower section 30 with substantially circular cross-sectional shape with a smaller radial extension from axis A than the first radius. Behind the narrower section the drill bit body comprises a rear section 29. Along the rear section 29 a number of guiding ribs 31 extend in a substantially radial direction from the drill bit body. The guiding ribs 31 extend substantially parallel to axis A along the rear section of the drill bit body and has a radial extension slightly smaller than the first radius, i.e. the maximum radius of the drill bit. The guiding ribs are intended to provide support for the drill bit against the side walls of the bore hole to reduce deviation from the desired straight bore direction.

[0031] In the guide adapter embodiment illustrated in figure 2, 3 and 5, the first coupling 104 is a male coupling element 110 and the second coupling 105 a female coupling element 111 corresponding to the male coupling 12 in the forward end of the drill string rod 10. The sleeve shaped adapter body 101 has a legth L along axis A, and the sleeve shaped adapteter body has a slightly smaller outer radius along the forward half than the outer radius of the rear half. The design of the adapter body could however be modified in several different ways to adapt the guide adapter to different needs.

[0032] The male coupling element 110 comprises a male spigot portion 112 extending co-axially to axis A from the forward end 102 of the adapter body 101. In the illustrated embodiment, the male spigot portion 112 has a smaller radius than the forward end 102 of the adapter body 101. The male spigot portion 112 comprises an external thread 113 extending along the entire length of the spigot portion along axis A. The spigot portion is ended by a contact surface 114 transverse to axis A. The contact surface is intended to bear against a corresponding surface in the drill bit such that axial loads are transferred from the drill bit to the guide adapter via the contact surface 112. The adapter body length L is defined as the total length of the guide adapter, i.e. the adapter body including the spigot portion of the male coupling.

[0033] At the opposite end of the adapter body to the male coupling, the female coupling 111 is arranged within the rear part of the adapter body 101. The female coupling 111 is embodied as a recess 113 with a circular cross-sectional shape transverse to axis A extending coaxially to axis A within the adapter body from the rear end of the guide adapter 100. The radius of the recess corresponds to the radius of the male coupling 12, i.e the male spigot portion 14 of the drill string rod to make it possible to connect the forward end of the drill string rod 10 to the guide adapter. The female coupling has internal threads 114 corresponding to the external threads 15 on the male spigot portion 14.

[0034] In order to provide the desired guiding of the drill bit during drilling, the guide adapter comprises guiding elements 106 extending along the rear part of the adapter body. The design of the guide elements is illustrated in figure 3, 4 and 5.

[0035] In a plane transverse to axis A, the guide elements have a base 115 illustrated in figure 3, arranged towards the sleeve shaped adapter body 101 and a first 116 and second 117 side surface extending from the adapter body. The guide elements have a tapered shape in radial direction from axis A and are ended by an outer end surface 107 extending between the first and second side surface. The outer end surface 107 is shaped like a cirular arc with a radius corresponding to the radius from axis A to the outer end surface. The design of the first and second side surface and the outer end surface could however be modified in many different ways.

[0036] The guide elements have substantially identical shape and dimension and are arranged side by side at constant distance from each other around the periphery of the adapter body. The guide elements extend along the rear end 103 of the adapter body substantially parallel to axis A.

[0037] The guiding elements 106 in the rear end of the guide adapter have an extension in radial direction from axis A corresponding to the maximum radius Rf of the drill bit and curved, straight or stepwise reduced radial extension towards the forward end along axis A which is illustrated in the appended figures.

[0038] In order to provide the desired guiding of the drill bit it is essential that the dimensions of the drill bit and the guide adapter correspond to each other and in figure 6 the radial extensions of the drill bit and a corresponding guide adapter are illustrated. The drill bit could be embodied in many different ways but the essential feature of the drill bit is the maximum radius, i.e. the first radius Rf, of the drill bit that will determine the dimension of the formed bore hole once the drilling is initiated. The guide adapter according to the invention intended for use in combination with the described drill bit preferably has guiding elements 106 with an extension in radial direction Rr from axis A in the rear end of about 94 - 96 % of said first radius Rf, i.e. the maximum radius of the drill bit intended to be used in combination with the guide adapter.

[0039] Since the radial extension of the guide elements is reduced towards the forward end of the guide adapter the radial extension Rm of the guide elements in the forward end of the guiding elements is about 89 - 91 % of said first radius Rf, i.e. the maximum radius of the drill bit intended to be used in combination with the guide adapter.

[0040] The radial extension of the guiding elements 106 in figure 6 are decreasing in the direction from the rear end towards the forward end such that the guide elements will have a convex shape along axis A. The decresing radial extension of the guiding element also results in that the outer end surface will be slightly wider transveres to axis A due to the tapered shape of the guiding elements. The same consequence will also apply if the guiding element radial extension is decreasing along a substantially straight shape angled in relation to axis A along axis A. In the illustrated embodiment of the guide adapter, a transition section 124 is formed adjacent to the forward end of the guide elements to form a smooth

transition between the forward end of the guide elements 106 and the sleeve shaped adapter body 101.

[0041] There are a number of drill bits in different sizes available on the market today and consequently corresponding guide adapters will be required to ensure the desired performance of the drill arrangement.

[0042] Each guiding element furthermore comprises a rear end surface 109. In the illustrated embodiment of the guide adapter the rear surfaces have an undulating shape instead of a flat surface transverse to axis A to facilitate the transport of particles or gravel from the bore hole. The end surface could be modified in several ways to adapt the guide element for different conditions.

[0043] To extend the life time of the guide adapter, surfaces exposed to severe wear during drilling could be covered by an additional protective hard layer 108 applied on the outer end surfaces 107 of the guiding elements since these surfaces will be in contact with the walls of the bore hole to guide the drill bit. The guide adapter is made of a metal material and either an limited area of the outer end surface or the entire outer end surface of one or more guiding elements are covered with the hard layer that is more resistant to wear. Preferably, all outer end surfaces are covered by the hard layer 108 to ensure that all guiding elements have similar characteristics.

[0044] Furthermore, the rear end surface 109 of one or more of the guide elements could be covered by a rear end surface hard layer 122.

[0045] The hard layers 108 and 122 are made of a material that is harder and more resistant to wear than the metal material of the guide adapter to make it possible for the exposed surfaces of the guide adapter to withstand the wear for an extended period of time.

[0046] The applied hard layer on the outer end surface 107 and the rear end surface 109 has a thickness in a direction perpendicular to the covered surface within the range of 0.1 - 10 mm. The hard layer thickness is either constant over the entire covered area or adapted such that a thicker layer is applied where the risk for wear is higher.

[0047] The layer of material that is harder and more resistant to wear could be different types of materials. Examples of materials are material including an iron-based alloy, a cobalt-based alloy, a nickel-based alloy, a refractory metal, a cemented carbide, a metal matrix composite and/or a chromium carbide alloy with the desired characteristics. Further materials are possible as well.

[0048] The technique of applying a layer of material that is harder and more resistant to wear is often referred to as "hardfacing". Hardfacing is a metal working process where harder or tougher material is applied to a base metal. The material is often welded to the base material to ensure that the applied material is adhered to the base material. An alternative method involves the use of powder metal alloys that are welded to the surface of the product that need the protective layer.

[0049] The guide adapter 100 furthermore comprises a wear indicator 120 arranged in the outer end surface 107 of at least one of the guide elements 106 to indicate when the guide adapter is worn out and needs to be replaced. The wear indicator is a notch 120, recess or cut out portion arranged in the top end surface 107 somewhere along the top end surface where it is easy for the operator to inspect. Preferably the the notch 120, recess or cut out portion is arranged close to the forward end of the guiding elements 106 where the radial extension of the guiding elements is smaller and the loads on the guide elements from the bore hole is smaller than in the rear end of the guide adapter to prevent that the strength of the guiding elements is affected. The notch, recess or cut out portion has a depth selected such that when the guide adapter 100 is worn out, the notch is no more visible in the top end surface 107. The depth of the wear indicator is selected such that the bottom of the wear indicator has a radial extension Rw within the range of 80 - 99 % of the guiding element extension in radial direction Rr from axis A in the rear end of the guide adapter. In a preferred embodiment of the war indicator the depth is within the range of 85 - 95 % of the guiding element extension Rr in radial direction from axis A in the rear end of the guide adapter.

[0050] While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiments. The skilled person understands that many modifications, variations and alterations are conceivable within the scope as defined in the appended claims.

[0051] Additionally, variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope of the claims.

Claims

1. Guide adapter (100) for guiding a drill bit during percusion drilling, said guide adapter is intended to be arranged between the drill bit (20) and an elongated drill string (10) extending along an axis A, said drill bit (20) having a first radius (Rf) transverse to axis A, said guide adapter (100) comprising:

   a sleeve shaped adapter body (101) intended to extend along axis A and comprising a forward

end (102) with a first coupling (104) intended for connecting the guide adapter to the drill bit, and a rear end (103) with a second coupling (105) intended for connecting the guide adapter (100) to the drill string; and
a plurality of guiding elements (106) extending substantially radially in relation toaxis A from the sleeve shaped adapter body (101),

wherein the guiding elements (106) extend along 60% or less of the adapter body length (L) along axis A and are arranged in the rear end (103) of the adapter body (101), said guiding elements (106) in the rear end (103) has an extension (Rr) in radial direction from axis A substantially equal to said first radius (Rf) and curved, straight or stepwise reduced radial extension towards the forward end along axis A.

2. Guide adapter according to claim 1, wherein the guide adapter (100) comprises at least five guide elements (106) with substantially identical shape and dimension.

3. Guide adapter according to claim 1 or 2, wherein the guide elements (106) are substantially straight and extending parallel to axis A along the sleeve shaped adapter body (101).

4. Guide adapter according to claim 1, 2 or 3, wherein the guide elements (106), in a plane transverse to axis A, have a base arranged towards the sleeve shaped adapter body (101), said guide elements (106) have a tapered shape in radial direction from axis A and are ended by an outer end surface (107).

5. Guide adapter according to claim 4, wherein the outer end surface (107) is shaped like a cirular arc with a radius corresponding to the radius from axis A to the outer end surface (107).

6. Guide adapter according to claim 4 or 5, wherein at least an area of the outer end surface (107) of at least one guiding element (106) is covered by a hard layer (108).

7. Guide adapter according to any one of claim 4 to 6, wherein the hard layer (108) is applied on the outer end surfaces (107) along the entire guide elements along axis A.

8. Guide adapter according to any one of the previous claims, wherein the guide elements (106) comprises a rear end surface (109) and the rear end surface of at least one guide element is covered by a rear end surface hard layer (110).

9. Guide adapter according to any one of the previous claims, wherein the guiding elements (106) in the rear end (103) has an extension in radial direction (Rr) from axis A of about 94 - 96 % of said first radius (Rf), and a radial extension (Rm) in the forward end of the guiding elements of about 89 - 91% of said first radius.

10. Guide adapter according to any one of claims 4 to 9, wherein a wear indicator (120) is arranged in the outer end surface (107) of at least one of the guide elements (106) to indicate when the guide adapter is worn out and needs to be replaced.

11. Guide adapter according to claim 10, wherein the wear indicator is a notch (120), recess or cut out portion arranged in the top end surface (107), said notch, recess or cut out portion has a depth selected such that when the guide adapter (100) is worn out, the notch is no more visible in the top end surface (107).

12. Guide adapter according to claim 10, wherein the distance (Rw) from axis A to the wear indicator is within the range of 80 - 99 % of the guiding element extension (Rr) in radial direction from axis A in the rear end of the guide adapter, and preferably within the range of 85 - 95 % of the guiding element extension (Rr) in radial direction from axis A in the rear end of the guide adapter.

13. Guide adapter according to anyone of the previous claims, wherein the guide elements (106) extend along 50% or less of the adapter body length (L) along axis A, alternatively 40% or less of the adapter body length (L) along axis A.

14. Guide adapter according to anyone of the previous claims, wherein the radial extension of the guiding elements (106) are decreasing in the direction from the rear end towards the forward end such that the guide elements will have a convex shape along axis A, or a substantially straight shape angled in relation to axis A along axis A.

15. Drill arrangement for percussion drilling comprising a drill string (10), a drill bit (20) having a first radius (Rf) transverse to axis A and a guide adapter (100) according to claim 1 arranged between the drill string and the drill bit to reduce the risk for deviation.

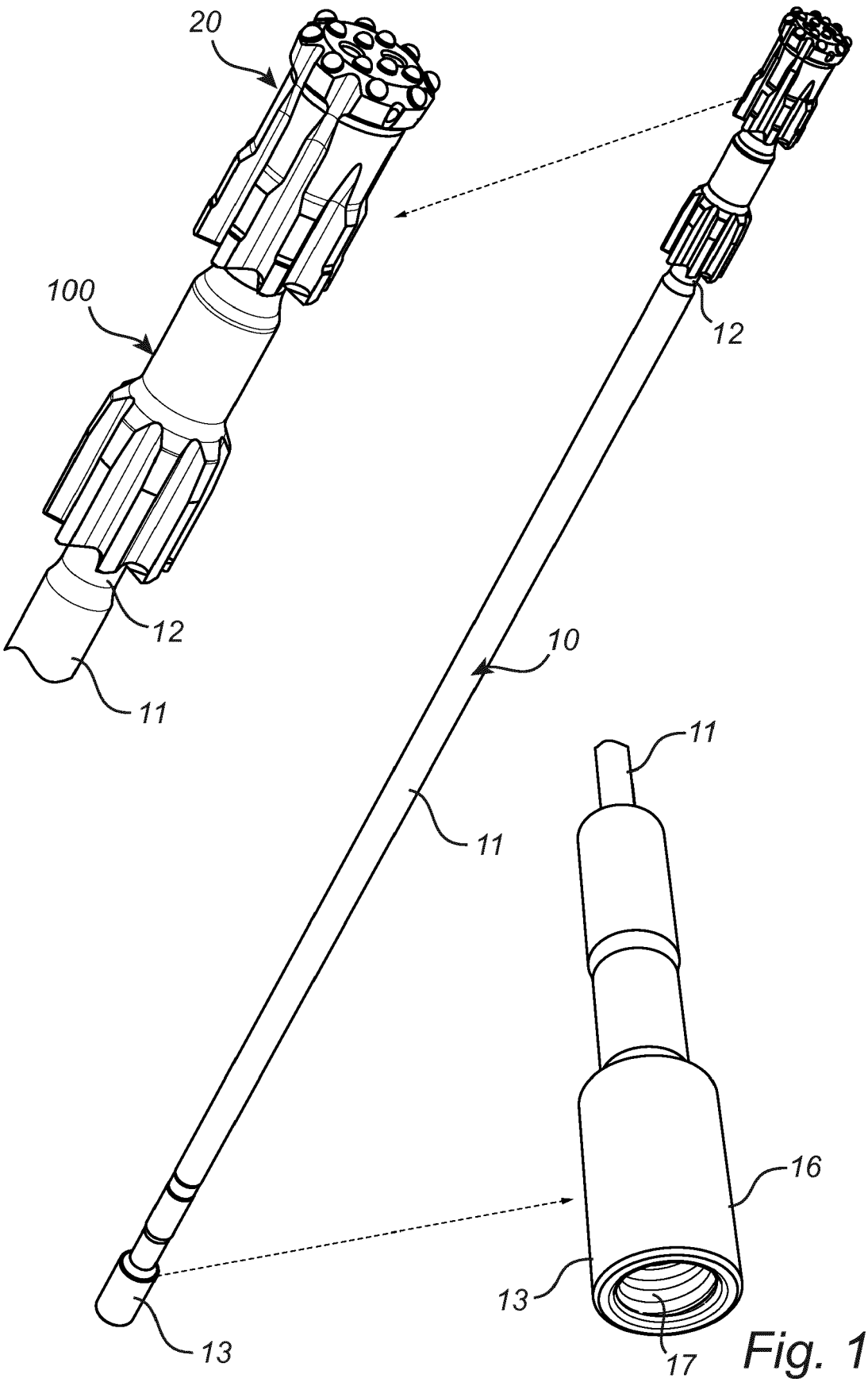

Fig. 1

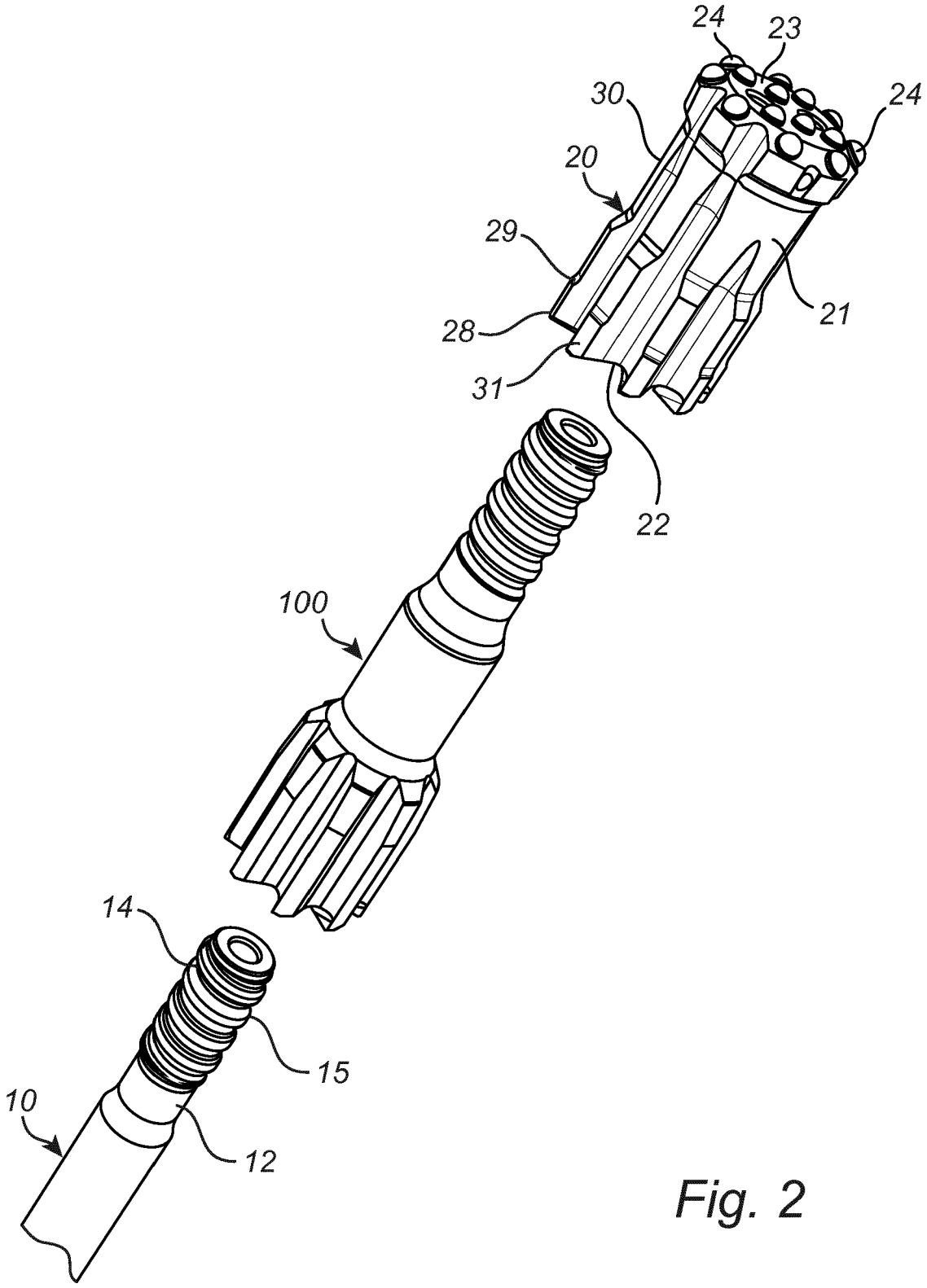

Fig. 2

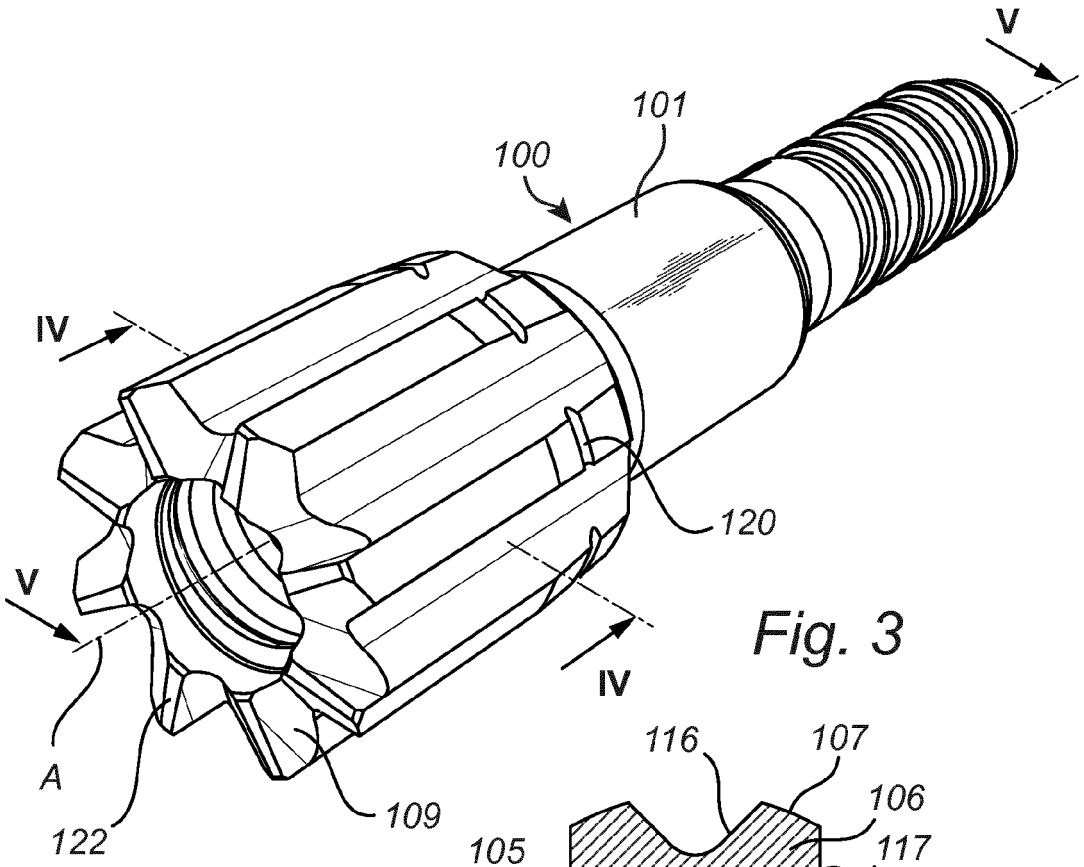

Fig. 3

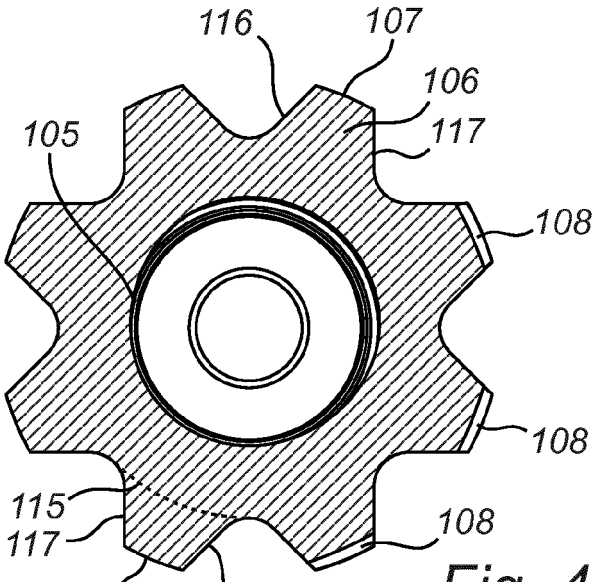

Fig. 4

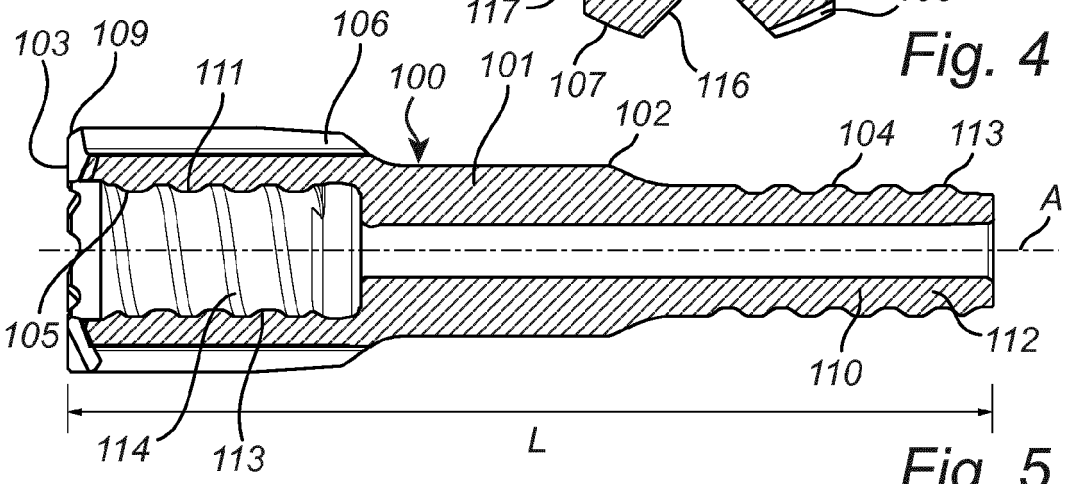

Fig. 5

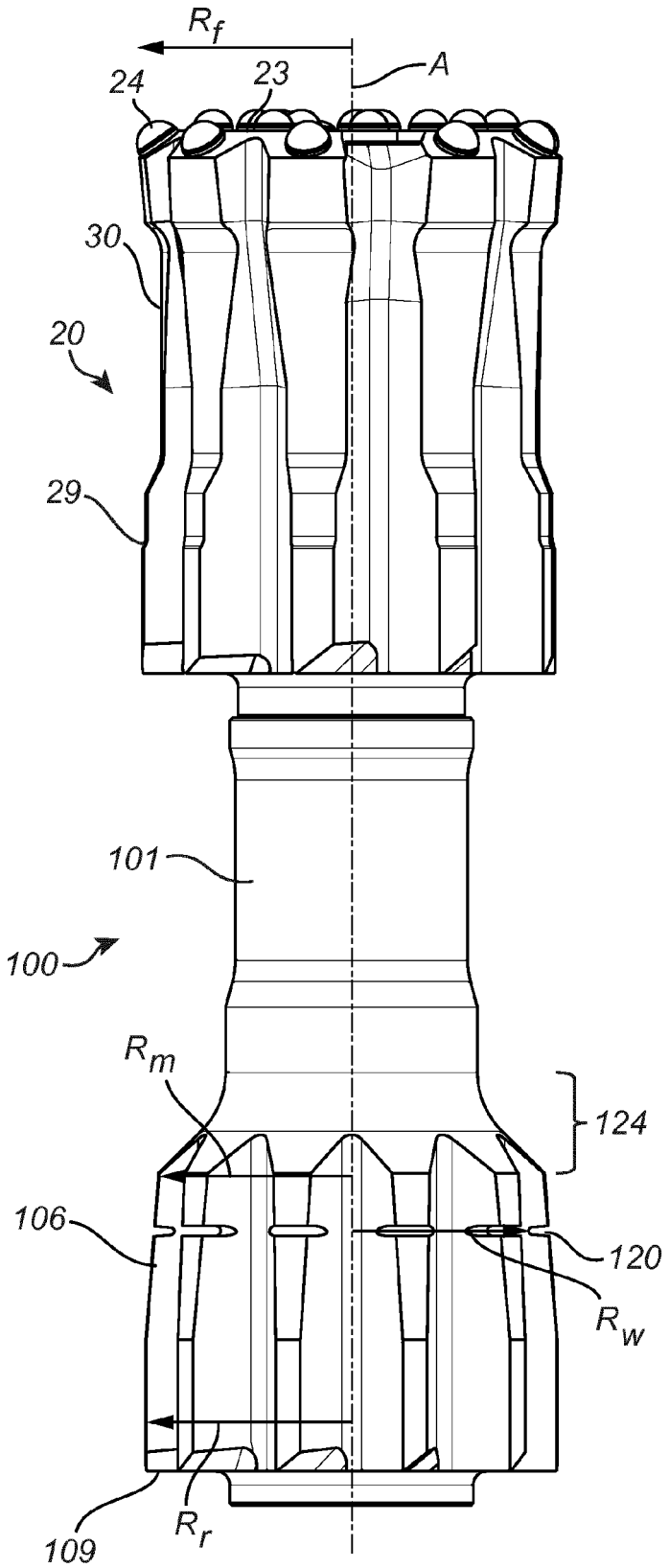

Fig. 6

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 19 18 0284

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 5 722 496 A (CONNELL STUART A [US] ET AL) 3 March 1998 (1998-03-03) * column 2, line 45 - column 3, line 26; figures 3,4,6 * -----	1-15	INV. E21B10/36 E21B17/042 E21B17/10
A	WO 2012/006671 A1 (STRYDOM GEORGE JOHAN [AU]) 19 January 2012 (2012-01-19) * abstract; figures 6-8 * -----	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

E21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	22 November 2019	Strømmen, Henrik

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 18 0284

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

22-11-2019

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5722496 A	03-03-1998	BR 9708102 A	27-07-1999
		CA 2249282 A1	25-09-1997
		CN 1218532 A	02-06-1999
		EP 0886716 A1	30-12-1998
		JP 2000506575 A	30-05-2000
		KR 20000064669 A	06-11-2000
		US 5722496 A	03-03-1998
		WO 9735092 A1	25-09-1997
WO 2012006671 A1	19-01-2012	US 2012125691 A1	24-05-2012
		WO 2012006671 A1	19-01-2012

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 8051927 B2 **[0003]**