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(54) **Title:** RADIAL AND CONICAL TOOLS WITH COMPRESSION BAND RETAINER

(57) **Abstract:** Tool bit for non-rotatable mounting in a bore of a holder has a cutting head, a shoulder and a shank arranged axially along an axis of the tool bit. A groove is disposed circumferentially about a portion of the shank, and a compression band seated therein. Two or more grooves on the shank can include a non-metallic compression band and an optional o-ring. The compression bands/o-ring protrude past the outermost surface of the shank and, when the tool bit is positioned in a bore of a holder or sleeve, cause an outermost surface of the shank to be in non-contact with an inner diameter surface of the mounting bore and seal the space between the shank and the inner diameter surface of the bore to help prevent moisture and dust encountered during operation from getting between the tool and the holder.



RADIAL AND CONICAL TOOLS WITH COMPRESSION BAND RETAINER

FIELD OF THE DISCLOSURE

[0001] The present disclosure relates to a tool for cutting geological formations or other hard materials. More specifically, the present disclosure relates to a tool bit including a compression band arrangement for retaining the tool bit in a holder. The tool bit is generally of the non-rotating type and can be either a radial tool bit or a conical tool bit. The disclosure relates to the tool bit per se, as well as to the combination of the tool bit and a holder and to the apparatus with such a tool bit.

BACKGROUND

[0002] In the discussion that follows, reference is made to certain structures and/or methods. However, the following references should not be construed as an admission that these structures and/or methods constitute prior art. Applicant expressly reserves the right to demonstrate that such structures and/or methods do not qualify as prior art against the present invention.

[0003] Road milling, stump cutting, mining, foundation drilling and trenching are examples of activities and equipment that generally cut earth and rock with cemented carbide tipped tool bits. The tool bits generally utilized in these activities and on this type of equipment are either a radial design or a conical design. The shanks of such tool bits typically are inserted into a bore in a holder, such as a block and sleeve assembly or a bore in a moving or rotating element of the equipment, either directly or with an intermediate sleeve. Examples of blocks and/or block and sleeve assemblies are disclosed in U.S. Pat. No. 7,097,257; U.S. Pat. No. 7,234,782; U.S. Pat. No. 5,251,964; DE 4 204 542; DE 196 30 653; and DE 198 21 147, the entire contents of each are incorporated herein by reference.

[0004] Different designs of tools function differently. For example, conical tool bits are characterized in that they can rotate to self sharpen the cemented carbide tip.

However, even though conical designs may have a conical shank, some conical designs do not rotate, particularly if the tool bit has a radial tip or a super hard tip that does not require sharpening and therefore no rotation is required. Also for example, radial designs are characterized in that they generally are not required to rotate.

[0005] Because the shanks of conical tool bits typically are circular in radial cross-section, the bore in which the shank is inserted is also conical. Radial tool bits generally utilize shanks having polygonal or non-circular radial cross-sections and utilize a correspondingly shaped bore, e.g., a rectangular or square hole, in the holder to retain the tool bit and prevent rotation. See for example, U.S. Patent Publication No. 2010/01 941 76, the entire contents of which are incorporated herein by reference.

[0006] As between the two, the conical bore is relatively easy to form in the body of the holder while the bore for the radial tool bit has a geometry that is relatively more difficult to form. The most common method of forming the bore for the shank of a radial tool bit is a broaching operation, which is slow and time consuming. This makes these types of holders relatively more expensive to produce.

[0007] The shank of the tool bit can be retained mechanically in the holder. However, because the shank of the tool bit typically must be pressed into the bore of the holder, tight tolerance machining and grinding is used to maintain the proper interference fit between the shank and the inner diameter of the bore. Alternatively, the shank may have a metal spring retainer, but such retainers can lose resilience or become brittle and crack or break. Further, dust, debris, corrosion, and rust between the steel components may become a problem, increasing the forces necessary to remove the shank from the bore of the holder block. In some cases, the shank and bore surfaces can become "frozen," for example due to the rust and corrosion, and they must then be torched off.

[0008] Accordingly, there is a need in the art for a mechanism to retain a tool bit in a holder that both secures the tool bit during use and is readily removable when necessary for maintenance and/or replacement.

SUMMARY

[0009] This disclosure describes a compression band arrangement for retaining a non-rotating radial or conical tool bit in a bore of a holder for cutting geological formations or other hard materials, such as utilized in road milling, stump cutting, mining, foundation drilling and trenching equipment. The compression bands are retained in grooves in the shank of the tool bit. The compression bands create an annular space between the shank of the tool bit and the bore of the block, and retain the tool bit in the holder by being resiliently compressed between the shank of the tool bit and the inner diameter of the bore. Additionally, the compression sleeves seal the annular space to prevent intrusion of water, moisture, dust, debris, and the like, so as to inhibit the formation of rust and to prevent binding of the tool bit to the holder.

[0010] An exemplary embodiment of tool bit for non-rotatable mounting in a bore of a holder comprises a cutting head at a front end with a cutting tip, a shank at a rear end, a shoulder at a transition between the front end and the shank, a groove disposed circumferentially about a portion of the shank, and a compression band seated in the groove, wherein the cutting head, shoulder and shank are arranged axially along an axis of the tool bit, wherein an outermost surface of the shank is located, in a direction normal from the axis, at a first radial distance, wherein at least a portion of an outermost surface of the compression band is located, in a direction normal from the axis, at a second radial distance, and wherein the second radial distance is greater than the first radial distance.

[0011] An exemplary embodiment of an assembly comprises a holder having a first bore extending rearwardly from a forwardly oriented front face, and a tool bit non-rotatably mounted in the first bore of the holder, the tool bit including a cutting head at a front end with a cutting tip, a shank at a rear end, a shoulder at a transition between the front end and the shank, a groove disposed circumferentially about a portion of the shank, and a compression band seated in the groove, wherein the cutting head,

shoulder and shank are arranged axially along an axis of the tool bit, wherein an outermost surface of the shank is located, in a direction normal from the axis, at a first radial distance, wherein at least a portion of an outermost surface of the compression band is located, in a direction normal from the axis, at a second radial distance, and wherein the second radial distance is greater than the first radial distance.

[0012] In another exemplary embodiment, a mining machine includes a rotatable member and one or more blocks mounted on the rotatable member, each block including a tool bit for non-rotatable mounting in a bore of a holder comprises a cutting head at a front end with a cutting tip, a shank at a rear end, a shoulder at a transition between the front end and the shank, a groove disposed circumferentially about a portion of the shank, and a compression band seated in the groove, wherein the cutting head, shoulder and shank are arranged axially along an axis of the tool bit, wherein an outermost surface of the shank is located, in a direction normal from the axis, at a first radial distance, wherein at least a portion of an outermost surface of the compression band is located, in a direction normal from the axis, at a second radial distance, and wherein the second radial distance is greater than the first radial distance.

BRIEF DESCRIPTION OF THE DRAWING

[0013] The following detailed description of preferred embodiments can be read in connection with the accompanying drawings in which like numerals designate like elements and in which:

[0014] FIGS. 1 and 3 illustrate the exemplary tool bit with one or two grooves, respectively, and without compression bands.

[0015] FIGS. 2 and 4 illustrate the exemplary tool bit with one or two grooves, respectively, in cross-sectional view and with the compression band(s).

[0016] FIGS. 5 and 6 show an exemplary embodiment of a tool bit of radial design.

[0017] FIGS. 7A and 7B illustrate an example of a conical tool having a shank with compression bands positioned in holder.

[0018] FIG. 8 illustrates an example of a radial tool having a shank with compression bands positioned in a holder.

[0019] FIG. 9 is a side elevation illustrating a tool bit with a single compression band and an optional o-ring arranged along the shank.

DETAILED DESCRIPTION

[0020] An exemplary embodiment of a tool bit with at least one, alternatively two or more, compression bands arranged along a length of the shank of the tool bit is schematically illustrated (with and without the compression bands) in FIGS. 1-4. FIGS. 1 and 3 illustrate an exemplary tool bit with one or two grooves, respectively, and without compression bands; FIGS. 2 and 4 illustrate another exemplary tool bit with one or two grooves, respectively, in cross-sectional view and with compression band(s). The illustrated tool bits 100 have a cutting head 102 at a front end 104 with a cutting tip 106, a shank 108 at a rear end 110 and a shoulder 112 at a transition between the front end 104 and the shank 108. The cutting head 102, shoulder 112 and shank 108 are arranged axially along an axis 114 of the tool bit 100. The shank 108 has an outermost surface 116 which is located, in a direction normal from the axis 114, at a first radial distance $R1$.

[0021] One or more grooves 120 are disposed circumferentially about a portion of the shank 108. For example, when there are two grooves, a first groove 120a is disposed circumferentially about a first portion of the shank 108 and a second groove 120b is disposed circumferentially about a second portion of the shank 108 and the first portion of the shank 108 is positioned axially rearward from the second portion of the shank 108.

[0022] As shown in FIGS. 2 and 4, a compression band 130 is seated in the groove(s) 120, 120a, 120b. At least a portion of an outermost surface 132 of the compression band 130 is located, in a direction normal from the axis 114, at a second radial distance $R2$. The second radial distance $R2$ is greater than the first radial

distance R1. The compression band 130 can be positioned in a respective one of the grooves 120, 120a, 120b by, for example, sliding the compression band 130 up the shank 108 from the rear end 122, in which case the compression band 130 radially expands to be movable over the non-grooved portions of the shank 108 and then radially contracts to sit in the groove 120, 120a, 120b. Alternatively, the compression band 130 can have a slit forming two ends which allows the compression band 130 to be opened and placed around the shank 108 at any desired intermediate position along the axial length, including directly into a groove 120, 120a, 120b.

[0023] The tool bits shown in FIGS. 1-4 are of a conical design, but the features related to the grooves and the compression bands disclosed and described in connection with FIGS. 1-4 can be equally incorporated into a tool bit of radial design. For example, FIGS. 5 and 6 show an exemplary embodiment of a tool bit of radial design. The radial tool bit 140 shown has a cutting head 142, a shank 144 with a substantially circular radial cross-section, grooves 150 for the compression bands, and, when installed, compression bands 160. The cutting head 142 and shank 144 are arranged axially along an axis 146 of the radial tool bit 140. In FIGS. 5 and 6, compression bands 160 are seated in each of the grooves 150 and the grooves 150 are not directly shown. The manner in which the compression bands 160 can be seated in the grooves 150 can be consistent with that described herein for the tool bit of conical design. Where a tool bit of radial design has a shank with a non-circular radial cross-section, the compression band can be formed to accommodate that shape and thereby be positioned within the grooves in substantially the same way as that described above with respect to the tool bit of conical design. In the example illustrated in FIGS. 4 and 5, two compression bands 160 are included, but one compression band, similar to that illustrated in FIG. 2, or more than two compression bands, can alternatively be utilized.

[0024] The shank 108, 144 with the compression bands 130, 160 is adapted to fit into a bore of a holder, either directly or with an intermediate hollow sleeve. An example of a sleeve includes that disclosed and described in U.S. Patent Application No. 13/338,318 entitled "Bit Sleeve With Compression Band Retainers" filed

concurrently herewith, the entire contents of which are incorporated herein by reference.

Sleeves with compression bands can also be utilized. The holder can be a block mounted on a rotatable element of a machine for mining, excavating, tunneling, road planing and/or construction (not shown), such as an Alpine Miner mining machine available from Sandvik AB, or can be a bore incorporated directly into such a rotatable element, such as in the stump grinder disclosed in U.S. Patent No. 7,007,414, the entire contents of which are incorporated herein by reference.

[0025] FIGS. 7A and 7B illustrate an example of a conical tool 200 having a shank 202 with compression bands 204 positioned in a holder 206. The holder 206 can be of any suitable form. In the illustrated example, the holder 206 includes a holder block having a first bore 210 extending rearwardly from a forwardly oriented front face and an intermediate sleeve 208 that is positioned in the bore 210 of the holder 206. The shank 202 of the conical tool 200 is directly mounted in the bore 212 of this intermediate sleeve 208.

[0026] FIG. 7B is a magnified view of the shank 202 of the conical tool 200 illustrating compression bands 204 and the position of the compression bands 204 and the outermost surface 214 of the shank 202 relative to the inner diameter surface 220 of the bore 212. As described herein, there is a difference Δ between the second radial distance R_2 associated with the outermost surface of the compression band 204 and the first radial distance R_1 associated with the outermost surface 214 of the shank 202 (e.g., R_2 is greater than R_1). This difference Δ results in at least a portion of the outermost surface 214 of the shank 202, or alternatively a majority of the length of the shank 202 or further alternatively all of the length of the shank 202, not being in contact with the inner diameter surface 220 of the bore 212. In preferred embodiments where two compression bands 204 are used, the portion of the shank 202 not in contact with the inner diameter surface 220 includes the portion of the shank 202 between the two compression bands 204. This produces a space 230 between the shank 202 and the inner diameter surface 220 of the bore 212.

[0027] As in the example illustrated in FIGS. 7A and 7B, the holder can be mounted on a rotatable element of a machine for mining, excavating, tunneling, road planing and/or construction (not shown). Alternatively, the holder is a bore incorporated directly into a rotatable element of a machine for mining, excavating, tunneling, road planing and/or construction (not shown).

[0028] FIG. 8 illustrates an example of a radial tool 300 having a shank 302 with compression bands 310 positioned in a bore 320 incorporated directly into a rotatable element 322. Similarly to what is illustrated in FIG. 7B, FIG. 8 illustrates, in a magnified view, the position of the compression bands 310 and the outermost surface 304 of the shank 302 relative to the inner diameter surface 324 of the bore 320. The difference Δ between the second radial distance R2 associated with the outermost surface of the compression band and the first radial distance R1 associated with the outermost surface of the shank (e.g., R2 is greater than R1) results in at least a portion of the outermost surface 304 of the shank 302, or alternatively a majority of the length of the shank 302 or further alternatively all of the length of the shank 302, not being in contact with the inner diameter surface 324 of the bore 320. In preferred embodiments where two compression bands 310 are used, the portion of the shank 302 not in contact with the inner diameter surface 324 includes the portion of the shank 302 between the two compression bands 310. This produces a space 330 between the shank 302 and the inner diameter surface 324 of the bore 320.

[0029] In exemplary embodiments, the compression bands are fitted into grooves on the shank. One compression band is typically located on the bottom (rear) of the tool and mates with a straight bore section on the holder. The other compression band is located on the top of the shank and also mates with the bore of the holder. When one compression band is used, it can be at either the bottom or the top location.

[0030] A tool bit with one or more compression bands as disclosed herein is advantageous. For example, a tool bit with compression bands does not rely on rectangular holes to prevent rotation. The tool can have a shank with a cylindrical

shape which fits into a substantially round bore. Therefore the bore can be easily drilled.

[0031] Also for example, the compression bands seal the space between the shank of the tool bit and the bore, preventing any water, moisture, dust or debris from entering that space. The compression band towards the front end of the tool bit seals the forward end of the space and the compression band seals the other, rearward end of the space. Sealing the space in the holder between the shank and the bore helps to prevent the major portion of moisture and dust encountered during operation from getting between the tool and the holder. This will help to prevent the surfaces from rusting and freezing together. In addition, because of the space created by the difference in radial distances, the metallic materials of the shank and of the bore do not rust together.

[0032] Further for example, the compression bands reduce wear on the holder (or intermediate sleeve) bore by absorbing vibration and keeping the tool shank away from the bore surface.

[0033] An additional example is that the compliance of the compression bands means the fit-up tolerance between the shank dimensions and the bore dimensions can be wider than with a typical interference press fit. This reduces manufacturing costs and reduces scrap.

[0034] Furthermore, the material of the compression bands make the tool bit easier to install and remove, while providing a secure fit. Accordingly, there are reduced or no separate or loose pieces to be concerned about. Separate pieces, such as nuts or retainers, often get lost or damaged.

[0035] An exemplary embodiment of a compression band is non-metallic and is formed of a compliant and resistant material. For example, a preferred embodiment of a non-metallic, compliant and resilient material consists essentially of nylon with embedded glass fibers, the glass fibers present at from 10 to 50 vol%, alternatively at about 30 vol%. Suitable nylon composite material is glass-filled nylon 66 available as

Ertalon 66®-GF30 available from, for example, Quadrant Engineering Plastic Products. Another suitable nylon composite material is glass reinforced nylon available as MolyGard wear rings from Zatkoff Seals & Packings of Farmington Hills, MI.

[0036] The material of construction of the compression bands enables the bit sleeve to be installed into and removed from the bore with relative ease (i.e., without binding or seizing) while providing a secure fit that prevents the bit sleeve from walking out of the bore as a result of the vibration imparted by the tool bit. For example, one and preferably both compression bands are made from a resilient abrasion-resistant material that is not susceptible to corrosion or rust, for example, a nylon composite material. In one variation, the compression bands are made from a nylon composite material including glass in the composite.

[0037] Further, the resilience or compliance of the compression bands enables the fit tolerance between the body and the bore to be wider than is typically required for a compression fit, which reduces manufacturing costs and scrap. Also, because the compression bands are retained in the grooves on the body, there are no separate parts that can be potentially lost or damaged.

[0038] The compression band maintains a space between most of the shank outermost surface and the inner diameter surface of the bore, thereby allowing none or only a small contact area between the surface of the shank and the bore. The small contact area substantially prevents the tool bit from locking together with the bore of the holder (or intermediate sleeve).

[0039] When mounted in the bore, the compression bands have a friction inducing contact with the inner surface of the bore. This friction provides a force that counteracts rotational forces of the tool bit when in operation. The value of this force is proportional to the area of the contact and the compressive force resulting from any differential in the radial size of the space in which the compression band is located and the thickness of the compression band itself. Accordingly, in an alternative embodiment, the rear groove (and the rear compression band) can have a length in the axial direction of the tool bit

that is about twice as large as the length in the axial direction of the front groove (and the front compression band). Consequently, the rear compression band provides more compressive force to retain the tool bit in the bore than the front compression band , while the front compression band serves to prevent the front portion of the shank from becoming locked against the bore.

[0040] Although presently contemplated as preferably having two grooves located on the shank, each of which has a compression band, the inventors contemplate that a single compression band can be utilized if it provides sufficient friction in contact with the inner surface of the bore of the holder to overcome the centrifugal and other forces generated when the tool bit is in use and thereby to prevent rotation of the tool bit relative to the bore of the holder. Accordingly, an optional o-ring can also be included. The o-ring can assist in sealing one end of the shank, as discussed herein with respect to the compression bands. FIG. 9 is a side elevation illustrating a tool bit 400 with a single compression band 402 and an optional o-ring 404 arranged along the shank 406. However, the use of an o-ring is not limited to embodiments using a single compression band. Further, although shown in FIG. 9 with respect to a radial tool bit, a similar use and arrangement of o-ring and compression band can be incorporated into conical tool bits.

[0041] Although the present invention has been described in connection with preferred embodiments thereof, it will be appreciated by those skilled in the art that additions, deletions, modifications, and substitutions not specifically described may be made without department from the spirit and scope of the invention as defined in the appended claims.

CLAIMS

What is claimed is:

1. A tool bit for non-rotatable mounting in a bore of a holder, the tool bit comprising:
 - a cutting head at a front end with a cutting tip;
 - a shank at a rear end;
 - a shoulder at a transition between the front end and the shank;
 - a groove disposed circumferentially about a portion of the shank; and
 - a compression band seated in the groove,wherein the cutting head, shoulder and shank are arranged axially along an axis of the tool bit,
 - wherein an outermost surface of the shank is located, in a direction normal from the axis, at a first radial distance,
 - wherein at least a portion of an outermost surface of the compression band is located, in a direction normal from the axis, at a second radial distance, and
 - wherein the second radial distance is greater than the first radial distance.
2. The tool bit of claim 1, wherein the tool bit includes two grooves, a first groove disposed circumferentially about a first portion of the shank and a second groove disposed circumferentially about a second portion of the shank, the first portion of the shank positioned axially rearward from the second portion of the shank.

3. The tool bit of claim 2, wherein a compression band is seated in each of the two grooves.
4. The tool bit of claim 2, wherein a compression band is seated in a first of the two grooves and an o-ring is seated in a second of the two grooves.
5. The tool bit of claim 1, wherein the compression band is non-metallic.
6. The tool bit of claim 1, wherein the compression band is formed from a compliant and resistant material.
7. The tool bit of claim 6, wherein the compliant and resistant material consists essentially of nylon with embedded glass fibers.
8. The tool bit of claim 7, wherein the embedded glass fibers are present at from 10 to 50 vol%.
9. The tool bit of claim 1, wherein the tool bit is a conical tool bit or a radial tool bit.
10. An assembly comprising:
 - a holder having a first bore extending rearwardly from a forwardly oriented front face; and

a tool bit non-rotatably mounted in the first bore of the holder, the tool bit including a cutting head at a front end with a cutting tip, a shank at a rear end, a shoulder at a transition between the front end and the shank, a groove disposed circumferentially about a portion of the shank, and a compression band seated in the groove,

wherein the cutting head, shoulder and shank are arranged axially along an axis of the tool bit,

wherein an outermost surface of the shank is located, in a direction normal from the axis, at a first radial distance,

wherein at least a portion of an outermost surface of the compression band is located, in a direction normal from the axis, at a second radial distance, and

wherein the second radial distance is greater than the first radial distance.

11. The assembly of claim 10, wherein at least a portion of the outermost surface of the shank is in non-contact with an inner diameter surface of the first bore.

12. The assembly of claim 11, wherein a majority of the length of the shank is in non-contact with an inner diameter surface of the first bore.

13. The assembly of claim 10, wherein the tool bit includes two grooves, a first groove disposed circumferentially about a first portion of the shank and a second groove disposed circumferentially about a second portion of the shank, the first portion of the shank positioned axially rearward from the second portion of the shank.

14. The assembly of claim 13, wherein a compression band is seated in each of the two grooves.

15. The assembly of claim 14, wherein an outermost surface of the shank is in non-contact with an inner diameter surface of the first bore along a majority of the length of the shank.

16. The assembly of claim 14, including a space between the shank and the inner diameter surface of the bore, the space located axially between the compression band seated in the first groove and the compression band seated in the second groove.

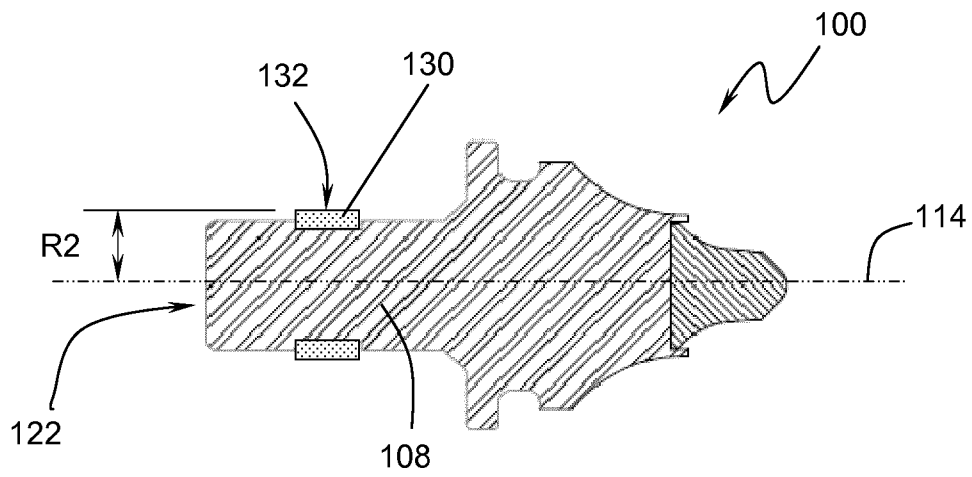
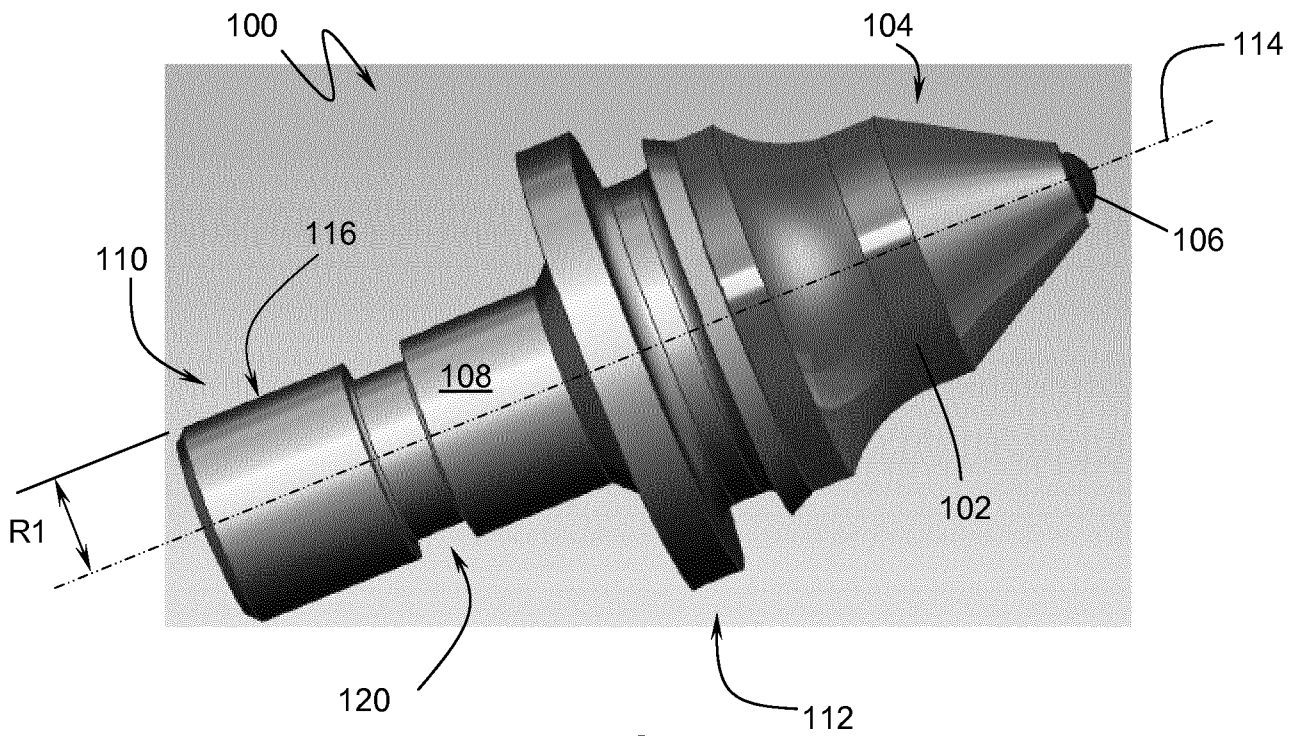
17. The assembly of claim 13, wherein a compression band is seated in a first of the two grooves and an o-ring is seated in a second of the two grooves.

18. The assembly of claim 17, wherein an outermost surface of the shank is in non-contact with an inner diameter surface of the first bore along a majority of the length of the shank.

19. The assembly of claim 17, including a space between the shank and the inner diameter surface of the bore, the space located axially between the compression band seated in the first groove and the o-ring seated in the second groove.

20. The assembly of claim 10, wherein the compression band is non-metallic.

21. The assembly of claim 20, wherein the compliant and resistant material consists essentially of nylon with embedded glass fibers.



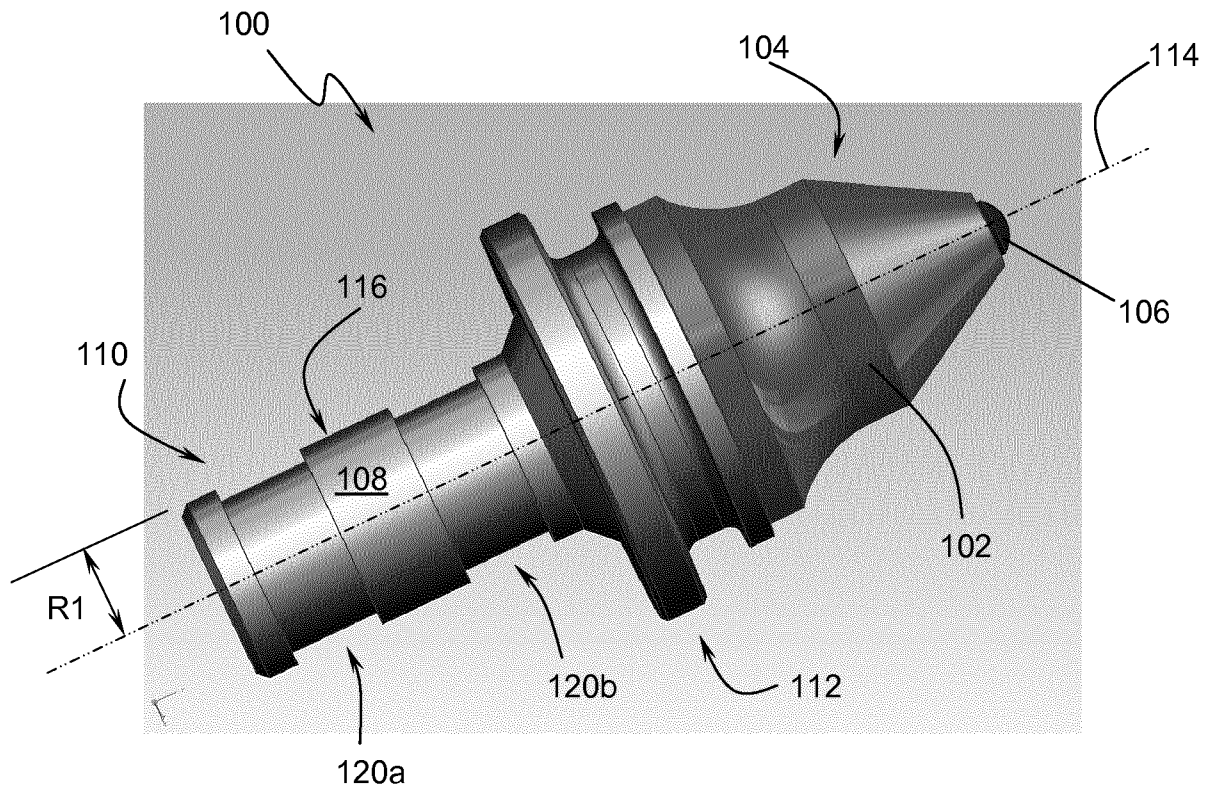


FIG. 3

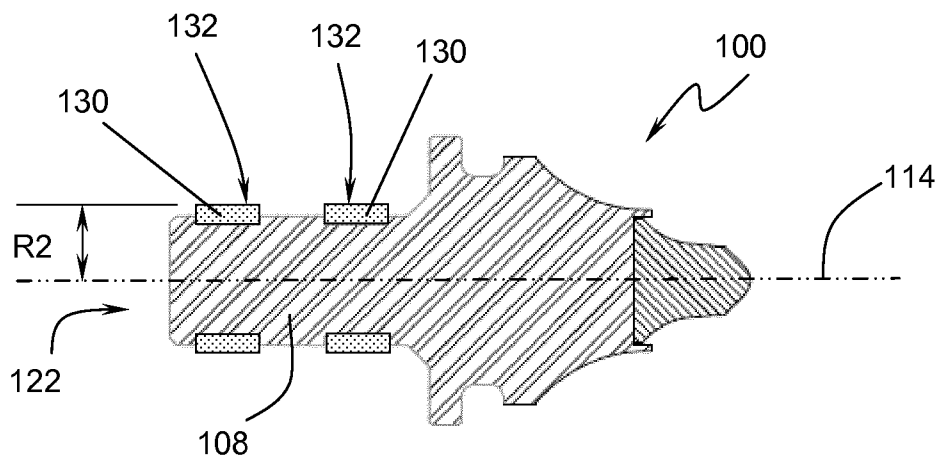


FIG. 4

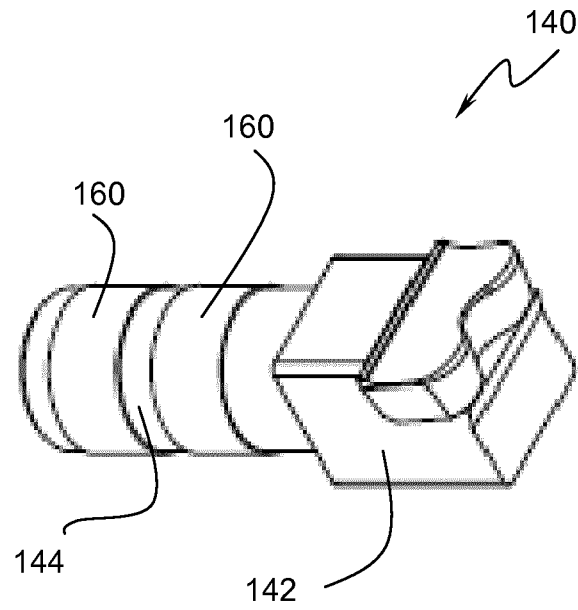


FIG. 5

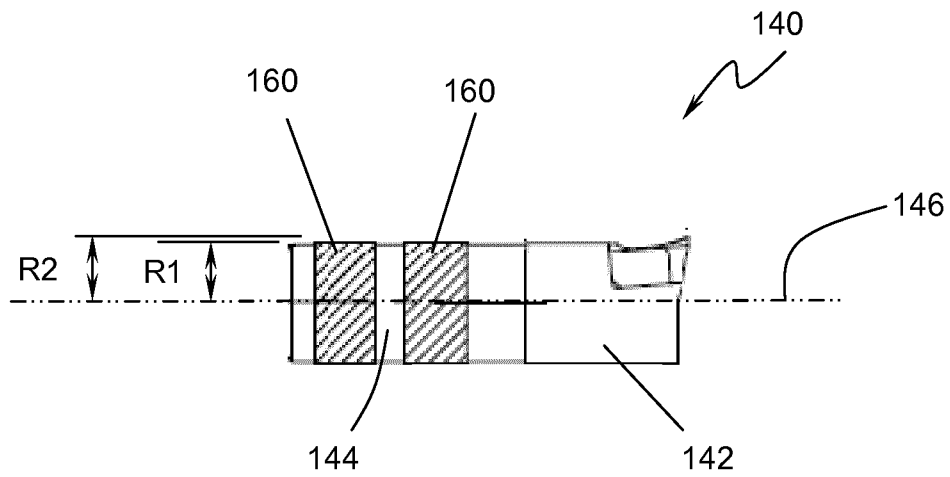


FIG. 6

FIG. 7B

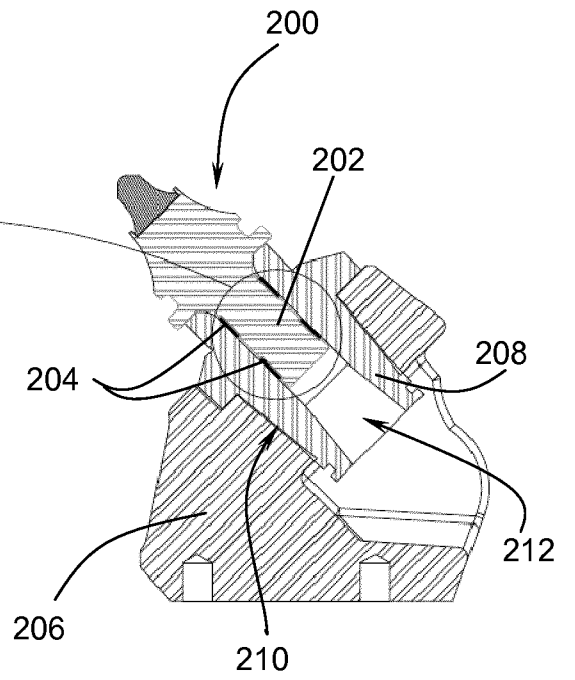
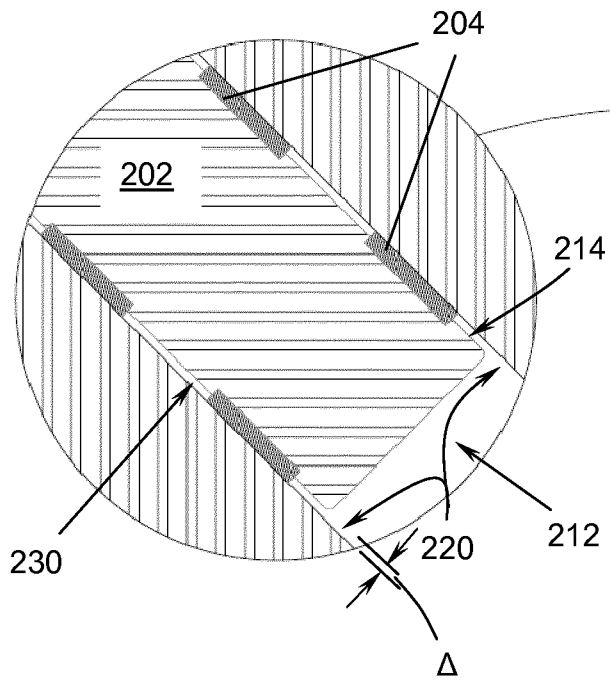


FIG. 7A

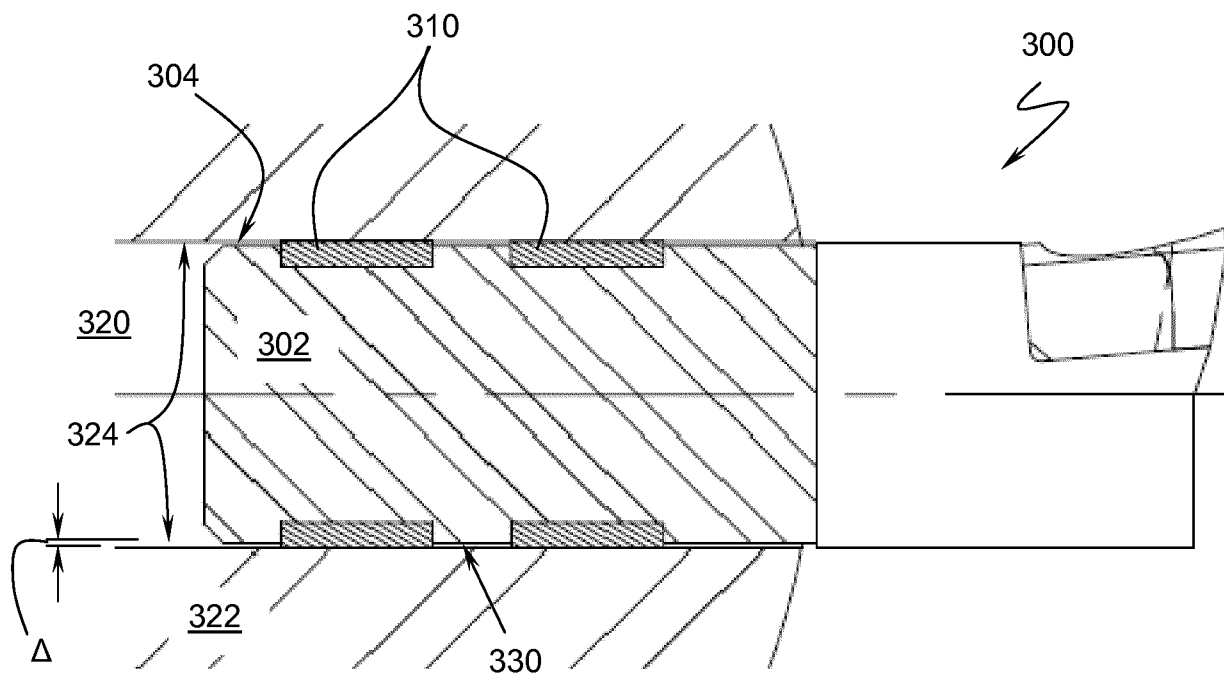


FIG. 8

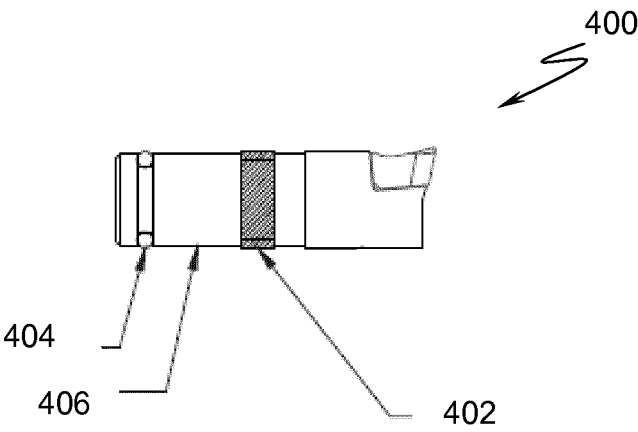


FIG. 9