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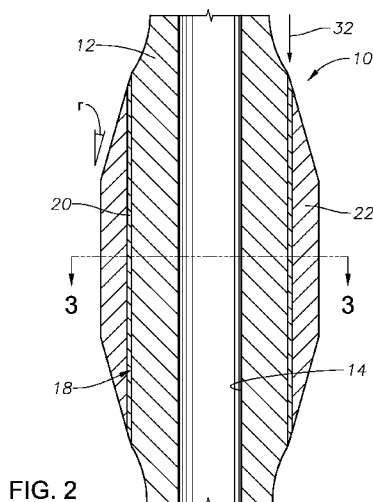
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(54) Title: CASING EXIT MILL ASSEMBLIES WITH REPLACEABLE BLADE SLEEVE



(57) Abstract: A mill assembly having a mill shaft body, removable bearing and removable blade sleeve. The shaft body presents a mounting portion having a plurality of arcuate curved contact faces for transmission of rotational forces.

CASING EXIT MILL ASSEMBLIES WITH REPLACEABLE BLADE SLEEVE**CROSS REFERENCE TO RELATED APPLICATIONS**

This application claims the benefit of U.S. Application No. 14/698320, filed on April 28, 2015, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION**1. Field of the Invention**

[0001] The invention relates generally to the design and construction of downhole milling tools used to perform casing exits and other metal cutting operations.

2. Description of the Related Art

[0002] Conventional large size casing exit mills have a cylindrical body with a larger diameter section that transitions to a smaller diameter pipe on both sides at a taper angle. Blades are welded upon the taper and an enlarged section. The blades are typically brazed with crushed tungsten carbide particles or a tungsten carbide insert of a particular shape suitable for cutting metal. Blades are welded onto the body, typically with a 3/8" fillet weld. The brazing of carbide onto the blades is carried out usually at temperatures that are from about 1650°F to 1700°F. If not performed in a uniform manner, that high temperature heating process results in bowing of the body and softening of the steel adjacent to the blades. Though mills are often heat treated after welding and brazing, consistency in the mechanical properties on the surface of the mill body is doubtful. Every heat cycle on the mill body and associated components changes the mechanical strength of the surface fibers. During a casing exit operation, the mill is subjected to cyclic bending loads and intermittent torsional loads. These loads induce cyclic bending stress and torsional stress in the surface fibers. The superimposition of the axial component of torsional stress and bending stress causes the surface fibers to fail resulting in cracks on the body. Hence, it is necessary for the surface fibers to maintain their mechanical strength during each casing exit operation. The higher the number of heat cycles, the higher the tendency for surface fibers to become softer, thus making the body susceptible to cracking under low bending stress. This reduction in the strength of surface fibers reduces the fatigue life of the body.

SUMMARY OF THE INVENTION

[0003] The invention provides improved designs for the construction of downhole mills. In other aspects, the invention provides methods of assembling a mill. An exemplary casing exit mill assembly is described in which a central shaft body is provided with a mounting portion that is shaped to prevent rotation of a blade sleeve mounted thereupon. In described embodiments, the mounting portion presents a plurality of arcuately curved contact surfaces. Adjacent contact surfaces on the mounting portion adjoin each other at angled corners. There are at least three curved contact surfaces. According to preferred embodiments, there are between three and twelve contact surfaces. The cross-sectional shape of each of the contact surfaces is defined as an arcuate segment from a circle having a radius which is greater than the radius of the contact surface upon the shaft body mounting portion.

[0004] A bearing and a blade sleeve surround the mounting portion. The bearing could be a separate component from the shaft and blade sleeve. In other embodiments, the bearing is a coating formed upon either the mounting portion of the shaft body or upon the inner surface of the central opening of the blade sleeve. The blade sleeve is provided with a central opening that is shaped and sized to be complementary to the mounting portion of the shaft body. Preferably, the components are secured together using a press fit or interference fit. The modular construction of the mill assembly permits the blade sleeve to be easily replaced when worn or damaged. Alternatively, the blade sleeve could be replaced by a blade sleeve having a different diameter or design of cutting structures.

[0005] The inventor has found that the use of a mounting portion having arcuately curved contact surfaces and a blade sleeve having a complementarily shaped engagement surface is advantageous. Torque forces can be effectively transmitted between the components while minimizing the stress that might result from other interfaces.

[0006] In certain embodiments, the shaft body of the mill assembly includes a radially enlarged portion which is located proximate the blade sleeve. A removable protection blade sleeve radially surrounds the radially enlarged portion. Like the blade sleeve, the protection blade sleeve is preferably press fit and features a tapered interface with the radially enlarged portion.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] For a thorough understanding of the present invention, reference is made to the following detailed description of the preferred embodiments, taken in conjunction with the accompanying drawings, wherein like reference numerals designate like or similar elements throughout the several figures of the drawings and wherein:

[0008] Figure 1 is a side, cross-sectional view of an exemplary casing exit mill assembly constructed in accordance with the present invention.

[0009] Figure 2 is an enlarged side, cross-sectional view of portions of the mill of Figure 1.

[0010] Figure 3 is an axial cross-section of the mill assembly taken along lines 3-3 in Figure 2.

[0011] Figure 4 is an axial cross-section of the mill assembly of Figures 1-3, now being subjected to torsional force.

[0012] Figure 5 is a schematic view of the mounting portion of the mill assembly shown in Figs. 1-4 in comparison to a larger circle.

[0013] Figure 6 is a side view of the shaft body of an alternative mill assembly wherein the mounting portion of the shaft body has six contact faces.

[0014] Figure 7 is a side view of an alternative mill assembly which incorporates the shaft body shown in Figure 6.

[0015] Figure 8 is an axial cross-section taken along lines 8-8 in Figure 6.

[0016] Figure 9 is an axial cross-section taken along lines 9-9 in Figure 7.

[0017] Figure 10 is a further axial cross-section of a mounting portion with six contact faces illustrating exemplary geometric features of the mounting portion.

[0018] Figure 11 is a side, cross-sectional view of another enlarged portion of the shaft body.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] Figures 1-2 depicts an exemplary casing exit mill assembly 10 constructed in accordance with the present invention. The mill assembly 10 includes a central shaft body 12 which defines an axial fluid passage 14 along its length. Threaded connections 16 are provided at each axial end of the shaft body 12 to permit the mill assembly to be incorporated into a downhole work string. The shaft body 12 is preferably cylindrical in shape along its

length except where otherwise indicated. A mounting portion 18 of the shaft body 12 has a shaped outer radial surface upon which a bearing 20 and a blade sleeve 22 are mounted. The outer radial surface of the mounting portion 18 is shaped to preclude rotation of the bearing 20 and blade sleeve 22 with respect to the shaft body 12. With further reference to Figures 3-4, it can be seen that the mounting portion 18 presents three arcuately curved convex contact faces 24 which adjoin one another at corners 26. The mounting portion 18 is designed to ensure that the blade sleeve 22 and bearing 20 do not rotate upon the shaft body 12. It should be appreciated with reference to Figures 3 and 4 that the mounting portion 18 is generally nearly round but still provides corners 26 that will prevent rotation of the surrounding bearing 20 and blade sleeve 22 upon the shaft body 12. It is noted that, in axial cross-section (i.e., Figures 3-4) the contact faces 24 of the mounting portion 18 preferably each form an arcuate segment of a circle that has a radius greater than the radius 25 of the mounting portion 18 at its widest point. Figure 5 illustrates a larger circle 27 of which a contact face 24 forms an arcuate segment. The larger circle 27 has a radius 29 that exceeds the radius 25 of the mounting portion 18 at its widest point. In certain preferred embodiment, the radius 29 is at least twice as large as the radius 25.

[0020] Referring once again to Figure 1, it is noted that the shaft body 12 also includes a radially enlarged portion 31 which is located proximate, but a spaced distance from, the mounting portion 18. A protection blade sleeve 33 radially surrounds the radially enlarged portion 31 and presents a hardened protruding portion for engaging a surrounding tubular during casing window cutting. The radially enlarged portion 31 and the protection blade sleeve 33 are preferably press fit.

[0021] Preferably, the mounting portion 18 is axially tapered to allow for ease of assembly. As illustrated in Figure 2, the mounting portion 18 is tapered at an angle “r”. In currently preferred embodiments, the angle of taper “r” is about 2 degrees, as measured from the central axis of the shaft body 12. This taper facilitates a press fit securing of the bearing 20 onto the mounting portion 18. As best seen in Figures 3-4, the blade sleeve 22 presents a plurality of cutting blades 28 which project radially outwardly from the sleeve 22. The cutting blades 28 are formed of or brazed with carbide cutters or other hardened cutting structures.

[0022] The bearing 20 is preferably formed of a material that is softer than the material making up the shaft body 12 and the blade sleeve 22. In preferred embodiments, the bearing 20 is formed of copper, manganese or bronze, or alloys which include these materials.

In alternative embodiments, the bearing 20 is formed of a viscoelastic material which provides an effective damper for torsional vibrations and shocks. The bearing 20 may be in the form of a separate component that is disposed between the shaft body 12 and the blade sleeve 22. Alternatively, the bearing 20 may be in the form of a coating that is applied to either or both of the shaft body 12 and/or the blade sleeve 22.

[0023] Figures 3 and 4 help illustrate the resistance of the blade sleeve 22 to rotation in response to torsional loading. Figure 3 illustrates the mill assembly 10 having no torsional loading applied. In Figure 4, a torsional force is being applied to the blade sleeve 22, as indicated by arrow 30. Bearing 20, if made of a viscoelastic material, deforms slightly to accommodate the loading. Absorption of torque spikes by the bearing 20 will help damp torsional impact loads on the blades 28. The absorption of torque spikes will essentially result in less wear upon the blades 28 and increase the life of the mill assembly 10.

[0024] The mill assembly 10 can be constructed by first sliding the bearing 20 onto the shaft body 12 and over the mounting portion 18. Thereafter, the blade sleeve 22 is slid onto the shaft body 12 to overlie the bearing 20 so that the bearing 20 is located radially between the shaft body 12 and the blade sleeve 22. A press fit, or interference fit, affixes the three components together.

[0025] It is noted that the modular construction of the mill assembly 10 permits users to easily replace a worn blade sleeve 22 or to replace the blade sleeve 22 with a blade sleeve having a larger or smaller outer diameter or having a different type or design of cutting blades or structures.

[0026] In operation, the mill assembly 10 is constructed as described above and is then incorporated into a work string. Thereafter, the work string is disposed into a wellbore. The mill assembly 10 is run in to a desired location within the wellbore and rotated, in a manner known in the art, so that the blade sleeve 22 of the mill assembly 10 mills or cuts away desired material.

[0027] In order to remove the blade sleeve 22 from the mill shaft body 12, as well as the bearing 20, axial force is applied to the blade sleeve 22 proximate the larger end of the taper of the mounting portion 18. Arrow 32 in Figure 2 illustrates the application of such force. The force applied must be sufficient to overcome the frictional force of the press fit, thereby causing the blade sleeve 22 and perhaps the bearing 20 to be unseated from the mill

shaft body 12. Thereafter, the blade sleeve 22 and/or the bearing 20 could be replaced as necessary.

[0028] Figures 6-10 illustrate features of an alternative embodiment for a mill assembly 50 constructed in accordance with the present invention. Except where otherwise described, the mill assembly 50 is constructed and operates in the same manner as the mill assembly 10 described previously. The shaft body 12' of the mill assembly 50 includes a tapered mounting portion 18'. The mounting portion 18' has six contact faces 24' rather than three. The contact faces 24' adjoin each other at corners 26'. As Figure 9 depicts, a bearing 20' may be disposed between the mounting portion 18' and the blade sleeve 22'.

[0029] Figures 8 and 10 help to illustrate geometric features associated with the contact faces 24' and the mounting portion 18' of the mill assembly 50. A true circle 52 is depicted in Figures 8 and 10 superimposed around the outer perimeter of the mounting portion 18'. Figure 10 shows that a gap 54 is defined between the contact faces 24' and the true circle 52. The gap 54 results from the fact that the central portions 55 of the contact faces 24' are defined as arcuate segments of a circle having a radius 56 which is larger than the radius 58 of the mounting portion 18' at its widest point. In other words, the contact faces 24' have a larger radius of curvature than circle 52. Figure 10 also illustrates an exemplary hexagonal outer surface 60 superimposed on the mounting portion 18' and drawn with its vertices at the corners 26'. It can be seen that the contact faces 24' extend radially outwardly beyond the sides 62 of the hexagonal outer surface 60.

[0030] In preferred embodiments, the contact faces 24' are further shaped to present contoured transition surface portions 64 that are located proximate the corners 26' of the mounting portion 18'. The transition surface portions 64 have a radius of curvature 66 smaller than either the true circle 52 or the central portions 55 of the contact faces 24'.

[0031] It is further noted that the mounting portion 18' is preferably axially tapered, as illustrated by Figure 6, in the same manner as described for mounting portion 18. The tapering will aid in assembly and repair of the mill assembly 50.

[0032] The inventor has determined that the use of arcuately curved contact faces in a mounting portion along with angled corners which adjoin the contact faces is an advantageous design for transmission of torque forces between the shaft body and the surrounding blade sleeve. Stress concentrations which are associated with other designs are avoided. In particular, shaft body/blade sleeve interfaces constructed in accordance with the

present invention provide increased contact area between the contact faces 24, 24' and the surrounding blade sleeve 22, 22', thereby increasing the ability of torque forces to be transmitted between the components and supplementing force transmission between the corners 26, 26' and the surrounding blade sleeve 22, 22'. According to certain preferred embodiments, contact faces, such as contact faces 24' have outer radial portions with different radii of curvature. For example, the central portion 55 of each contact face 24' has a radius of curvature 56 that is greater than the radius of curvature 58 of the mounting portion 18', as measured from its widest point. Lateral portions 64 of the contact face 24', however, have a radius of curvature 66 that is smaller than the radius of curvature 58 for the mounting portion 18' and the radius of curvature 56 of the central portion 55 of the contact face 24'.

[0033] In particular embodiments, the mounting portions 18, 18' have at least three contact faces or the type described previously. In preferred embodiments, there are from three to twelve contact faces. In particularly preferred embodiments, there are from three to six contact faces.

[0034] Figure 11 illustrates the radially enlarged portion 31 and the protection blade sleeve 33 in greater detail. The radially enlarged portion 31 preferably presents an outer radial surface that is shaped with contact faces and corners similar to those described previously with respect to the mounting portions 18, 18'. The largest diameter on this axially tapered enlarged portion 31 is preferred to be equal to or smaller than the smallest diameter of the mounting portion 18, to aid the axial passage of the smallest inner diameter of the blade sleeve 22. Preferably also, the radially enlarged portion 31 is axially tapered in the same manner as the mounting portions 18, 18'. In certain embodiments, a bearing 68 is disposed between the radially enlarged portion 31 and the protection blade sleeve 33. During operation, the protection blade sleeve 33 will provide a hardened contact point for the mill assembly 10 or 50 to assist in casing window exit operations.

[0035] Those of skill in the art will recognize that numerous modifications and changes may be made to the exemplary designs and embodiments described herein and that the invention is limited only by the claims that follow and any equivalents thereof.

CLAIMS

What is claimed is:

1. A mill assembly for cutting in a subterranean location, the mill assembly comprising:
 - a shaft body; and
 - a blade sleeve that radially surrounds a portion of the shaft body, the blade sleeve being removable from the shaft body.
2. The mill assembly of claim 1 further comprising a bearing disposed radially between the shaft body and the blade sleeve.
3. The mill assembly of claim 2 wherein the shaft body, blade sleeve and bearing are secured together by press fit so that the blade sleeve and bearing are removable from the shaft body.
4. The mill assembly of claim 2 wherein the shaft body further includes a mounting portion upon which the bearing and blade sleeve are mounted, the mounting portion having an outer radial surface that is shaped to preclude rotation of the bearing and blade sleeve with respect to the shaft body.
5. The mill assembly of claim 2 wherein the bearing is formed of a material that is softer than material forming the blade sleeve and shaft body.
6. The mill assembly of claim 5 wherein the bearing is formed of at least one of the materials from the group consisting of: brass; manganese; bronze; alloys including brass, manganese or bronze; and viscoelastomer.
7. The mill assembly of claim 4 wherein the mounting portion presents an outer radial surface having at least three arcuately curved contact faces adjoined by corners.
8. The mill assembly of claim 7 wherein:
 - the mounting portion has a maximum radius as measured from a most distant radial point; and
 - each of the contact faces presents an outer radial surface having a radius of curvature which is greater than the maximum radius of curvature of the mounting portion.
9. The mill assembly of claim 8 wherein, for each of the contact faces:
 - a central portion of the contact face has a radius of curvature that is greater than the maximum radius of curvature of the mounting portion; and
 - a lateral portion of the contact face has a radius of curvature that is smaller than the maximum radius of curvature of the mounting portion.

10. The mill assembly of claim 4 wherein the mounting portion is axially tapered.
11. A mill assembly for cutting in a subterranean location, the mill assembly comprising:
 - a shaft body having a mounting portion;
 - a blade sleeve that radially surrounds the mounting portion of the shaft body; and
 - the mounting portion is axially tapered.
12. The mill assembly of claim 11 wherein the shaft body, blade sleeve and bearing are secured together by press fit so that the blade sleeve and bearing are removable from the shaft body.
13. The mill assembly of claim 11 further comprising a bearing that is disposed between the shaft body and the blade sleeve, the bearing being formed of at least one of the materials from the group consisting of: brass; manganese; bronze; alloys including brass, manganese or bronze; and viscoelastomer.
14. The mill assembly of claim 11 wherein the mounting portion presents an outer radial surface having at least three arcuately curved contact faces adjoined by corners.
15. The mill assembly of claim 14 wherein there are between three and twelve contact faces.
16. The mill assembly of claim 14 wherein:
 - the mounting portion has a maximum radius as measured from a most distant radial point; and
 - each of the contact faces presents an outer radial surface having an axial cross-sectional shape that forms an arcuate segment of a circle having a radius which is greater than the maximum radius of the mounting portion.
17. A method of assembling a mill assembly for cutting in a downhole location, the method comprising:
 - disposing a bearing onto a mounting portion of a mill shaft body;
 - disposing a blade sleeve onto the bearing; and
 - wherein the mill shaft body, bearing and blade sleeve are press fit together.
18. The method of claim 17 wherein the bearing is formed of a material that is softer than material forming the blade sleeve and shaft body.
19. The method of claim 17 wherein the mounting portion is axially tapered to facilitate the press fit.

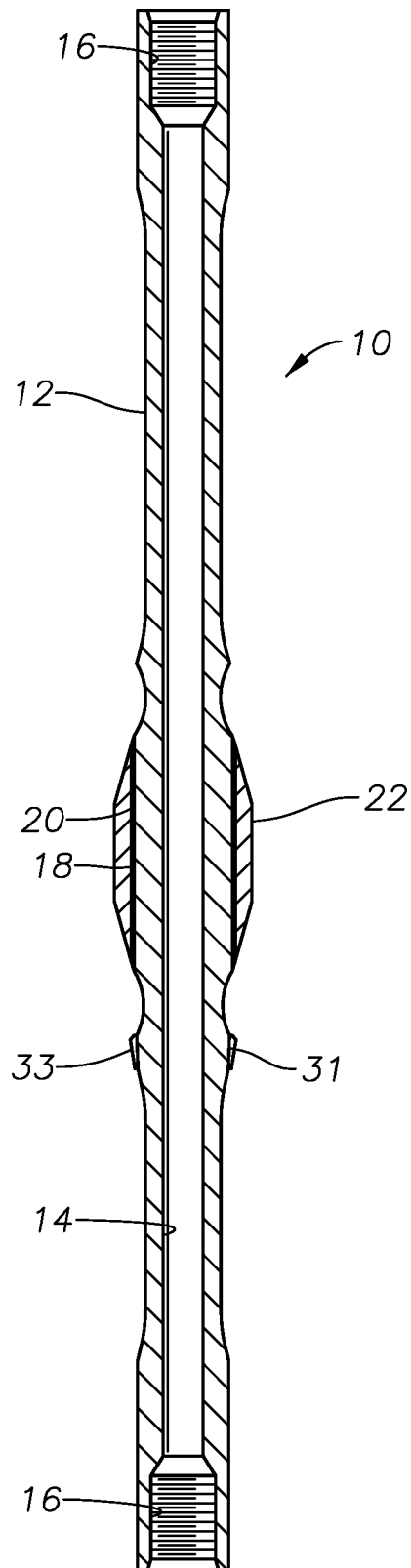


FIG. 1

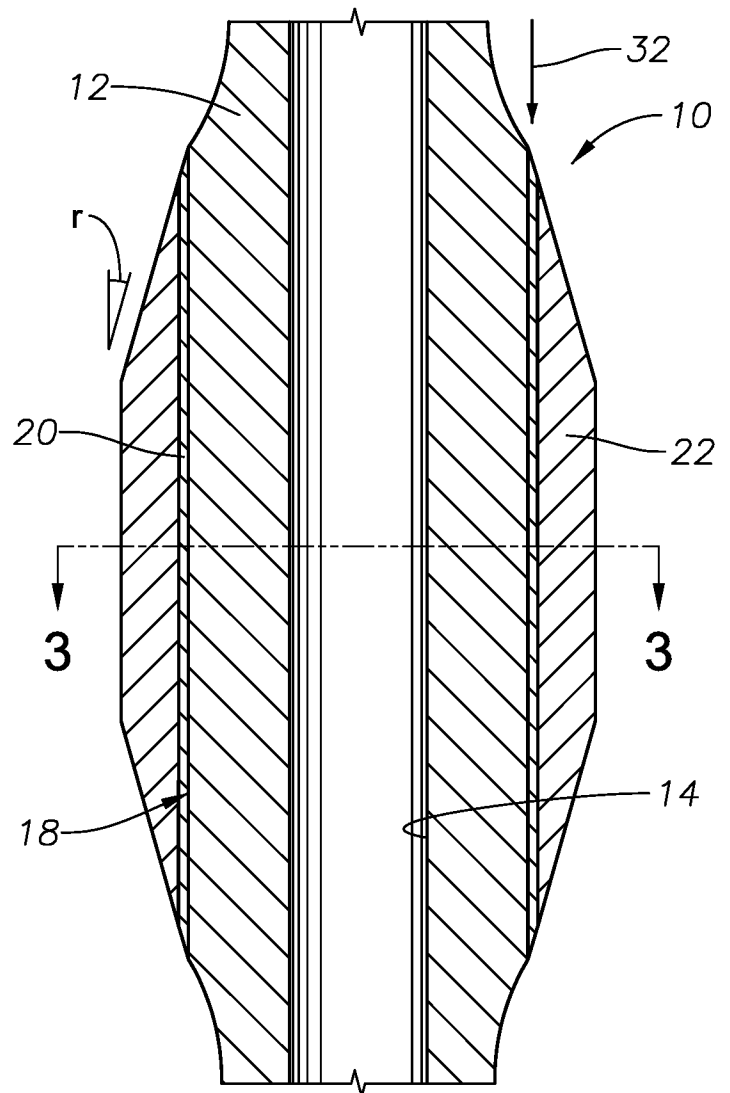


FIG. 2

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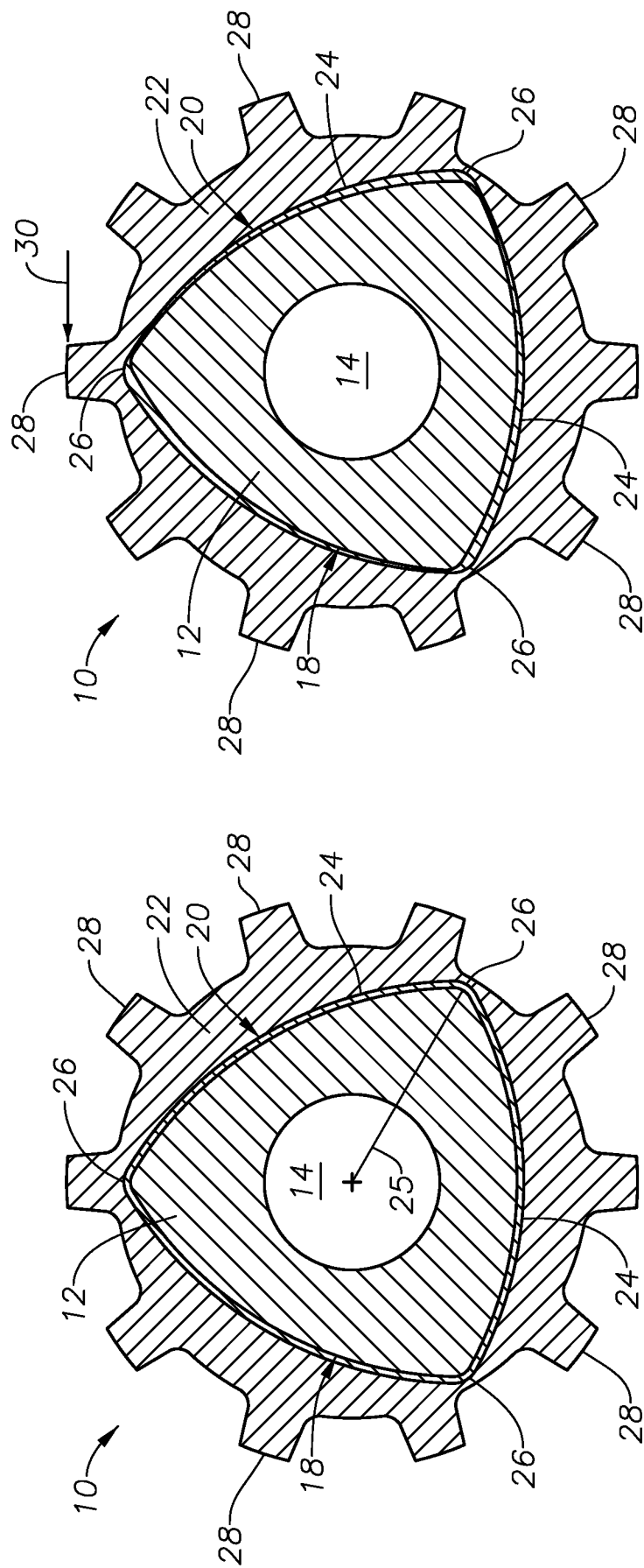


FIG. 4

FIG. 3

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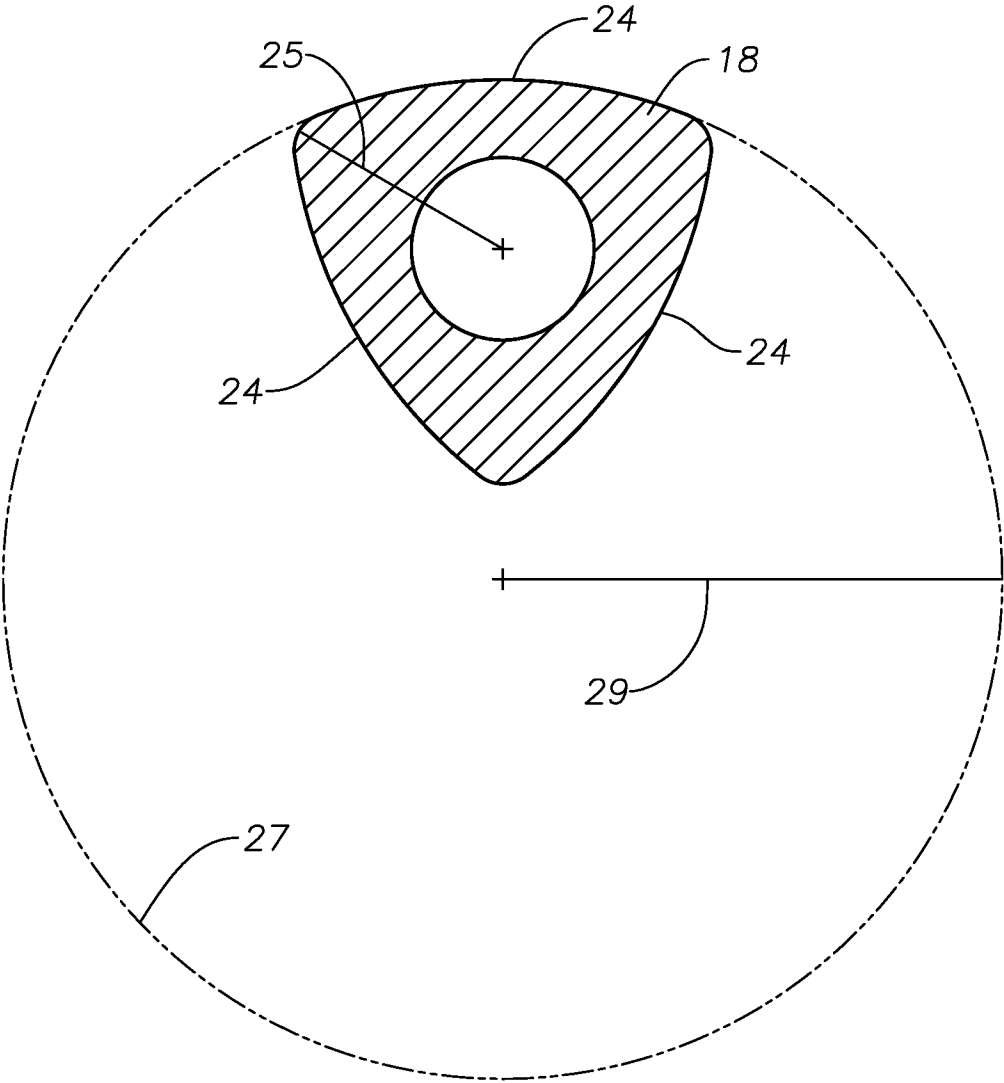


FIG. 5

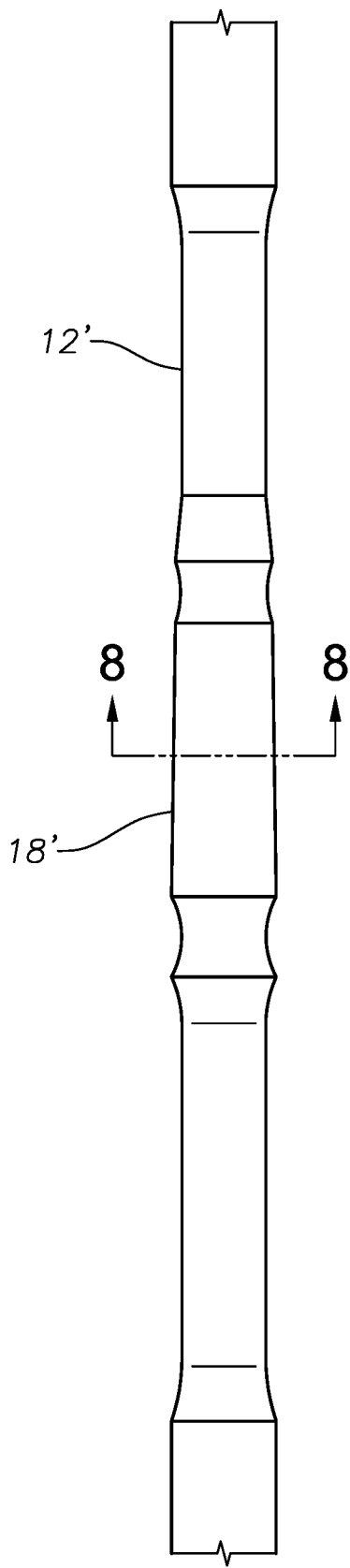


FIG. 6

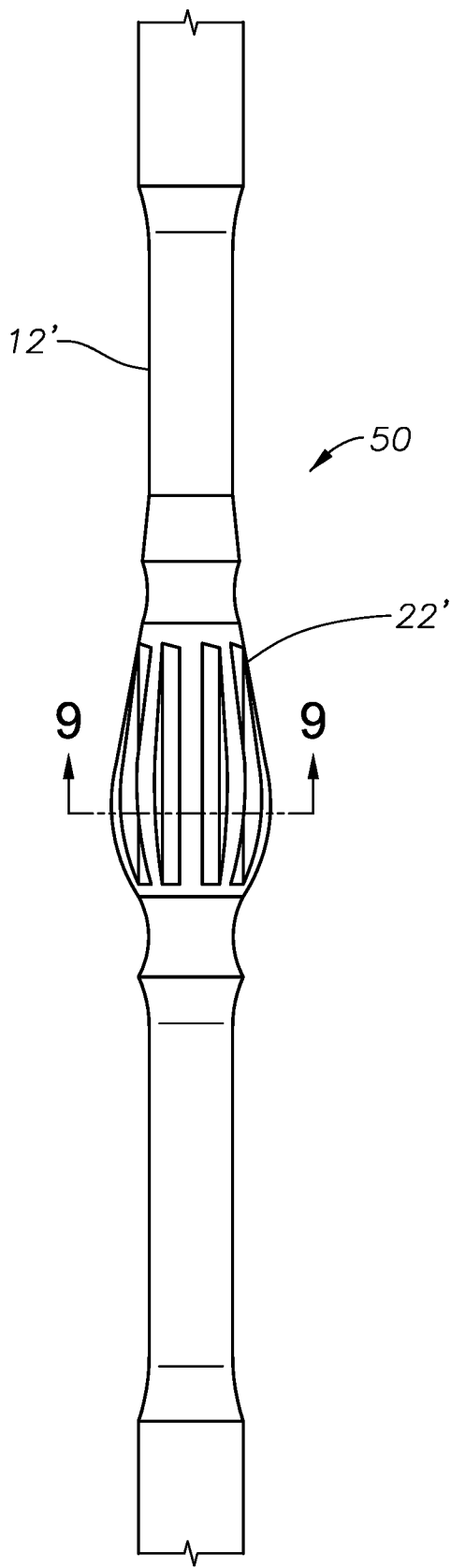


FIG. 7

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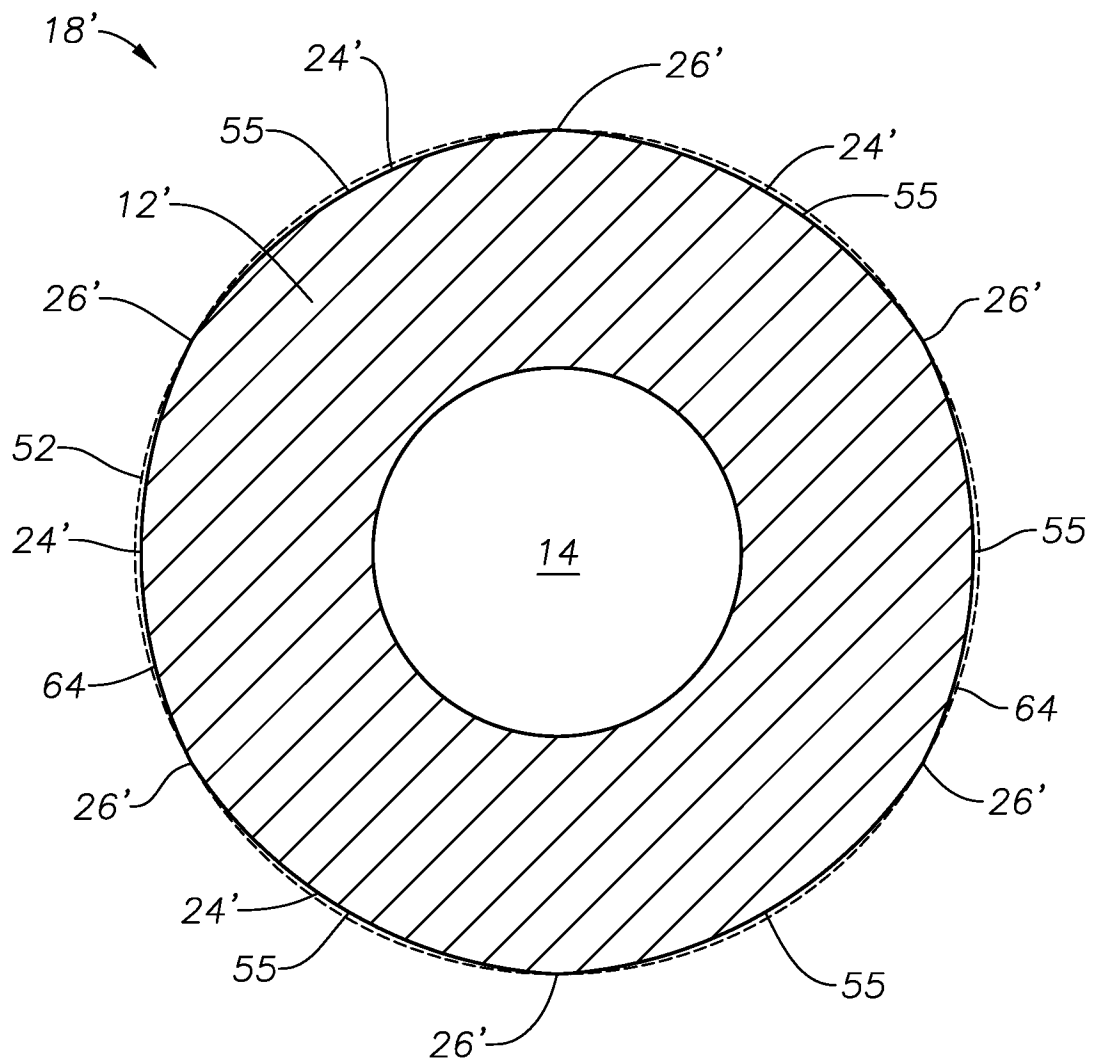


FIG. 8

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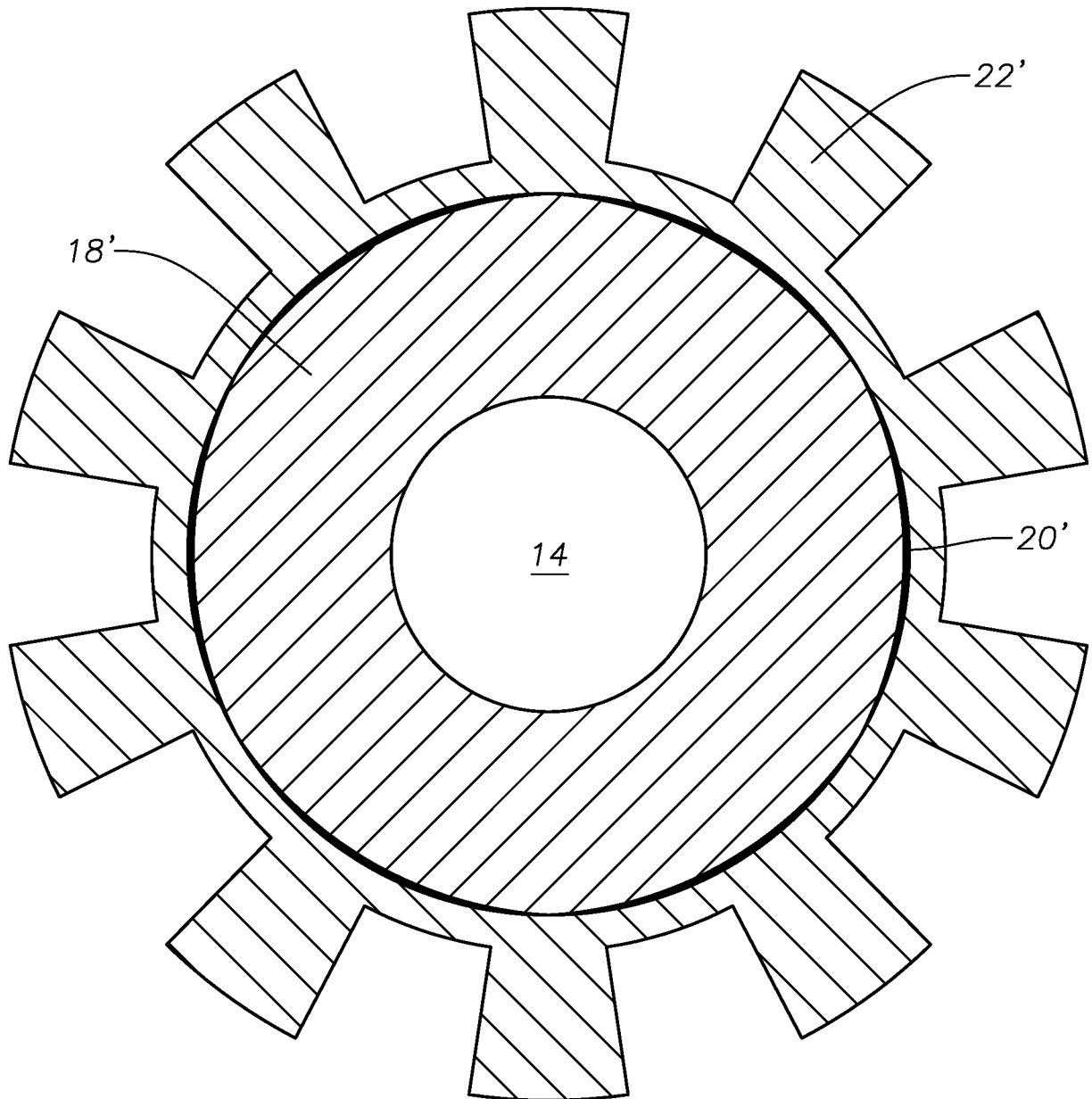


FIG. 9

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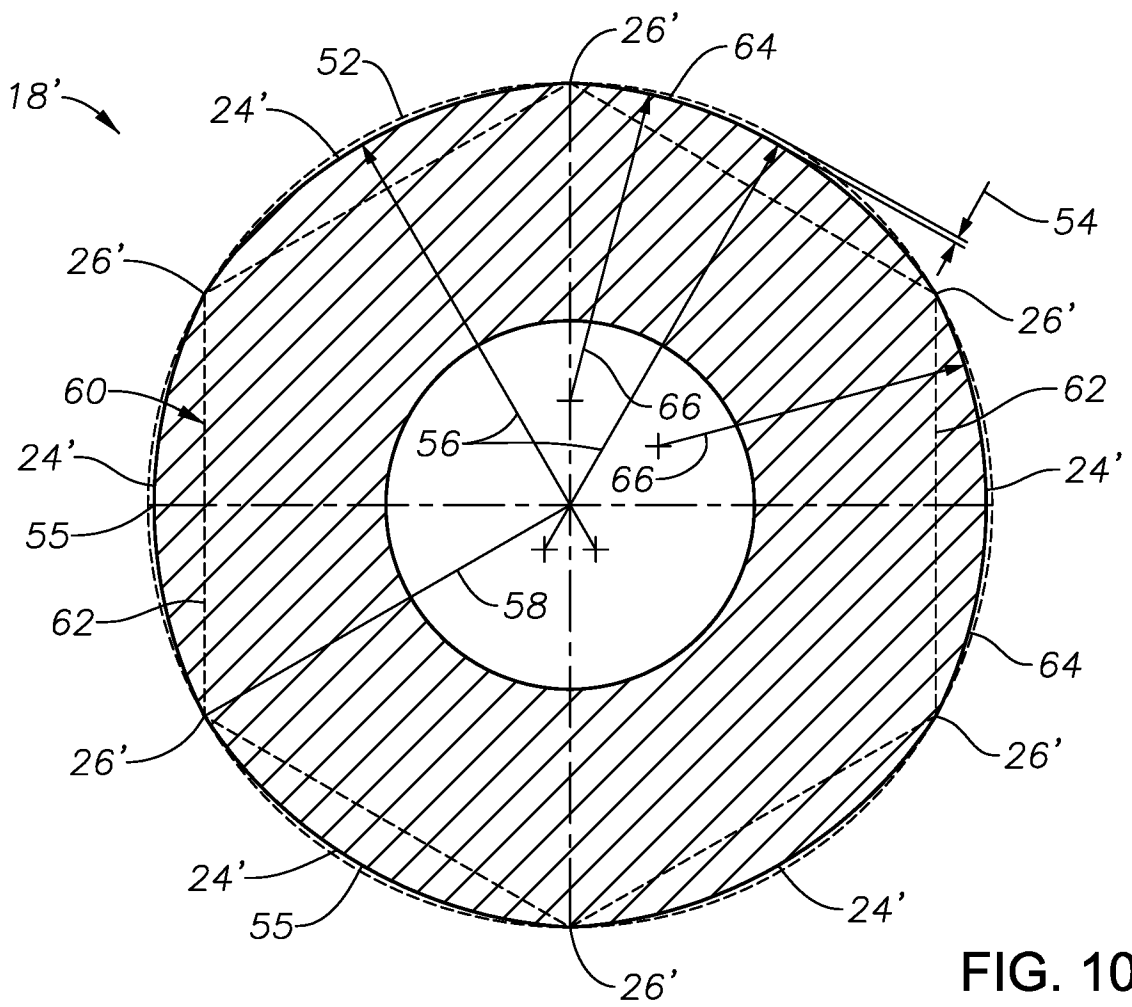


FIG. 10

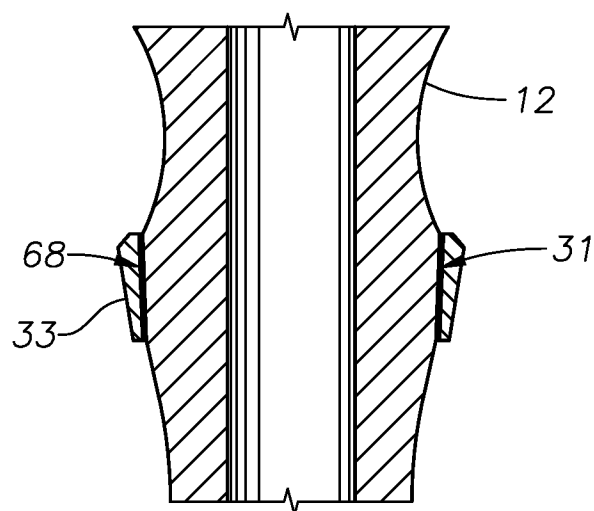


FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/029449**A. CLASSIFICATION OF SUBJECT MATTER****E21B 7/06(2006.01)i, E21B 29/00(2006.01)i, E21B 29/06(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E21B 7/06; B24B 9/00; E21B 17/10; E21B 10/26; B02C 18/16; B24B 7/00; E21B 7/28; B27G 13/12; E21B 29/00; E21B 29/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & keywords: mill, shaft body, blade sleeve, bearing, mounting portion, and contact face

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009-0250266 A1 (DIMITROFF, TED R.) 08 October 2009 See abstract, paragraphs [0033]–[0034], and figures 6	1, 11, 14–16
Y		2–10, 12–13, 17–19
Y	US 2013-0292183 A1 (EIDEM et al.) 07 November 2013 See abstract, paragraphs [0052]–[0053], and figures 1a–1e.	2–10, 12–13, 17–19
A	US 5201353 A (WEILL, THEODORE C.) 13 April 1993 See abstract, column 3, lines 14–54, and figure 1.	1–19
A	US 5676321 A (KROGER, BRUCE R.) 14 October 1997 See abstract, column 2, line 15 – column 3, line 21, and figures 1–2.	1–19
A	US 5785583 A (WILLIAMS, JR. et al.) 28 July 1998 See abstract, column 2, lines 18–65, and figure 1.	1–19

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

08 August 2016 (08.08.2016)

Date of mailing of the international search report

09 August 2016 (09.08.2016)

Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

189 Cheongsu-ro, Seo-gu, Daejeon, 35208, Republic of Korea

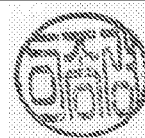


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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/029449

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2009-0250266 A1	08/10/2009	US 8365841 B2	05/02/2013
US 2013-0292183 A1	07/11/2013	CA 2823997 A1	12/07/2012
		GB 2503124 A	18/12/2013
		NO 20131077 A	07/08/2013
		WO 2012-092985 A1	12/07/2012
US 5201353 A	13/04/1993	None	
US 5676321 A	14/10/1997	EP 0736327 A1	09/10/1996
		EP 0736327 B1	31/05/2000
US 5785583 A	28/07/1998	CA 2231600 C	07/11/2000
		JP 03168336 B2	21/05/2001
		JP 10-314615 A	02/12/1998