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BOHRHAMMER

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Description

BACKGROUND OF THE INVENTION

[0001] This invention relates to downhole tools. More particularly, but not by way of limitation, this invention relates to a downhole percussion tool.

[0002] In the drilling of oil and gas wells, a bit means is utilized to drill a wellbore.

[0003] Downhole percussion tools, sometimes referred to as hammers, thrusters, or impactors are employed in order to enhance the rate of penetration in the drilling of various types of subterranean formations. In some types of wellbores, such as deviated and horizontal wells, drillers may utilize downhole mud motors. The complexity and sensitivity of bottom hole assemblies affects the ability of drillers to use certain tools, such as downhole hammers.

[0004] Patent document US2613917A discloses a rotary-impact well drilling tool adapted to be positioned at the lower end of a conduit extending downwardly from the surface and including a prime mover adjacent the lower end of the conduit having a housing connected to said conduit and a downwardly extending rotatable shaft concentric therewith.

[0005] Patent document US 2002/185312A1 discloses an impact tool for use in a well bore. The impact tool provides a hammer action through reciprocal movement of a cam within a spring mechanism. In an embodiment a drill bit is included to provide an impact drilling tool which requires minimum weight on bit to operate. The impact tool can therefore be run on coiled tubing and wireline.

[0006] Patent document US 6761231B1 discloses a percussive tool adapted to receive rotational energy from the inner member of a dual-member drill string. In a preferred embodiment the percussive tool has a hydraulic pump, driven by a drive member, to operate the hammer assembly. In another preferred embodiment the percussive tool has a rotary-driven cam assembly adapted to mechanically operate the hammer assembly. This invention provides increased control and efficiency for the use of percussive force in horizontal directional drilling operations.

[0007] Patent document US 2634951A discloses a rotary impact drill for earth boring which includes: a shank adapted to have a bit attached thereon and to be rotated in an earth bore; retarder means loosely mounted on said shank so as to rotate eccentrically relative there-to and for sliding frictional engagement with the wall of said bore without undercutting said wall; an impact means reciprocally mounted between said shank and said retarder means to produce periodic impacts on said shank.

SUMMARY OF THE INVENTION

[0008] In one embodiment, the invention provides a downhole apparatus connected to a workstring within a wellbore according to claim 1. Preferred embodiments are disclosed in claims 2-5.

[0009] Also disclosed in one embodiment, is a method for drilling a wellbore with a workstring according to claim 6.

[0010] Preferred embodiments are disclosed in claims 7-13.

[0011] A feature of the invention is that the resistance of the spring can be adjusted without moving the mandrel relative to the housing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

FIGURE 1 is a partial sectional view of a first embodiment of the downhole apparatus.

FIGURE 2 is a partial sectional view of lower housing of the downhole apparatus of the first embodiment in the engaged mode.

FIGURE 3 is a partial sectional view of the lower housing of the downhole apparatus of the first embodiment in the disengaged mode.

FIGURE 4 is a partial sectional view of the downhole apparatus of the first embodiment as part of a bottom hole assembly.

FIGURE 5 is a partial sectional view of lower housing of the downhole apparatus of a second embodiment in the engaged mode.

FIGURE 6 is a partial sectional view of the lower housing of the downhole apparatus of the second embodiment in the disengaged mode.

FIGURE 7A is perspective view of one embodiment of the anvil radial cam member.

FIGURE 7B is a top view of the anvil radial cam member seen in FIGURE 7A.

FIGURE 8 is a perspective view of one embodiment of the hammer radial cam member.

FIGURE 9 is a schematic depicting the downhole apparatus of the present invention in a wellbore.

FIGURE 10A is a graph of static weight on bit (WOB) versus time during drilling operations.

FIGURE 10B is a graph of dynamic WOB utilizing a percussion unit.

FIGURE 10C is a graph of dynamic WOB utilizing percussion unit, wherein the impact force is overlaid

relative to the static load.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] Referring now to the Fig. 1, a partial sectional view of the downhole apparatus 2 of a first embodiment will now be discussed. The first embodiment apparatus 2 includes a power mandrel, seen generally at 4, that is operatively attached to the output of a downhole mud motor (not shown). The apparatus 2 also includes a radial bearing housing unit, seen generally at 6. The radial bearing housing unit 6 will be operatively attached to the workstring, such as drill pipe or coiled tubing, as will be described later in this disclosure. More particularly, Fig. 1 shows the power mandrel 4 (which is connected to the output of the motor section, as is well understood by those of ordinary skill in the art). The mandrel 4 may be referred to as the power mandrel or flex shaft. Also shown in Fig. 1 is the upper bearing housing 10a which includes the upper radial bearings 12a, lower radial bearing 14a, balls 16a and thrust races 18a. The lower housing is seen generally at 20a in Fig. 1 and will be described in further detail.

[0014] As seen in Fig. 1, a partial sectional view of lower housing 20a of the downhole apparatus 2 of the first embodiment is shown. Fig. 1 depicts the hammermass 22a (sometimes referred to as the hammer member or hammer), which is attached (for instance, by spline means via a spring saddle 40a) to the radial bearing housing unit 6. The hammermass 22a will have a radial cam surface 24a. The hammermass 22a will engage with the anvil 26a, wherein the anvil 26a has a first end that contains a radial cam surface 28a, wherein the radial cam surface 28a and radial cam surface 24a are reciprocal and cooperating in the preferred embodiment, as more fully set out below. Fig. 1 also depicts the power mandrel 4, which is fixed connected to the driveshaft 30a via thread connection or similar means. A key 32a (also referred to as a spline) allows for rotational engagement of the power mandrel 4 and the driveshaft 30a with the bitbox sub 34a, while also allowing for lateral movement of the bitbox sub 34 relative to the drive shaft 30a. The anvil 26a is fixedly connected to the bitbox sub 34a.

[0015] Fig. 1 also depicts the spring means 36 for biasing the hammermass 22a. The spring means 36 is for instantaneous action. More specifically, Fig. 1 depicts the spring saddle 40a that is an extension of the bearing housing 6 i.e. the spring saddle 40a is attached (via threads for instance) to the bearing housing 6. The spring saddle 40a is disposed about the driveshaft 30a. Disposed about the spring saddle 40a is the spacer sub 42a, wherein the spacer sub 42a can be made at a variable length depending on the amount of force desired to load the spring means 36. As shown, the spring means 36 is a coiled spring member. The spring means 36 may also be a Belleville washer spring. One end of the spring means 36 abuts and acts against the hammermass 22a which in turn urges to engagement with the anvil 26a.

[0016] In Fig. 2, a partial sectional view of the lower housing 20a of the downhole apparatus 2 of the first embodiment in the engaged mode is shown. It should be noted that like numbers appearing in the various figures refer to like components. The cam surface 24a and cam surface 28a are abutting and are face-to-face. Note the engaged position of the end 37a of the driveshaft 30a with the angled inner surface 38a of the bitbox sub 34a securing the axial transmission of the WOB from the drillstring to the bitbox sub 34a and the bit (not showing here). In Fig. 3, a partial sectional view of the lower housing 20a of the downhole apparatus 2 of the first embodiment in the disengaged mode will now be described. In this mode, the apparatus 2 can be, for instance, running into the hole or pulling out of the hole, as is well understood by those of ordinary skill in the art. Therefore, the radial cam surface 24a of hammer 22a is no longer engaging the radial cam surface 28a of the anvil 26a. Note the position of the end 37a of the driveshaft 30a in relation to the angled inner surface 38a of the bitbox sub 34a. As stated previously, the bit member (not shown in this view) is connected by ordinary means (such as by thread means) to the bitbox sub 34a.

[0017] Referring now to the Fig. 4, a schematic view of the downhole apparatus 2 of the first embodiment will now be discussed as part of a bottom hole assembly. The first embodiment the apparatus 2 includes the power mandrel, seen generally at 4, that is operatively attached to the output of a downhole mud motor "MM". The apparatus 2 also includes a radial bearing housing unit, seen generally at 6. The radial bearing housing unit 6 will be operatively attached to the workstring 100, such as drill pipe or coiled tubing. Also shown in Fig. 4 is the upper bearing housing 10a which includes the upper radial bearings 12a, lower radial bearing 14a, balls 16a and thrust races 18a. The lower housing is seen generally at 20a. As shown in Fig. 4, the bit 102 is attached to the apparatus 2, wherein the bit 102 will drill the wellbore as readily understood by those of ordinary skill in the art.

[0018] Fig. 5 and Fig. 6 depict the embodiment of the apparatus 2 without the spring means. Referring now to Fig. 5, a partial sectional view of lower housing 20b of the downhole apparatus 2 of a second embodiment in the engaged mode is shown. Fig. 5 depicts the hammermass 22b (sometimes referred to as the hammer member or hammer), which is attached (for instance, by spline means) to the spring saddle and the radial bearing housing unit (not shown here). The hammermass 22b will have a radial cam surface 24b. The hammermass 22b will engage with the anvil 26b, wherein the anvil 26b has a first end that contains a radial cam surface 28b, wherein the radial cam surface 28b and radial cam surface 24b of the hammermass 22b are reciprocal and cooperating in the preferred embodiment, as more fully set out below. Fig. 5 also depicts the driveshaft 30b (with the driveshaft 30b being connected to the power mandrel, not shown here). A key 32b (also referred to as a spline) allows for rota-

tional engagement of the drive shaft 30b with the bitbox sub 34b, while also allowing for lateral movement of the bitbox sub 34b relatively to the driveshaft 30b -. The anvil 26b is fixed connected to the bitbox sub 34b.

[0019] In Fig. 6, a partial sectional view of the lower housing 20b of the downhole apparatus 2 of the second embodiment in the disengaged mode will now be described. In this mode, the apparatus 2 can be, for instance, running into the hole or pulling out of the hole, as well understood by those of ordinary skill in the art. Hence, the radial cam surface 24b of hammermass 22b is no longer engaging the radial cam surface 28b of the anvil 26b. Note the position of the end 37b of the driveshaft 30b in relation to the angled inner surface 38b of the bitbox sub 34b. As previously mentioned, a bit member is connected (such as by thread means) to the bitbox sub 34b.

[0020] Referring now to Fig. 7A, a perspective view of one embodiment of the anvil radial cam member. More specifically, Fig. 7A depicts the anvil 26a having the radial cam surface 28a, wherein the radial cam surface 28a includes an inclined portion 50, horizontal (flat) portion 51, and an upstanding portion 52. The inclined portion 50 may be referred to as a ramp that leads to the vertical upstanding portion 52 as seen in Fig. 7A. Fig. 7B is a top view of the anvil radial cam member seen in Fig. 7A. In one embodiment, multiple ramps (such as inclined portion 50, horizontal portion 51, extending to an upstanding portion 52) can be provided on the radial cam surface 26a.

[0021] In Fig. 8, a perspective view of one embodiment of the hammer radial cam member is depicted. More specifically, Fig. 8 shows the hammermass 22a that has a radial cam surface 24a. The radial cam surface 24a also has an inclined portion 54, horizontal (flat) portion 55 and an upstanding portion 56, which are reciprocal and cooperating with the inclined portion and upstanding portion of the anvil radial cam surface 28a, as noted earlier. Note that the cam means depicted in Figs. 7A, 7B and 8 will be the same cam means for the second embodiment of the apparatus 2 illustrated in Figs. 5 and 6.

[0022] A schematic of a drilling rig 104 with a wellbore extending therefrom is shown in Fig. 9. The downhole apparatus 2 is generally shown attached to a workstring 100, which may be a drill string, coiled tubing, snubbing pipe or other tubular. The bit member 102 has drilled the wellbore 106 as is well understood by those of ordinary skill in the art. The downhole apparatus 2 can be used, as per the teachings of this disclosure, to enhance the drilling rate of penetration by use of a percussion effect with the hammer 22a/22b impacting force on the anvil 26a/26b, previously described. In one embodiment, the downhole hammer is activated by the bit member 102 coming into contact with a reservoir interface, such as reservoir rock 108 found in subterranean wellbores or other interfaces, such as bridge plugs. In one embodiment, a driller can drill and hammer at the same time. As per the teachings of this invention, in the spring (first) embodiment, the hammermass will be accelerated by a spring force of the compressed spring thus generating an impact force when the hammermass hits the anvil member.

[0023] Referring now to Figs. 10A, 10B and 10C, graphs of the weight on bit (WOB) versus time during drilling operations will now be discussed. More specifically, Fig. 10A is the static WOB versus time; Fig. 10B is a dynamic WOB utilizing the hammer and anvil members (i.e. percussion unit); and, Fig. 10C represents -the summarized WOB wherein the impact force is graphically overlaid (i.e. summation) relative to the static load, in accordance with the teachings of this disclosure. As noted earlier, the percussion unit is made-up of the anvil, hammer, cam shaft arrangement and spring. The wave form W depicted in Figs. 10B and 10C represent the oscillating impact force of the percussion unit during use. Note that in Fig. 10C, W1 represents the force when the hammermass impacts the anvil and W2 represents the force when the hammermass does not impact the anvil. It must be noted that the size and shape of the wave form can be diverse depended on the material and the design of the spring, the anvil, the hammermass and the spacer sub.

[0024] An aspect of the disclosure is that the static weight of the drill string is transmitted different to the bit than the impact force (dynamic weight on bit) created by the hammer and anvil member. The static WOB is not transmitted through the hammer and anvil members including cam surface (i.e. cam shaft arrangement). The impact force is transmitted through the hammer and anvil to the bit and not through the camshaft arrangement. The percussion unit will generate the impact force if the cam shafts arrangements are engaged independently of the amount of WOB. Yet another aspect of one embodiment of the disclosure is the power section of the motor is simultaneously rotationally driving the bit and axially driving the hammer member. No relative axial movement is taking place between the housing of the apparatus and the inner drive train (including the power mandrel and the driveshaft) that is driving the bit and the percussion unit.

[0025] Another aspect of the one embodiment is the anvil is positioned as close as possible to the bit; the bit box and/or bit can function as an anvil. Still yet another aspect of one embodiment is that when the bit does not encounter a resistance, no interaction between the two cams is experienced and thus no percussion motion.

Claims

1. A downhole apparatus (2) connected to a workstring (100) within a wellbore (106), the workstring (100) being connected to a bit member (102) with a motor means (MM) comprising:

a power mandrel (4) operatively connected to

the motor means (MM) and to a drive shaft (30a); an anvil member (26a) operatively formed on the bit member (102), the anvil member (26a) being operatively connected to the power mandrel (4) and to the drive shaft (30a); a radial bearing housing unit (6) operatively connected to the workstring (100), the radial bearing housing unit (6) being disposed about the power mandrel (4) and the drive shaft (30a); and having an upper end and a lower end; a spring saddle (40a) configured as a tubular extension of the radial bearing housing unit (6), the spring saddle (40a) being disposed about the drive shaft (30a) and having an upper section and a lower section, the upper section of the spring saddle (40a) being operatively and directly attached to the lower end of the radial bearing housing unit (6); a spring spacer (42a) disposed about the lower section of the spring saddle (40a); a spring (36) disposed about the lower section of spring saddle (40a) and having a first end and a second end, the first end of the spring (36) abutting the spring spacer (42a); and a hammer member (22a) slidably positioned between the anvil member (26a) and the spring saddle (40a), wherein the hammer member (22a) abuts the second end of the spring (36).

2. The apparatus of claim 1 wherein the hammer member (22a) and the anvil member (26a) are positioned below the radial bearing housing unit (6).

3. The apparatus of claim 1 or 2 wherein the workstring (100) is selected from a tubular drill string and a coiled tubing string.

4. The apparatus of any of claims 1 to 3 wherein the anvil member (26a) contains a radial cam face (28a) having an inclined portion (50) and an upstanding portion (52).

5. The apparatus of any of claims 1 to 4 wherein the hammer member (22a) contains a radial cam face (24a) having an inclined portion (54) and an upstanding portion (56).

6. A method for drilling a wellbore (106) with a workstring (100), comprising the steps of:

a) providing a downhole apparatus (2), the downhole apparatus (2) being connected to the workstring (100) within the wellbore (106) and to a bit member (102), the downhole apparatus (2) comprising: a power mandrel (4) operatively connected to a motor means (MM) and to a drive shaft (30a); an anvil member (26a) with a radial cam surface (28a) operatively formed on the bit member (102), the anvil member (26a) being operatively connected to the power mandrel (4) and to the drive shaft (30a); a radial bearing housing unit (6) operatively connected to the workstring (100), the radial bearing housing unit (6) being disposed about the power mandrel (4) and the drive shaft (30a); and having an upper end and a lower end; a spring saddle (40a) configured as a tubular extension of the radial bearing housing unit (6), the spring saddle (40a) being disposed about the drive shaft (30a) and having an upper section and a lower section, the upper section of the spring saddle (40a) being operatively and directly attached to the lower end of the radial bearing housing unit (6); a spring spacer (42a) disposed about the lower section of the spring saddle (40a), a spring (36) disposed about the lower section of the spring saddle (40a) and having a first end and a second end, the first end of the spring (36) abutting the spring spacer (42a); a hammer member (22a) with a radial cam surface (24a) slidably positioned between the anvil member (26a) and the spring saddle (40a), wherein the hammer member (22a) abuts the second end of the spring (36);

b) lowering the workstring (100) into the wellbore (106);

c) contacting the bit member (102) with a reservoir interface (108);

d) engaging a distal end of the drive shaft (30a) with a surface of the bit member (102); and

e) engaging the radial cam surface (28a) of the anvil member (26a) with the radial cam surface (24a) of the hammer member (22a) so that the hammer member (22a) imparts an impact force on the anvil member (26a) that is transmitted to the bit member (102) in the form of a dynamic weight on bit member.

7. The method of claim 6 wherein the workstring (100) produces a static load that is transmitted to the bit member (102) in the form of a static weight on bit member, wherein the static weight on bit member and the dynamic weight on bit member represent a maximum force on bit member.

8. The method of claim 7 wherein the static weight on bit member is transmitted to the bit member (102) substantially without transmission through the hammer and anvil members (22a, 26a).

9. The method of claims 7 or 8 wherein the dynamic weight on bit member is an oscillating impact force generated substantially independent of the static weight on bit member.

10. The method of any of claims 6 to 9 further comprising

the step of causing the motor means (MM) to rotate the power mandrel (4) and the drive shaft (30a) to simultaneously rotationally drive the bit member (102) and axially drive the hammer member (22a).

11. The method of any of claims 6 to 10 wherein no relative axial movement takes place between the radial bearing housing unit (6) and the power mandrel (4) and the drive shaft (30a) that are rotationally driving the bit member (102) and axially driving the hammer member (22a).

12. The method of claim 6 wherein the anvil member (26a) is a bit box sub (34a) operatively connected to the bit member (102).

13. The method of claim 6 wherein when the radial cam surface (24a) of the hammer member (22a) and the radial cam surface (28a) of the anvil member (26a) are engaged, and the hammer member (22a) is sliding axially relative to the anvil member (26a), the spring (36) will be periodically compressed and released thereby periodically accelerating the hammer member (22a) towards the anvil member (26a) which in turn generates an additional impact force.

Patentansprüche

1. Eine Untertagevorrichtung (2), die mit einem Arbeitsstrang (100) innerhalb eines Bohrlochs (106) verbunden ist, wobei der Arbeitsstrang (100) mit einem Meißelelement (102) mit einem Motormittel (MM) verbunden ist, beinhaltend:

eine Kraftspindel (power mandrel) (4), die betriebsfähig mit dem Motormittel (MM) und mit einer Antriebswelle (30a) verbunden ist;
ein Ambosselement (26a), das betriebsfähig auf dem Meißelelement (102) gebildet ist, wobei das Ambosselement (26a) betriebsfähig mit der Kraftspindel (4) und mit der Antriebswelle (30a) verbunden ist;
eine Radiallagergehäuseeinheit (6), die betriebsfähig mit dem Arbeitsstrang (100) verbunden ist, wobei die Radiallagergehäuseeinheit (6) um die Kraftspindel (4) und die Antriebswelle (30a) angeordnet ist und ein oberes Ende und ein unteres Ende aufweist; einen Federschuh (40a), der als eine röhrenförmige Verlängerung der Radiallagergehäuseeinheit (6) konfiguriert ist, wobei der Federschuh (40a) um die Antriebswelle (30a) angeordnet ist und einen oberen Abschnitt und einen unteren Abschnitt aufweist, wobei der obere Abschnitt des Federschuhs (40a) betriebsfähig und direkt an dem unteren Ende der Radiallagergehäuseeinheit (6) angebracht ist;
einen Federabstandshalter (42a), der um den unteren Abschnitt des Federschuhs (40a) angeordnet ist;
eine Feder (36), die um den unteren Abschnitt des Federschuhs (40a) angeordnet ist und ein erstes Ende und ein zweites Ende aufweist, wobei das erste Ende der Feder (36) an den Federabstandshalter (42a) anstößt; und
ein Hammerelement (22a), das verschiebbar zwischen dem Ambosselement (26a) und dem Federschuh (40a) positioniert ist, wobei das Hammerelement (22a) an das zweite Ende der Feder (36) anstößt.

2. Vorrichtung gemäß Anspruch 1, wobei das Hammerelement (22a) und das Ambosselement (26a) unter der Radiallagergehäuseeinheit (6) positioniert sind.

3. Vorrichtung gemäß Anspruch 1 oder 2, wobei der Arbeitsstrang (100) aus einem röhrenförmigen Bohrstrang und einem Rohrwendelstrang ausgewählt ist.

4. Vorrichtung gemäß einem der Ansprüche 1 bis 3, wobei das Ambosselement (26a) eine Steuerkurvenoberfläche (28a) mit einem schrägen Teil (50) und einem aufrechten Teil (52) enthält.

5. Vorrichtung gemäß einem der Ansprüche 1 bis 4, wobei das Hammerelement (22a) eine Steuerkurvenoberfläche (24a) mit einem schrägen Teil (54) und einem aufrechten Teil (56) enthält.

6. Ein Verfahren zum Bohren eines Bohrlochs (106) mit einem Arbeitsstrang (100), beinhaltend die folgenden Schritte:

a) Bereitstellen einer Untertagevorrichtung (2), wobei die Untertagevorrichtung (2) mit dem Arbeitsstrang (100) innerhalb des Bohrlochs (106) und mit einem Meißelelement (102) verbunden ist, wobei die Untertagevorrichtung (2) Folgendes beinhaltet: eine Kraftspindel (4), die betriebsfähig mit einem Motormittel (MM) und mit einer Antriebswelle (30a) verbunden ist; ein Ambosselement (26a) mit einer Steuerkurvenoberfläche (28a), das betriebsfähig auf dem Meißelelement (102) gebildet ist, wobei das Ambosselement (26a) betriebsfähig mit der Kraftspindel (4) und mit der Antriebswelle (30a) verbunden ist; eine Radiallagergehäuseeinheit (6), die betriebsfähig mit dem Arbeitsstrang (100) verbunden ist, wobei die Radiallagergehäuseeinheit (6) um die Kraftspindel (4) und die Antriebswelle (30a) angeordnet ist und ein oberes Ende und ein unteres Ende aufweist; einen Federschuh (40a), der als eine röhrenförmige Verlängerung der Radiallagergehäuseeinheit (6) konfiguriert ist, wobei der Federschuh (40a) um die Antriebs-

welle (30a) angeordnet ist und einen oberen Abschnitt und einen unteren Abschnitt aufweist, wobei der obere Abschnitt des Federschuhs (40a) betriebsfähig und direkt an dem unteren Ende der Radiallagergehäuseeinheit (6) angebracht ist; einen Federabstandshalter (42a), der um den unteren Abschnitt des Federschuhs (40a) angeordnet ist, eine Feder (36), die um den unteren Abschnitt des Federschuhs (40a) angeordnet ist und ein erstes Ende und ein zweites Ende aufweist, wobei das erste Ende der Feder (36) an den Federabstandshalter (42a) anstößt; ein Hammerelement (22a) mit einer Steuerkurvenoberfläche (24a), das verschiebbar zwischen dem Ambosselement (26a) und dem Federschuh (40a) positioniert ist, wobei das Hammerelement (22a) an das zweite Ende der Feder (36) anstößt;
b) Absenken des Arbeitsstrangs (100) in das Bohrloch (106);
c) In-Kontakt-Bringen des Meißelelements (102) mit einer Lagerstättenkontaktfläche (108);
d) In-Eingriff-Bringen eines distalen Endes der Antriebswelle (30a) mit einer Oberfläche des Meißelelements (102); und
e) In-Eingriff-Bringen der Steuerkurvenoberfläche (28a) des Ambosselements (26a) mit der Steuerkurvenoberfläche (24a) des Hammerelements (22a), sodass das Hammerelement (22a) eine Stoßkraft auf das Ambosselement (26a) ausübt, die in Form einer dynamischen Meißelelementbelastung auf das Meißelelement (102) übertragen wird.

7. Verfahren gemäß Anspruch 6, wobei der Arbeitsstrang (100) eine statische Last produziert, die in Form einer statischen Meißelelementbelastung auf das Meißelelement (102) übertragen wird, wobei die statische Meißelelementbelastung und die dynamische Meißelelementbelastung eine maximale Kraft auf das Meißelelement darstellen.

8. Verfahren gemäß Anspruch 7, wobei die statische Meißelelementbelastung im Wesentlichen ohne Übertragung durch das Hammer- und das Ambosselement (22a, 26a) auf das Meißelelement (102) übertragen wird.

9. Verfahren gemäß Anspruch 7 oder 8, wobei die dynamische Meißelelementbelastung eine oszillierende Stoßkraft ist, die im Wesentlichen unabhängig von der statischen Meißelelementbelastung erzeugt wird.

10. Verfahren gemäß einem der Ansprüche 6 bis 9, ferner beinhaltend den Schritt des Veranlassens des Motormittels (MM), die Kraftspindel (4) und die Antriebswelle (30a) zu drehen, um gleichzeitig das Meißelelement (102) drehend anzutreiben und das Hammerelement (22a) axial anzutreiben.

11. Verfahren gemäß einem der Ansprüche 6 bis 10, wobei zwischen der Radiallagergehäuseeinheit (6) und der Kraftspindel (4) und der Antriebswelle (30a), die das Meißelelement (102) drehend antreiben und das Hammerelement (22a) axial antreiben, keine relative axiale Bewegung stattfindet.

12. Verfahren gemäß Anspruch 6, wobei das Ambosselement (26a) ein Bit-Box-Zwischenstück (34a) ist, das betriebsfähig mit dem Meißelelement (102) verbunden ist.

13. Verfahren gemäß Anspruch 6, wobei, wenn die Steuerkurvenoberfläche (24a) des Hammerelements (22a) und die Steuerkurvenoberfläche (28a) des Ambosselements (26a) ineinandergreifen und das Hammerelement (22a) relativ zu dem Ambosselement (26a) axial verschoben wird, die Feder (36) periodisch zusammengedrückt und entspannt wird, wodurch das Hammerelement (22a) zu dem Ambosselement (26a) hin periodisch beschleunigt wird, was wiederum eine zusätzliche Stoßkraft erzeugt.

Revendications

1. Un appareil de fond (2) raccordé à une colonne de travail (100) au sein d'un puits de forage (106), la colonne de travail (100) étant raccordée à un élément formant trépan (102) avec un moyen formant moteur (MM) comprenant :

un mandrin à force motrice (4) raccordé de façon opérationnelle au moyen formant moteur (MM) et à un arbre d'entraînement (30a) ;
un élément formant enclume (26a) formé de façon opérationnelle sur l'élément formant trépan (102), l'élément formant enclume (26a) étant raccordé de façon opérationnelle au mandrin à force motrice (4) et à l'arbre d'entraînement (30a) ;
un bloc formant logement de palier radial (6) raccordé de façon opérationnelle à la colonne de travail (100), le bloc formant logement de palier radial (6) étant disposé autour du mandrin à force motrice (4) et de l'arbre d'entraînement (30a) ; et présentant une extrémité supérieure et une extrémité inférieure ;
un étrier de ressort (40a) configuré comme une extension tubulaire du bloc formant logement de palier radial (6), l'étrier de ressort (40a) étant disposé autour de l'arbre d'entraînement (30a) et présentant une section supérieure et une section inférieure, la section supérieure de l'étrier de ressort (40a) étant attachée de façon opéra-

tionnelle et
directe à l'extrémité inférieure du bloc formant logement de palier radial (6) ; un espaceur de ressort (42a) disposé autour de la section inférieure de l'étrier de ressort (40a) ;
un ressort (36) disposé autour de la section inférieure de l'étrier de ressort (40a) et présentant une première extrémité et une deuxième extrémité, la première extrémité du ressort (36) étant en aboutement contre l'espaceur de ressort (42a) ; et
un élément formant marteau (22a) positionné de façon à pouvoir coulisser entre l'élément formant enclume (26a) et l'étrier de ressort (40a), l'élément formant marteau (22a) étant en aboutement contre la deuxième extrémité du ressort (36).

2. L'appareil de la revendication 1 dans lequel l'élément formant marteau (22a) et l'élément formant enclume (26a) sont positionnés en-dessous du bloc formant logement de palier radial (6).

3. L'appareil de la revendication 1 ou de la revendication 2 dans lequel la colonne de travail (100) est sélectionnée parmi une colonne de forage formant tubulaire et une colonne formant tube spiralé.

4. L'appareil de n'importe lesquelles des revendications 1 à 3 dans lequel l'élément formant enclume (26a) contient une face de came radiale (28a) présentant une portion inclinée (50) et une portion qui se tient droite (52).

5. L'appareil de n'importe lesquelles des revendications 1 à 4 dans lequel l'élément formant marteau (22a) contient une face de came radiale (24a) présentant une portion inclinée (54) et une portion qui se tient droite (56).

6. Un procédé pour le forage d'un puits de forage (106) avec une colonne de travail (100), comprenant les étapes consistant :

a) à fournir un appareil de fond (2), l'appareil de fond (2) étant raccordé à la colonne de travail (100) au sein du puits de forage (106) et à un élément formant trépan (102), l'appareil de fond (2) comprenant : un mandrin à force motrice (4) raccordé de façon opérationnelle à un moyen formant moteur (MM) et à un arbre d'entraînement (30a) ; un élément formant enclume (26a) avec une surface de came radiale (28a) formé de façon opérationnelle sur l'élément formant trépan (102), l'élément formant enclume (26a) étant raccordé de façon opérationnelle au mandrin à force motrice (4) et à l'arbre d'entraînement (30a) ; un bloc formant logement de palier radial (6) raccordé de façon opérationnelle à la colonne de travail (100), le bloc formant logement de palier radial (6) étant disposé autour du mandrin à force motrice (4) et de l'arbre d'entraînement (30a) ; et présentant une extrémité supérieure et une extrémité inférieure ; un étrier de ressort (40a) configuré comme une extension tubulaire du bloc formant logement de palier radial (6), l'étrier de ressort (40a) étant disposé autour de l'arbre d'entraînement (30a) et présentant une section supérieure et une section inférieure, la section supérieure de l'étrier de ressort (40a) étant attachée de façon opérationnelle et directe à l'extrémité inférieure du bloc formant logement de palier radial (6) ; un espaceur de ressort (42a) disposé autour de la section inférieure de l'étrier de ressort (40a), un ressort (36) étant disposé autour de la section inférieure de l'étrier de ressort (40a) et présentant une première extrémité et une deuxième extrémité, la première extrémité du ressort (36) étant en aboutement contre l'espaceur de ressort (42a) ; un élément formant marteau (22a) avec une surface de came radiale (24a) positionné de façon à pouvoir coulisser entre l'élément formant enclume (26a) et l'étrier de ressort (40a), l'élément formant marteau (22a) étant en aboutement contre la deuxième extrémité du ressort (36) ;
b) à abaisser la colonne de travail (100) dans le puits de forage (106) ;
c) à mettre l'élément formant trépan (102) en contact avec une interface de réservoir (108) ;
d) à mettre une extrémité distale de l'arbre d'entraînement (30a) en prise avec une surface de l'élément formant trépan (102) ; et
e) à mettre la surface de came radiale (28a) de l'élément formant enclume (26a) en prise avec la surface de came radiale (24a) de l'élément formant marteau (22a) de sorte que l'élément formant marteau (22a) confère une force de choc sur l'élément formant enclume (26a) qui est transmise à l'élément formant trépan (102) sous la forme d'un poids dynamique sur l'élément formant trépan.

7. Le procédé de la revendication 6 dans lequel la colonne de travail (100) produit une charge statique qui est transmise à l'élément formant trépan (102) sous la forme d'un poids statique sur l'élément formant trépan, le poids statique sur l'élément formant trépan et le poids dynamique sur l'élément formant trépan représentant une force maximale sur l'élément formant trépan.

8. Le procédé de la revendication 7 dans lequel le poids statique sur l'élément formant trépan est transmis à l'élément formant trépan (102) substantiellement

sans transmission à travers les éléments formant marteau et enclume (22a, 26a).

9. Le procédé des revendications 7 ou 8 dans lequel le poids dynamique sur l'élément formant trépan est une force de choc oscillante générée de façon substantiellement indépendante du poids statique sur l'élément formant trépan.

10. Le procédé de n'importe lesquelles des revendications 6 à 9 comprenant en sus l'étape consistant à amener le moyen formant moteur (MM) à faire tourner le mandrin à force motrice (4) et l'arbre d'entraînement (30a) pour, simultanément, entraîner rotativement l'élément formant trépan (102) et entraîner axialement l'élément formant marteau (22a).

11. Le procédé de n'importe lesquelles des revendications 6 à 10 dans lequel il ne s'opère aucun déplacement axial relatif entre le bloc formant logement de palier radial (6) et le mandrin à force motrice (4) et l'arbre d'entraînement (30a) qui entraînent rotativement l'élément formant trépan (102) et axialement l'élément formant marteau (22a).

12. Le procédé de la revendication 6 dans lequel l'élément formant enclume (26a) est un raccord de boîte de trépan (*bit box*) (34a) raccordé de façon opérationnelle à l'élément formant trépan (102).

13. Le procédé de la revendication 6 dans lequel lorsque la surface de came radiale (24a) de l'élément formant marteau (22a) et la surface de came radiale (28a) de l'élément formant enclume (26a) sont mises en prise, et que l'élément formant marteau (22a) coulisse axialement relativement à l'élément formant enclume (26a), le ressort (36) sera périodiquement comprimé et relâché accélérant de ce fait périodiquement l'élément formant marteau (22a) en direction de l'élément formant enclume (26a) ce qui génère à son tour une force de choc supplémentaire.

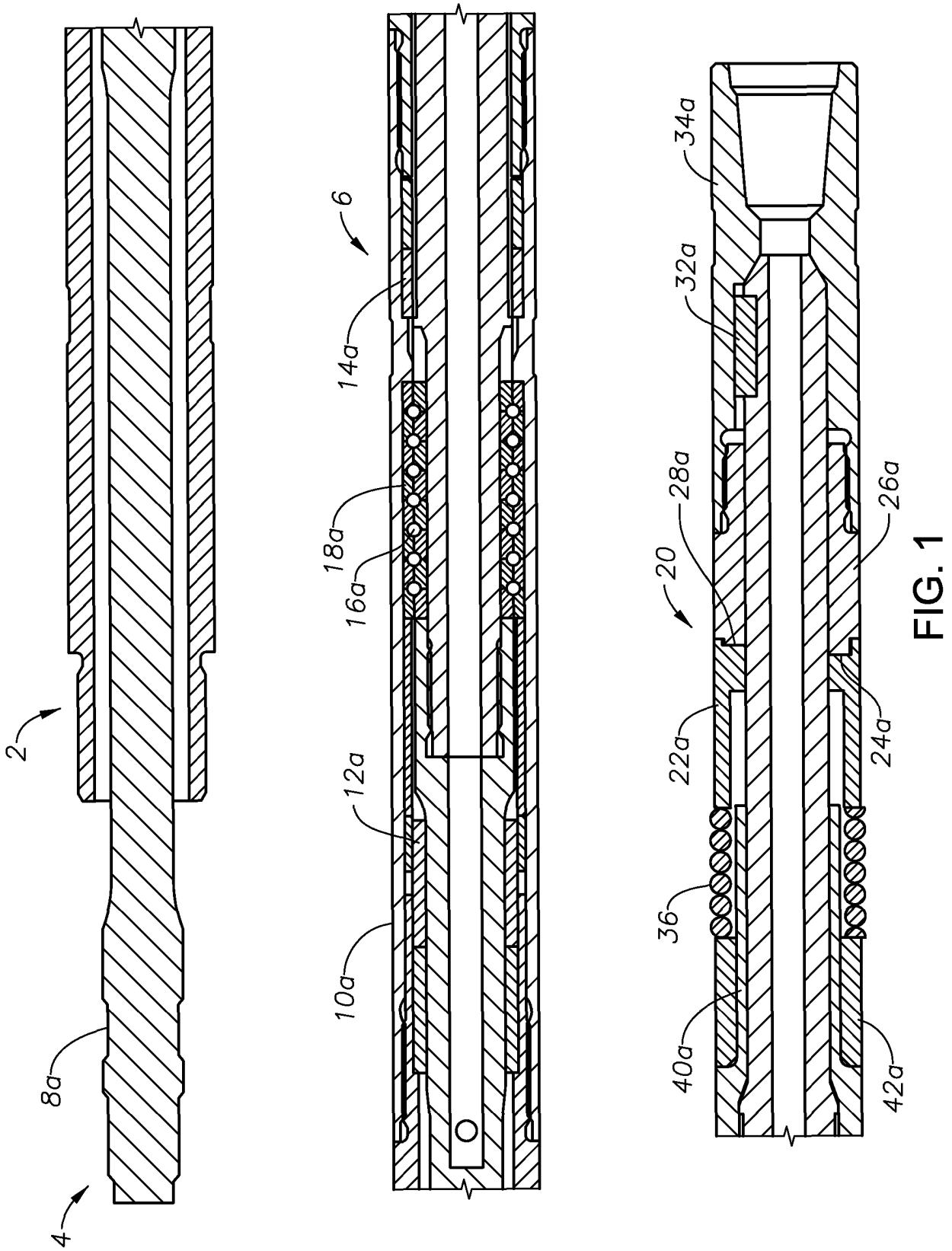

FIG. 1

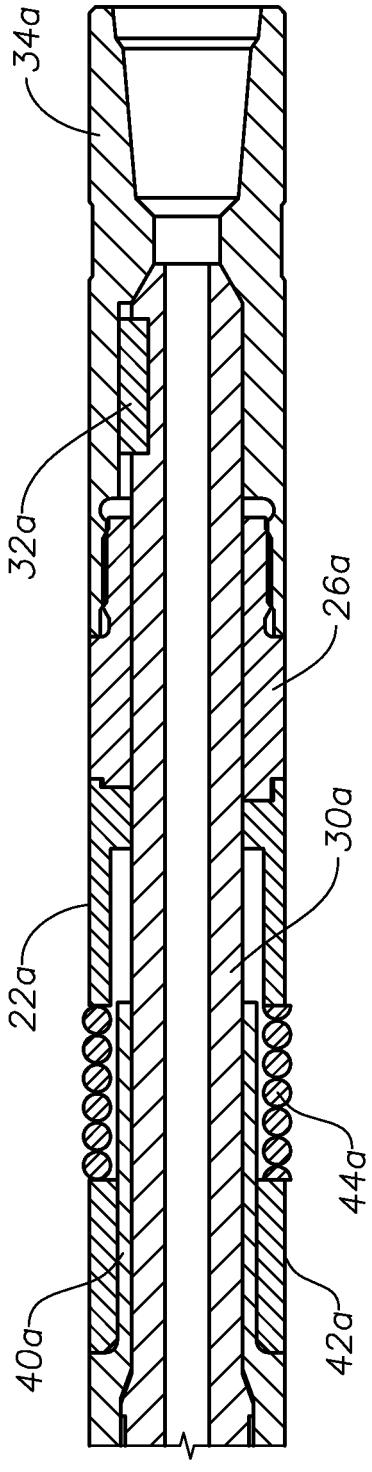
34a
32a
26a
30a
22a
44a
40a
42a

FIG. 2

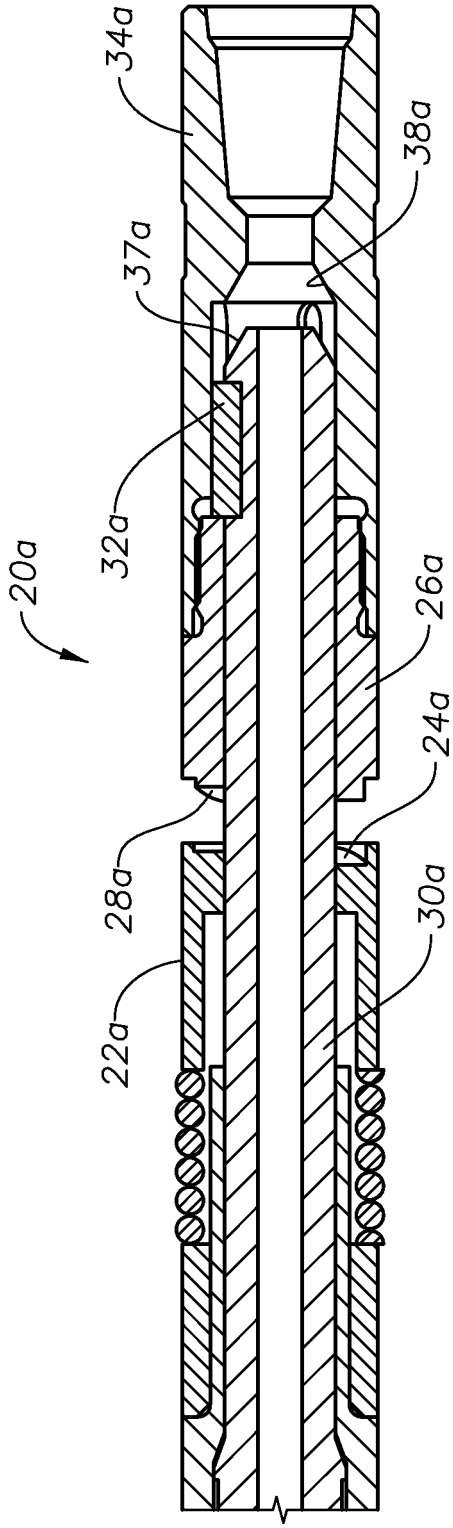
34a
38a
37a
32a
20a
26a
24a
28a
30a
22a

FIG. 3

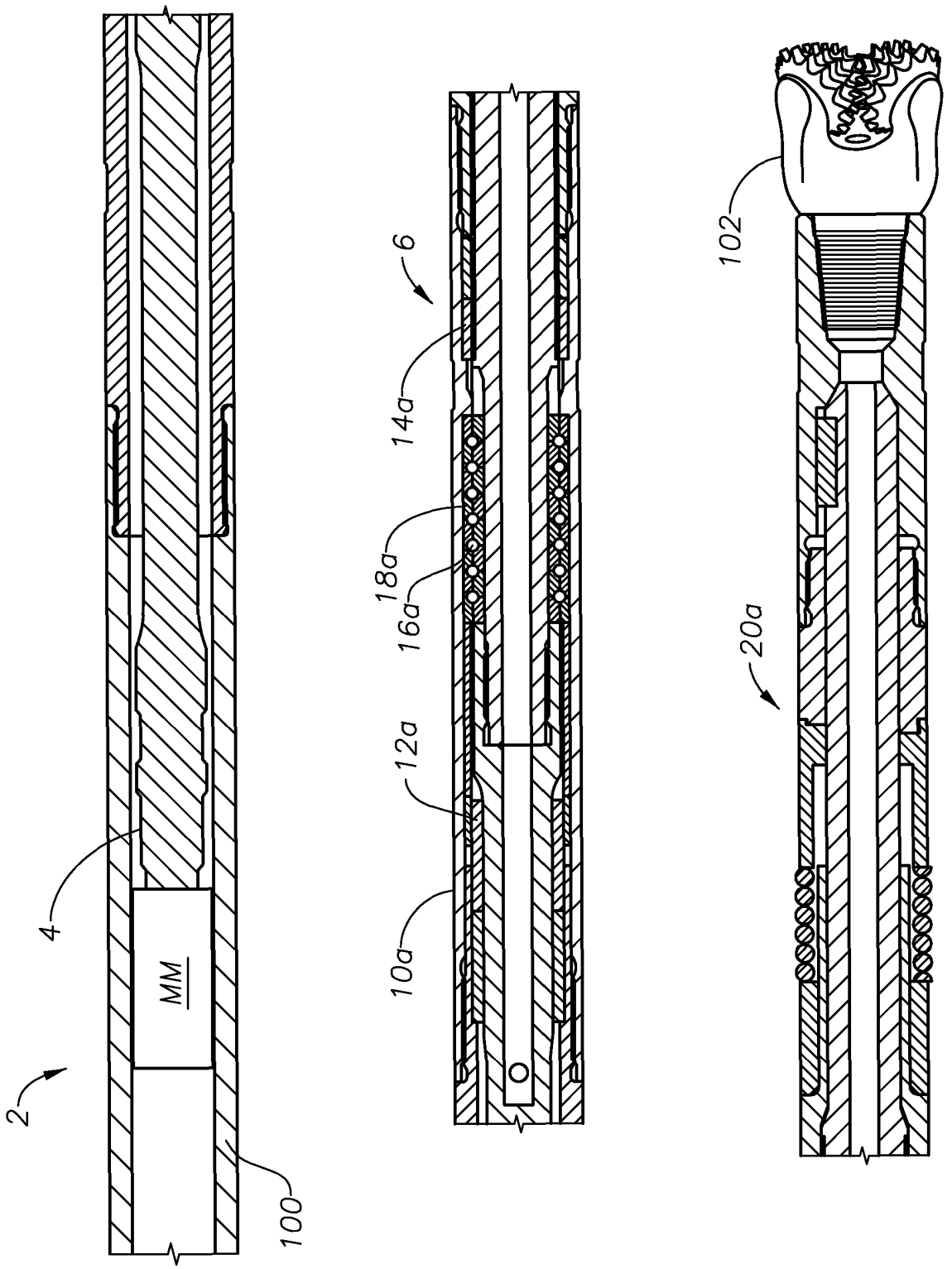

FIG. 4

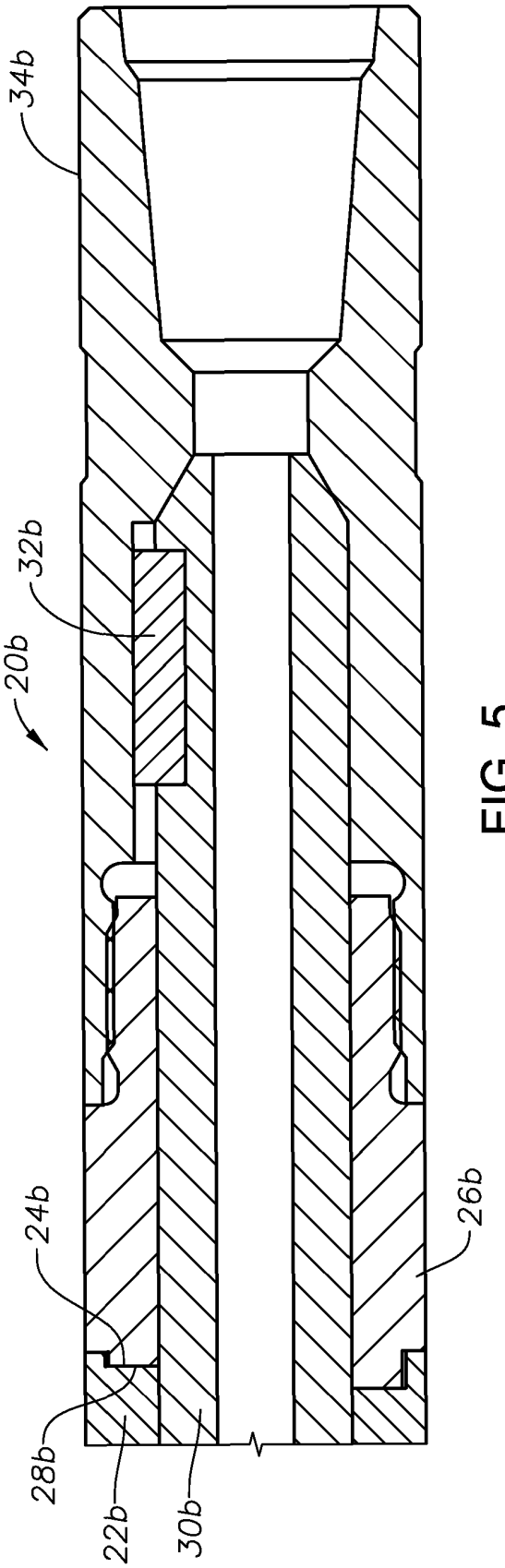
34b
32b
20b
24b
26b
28b
22b
30b

FIG. 5

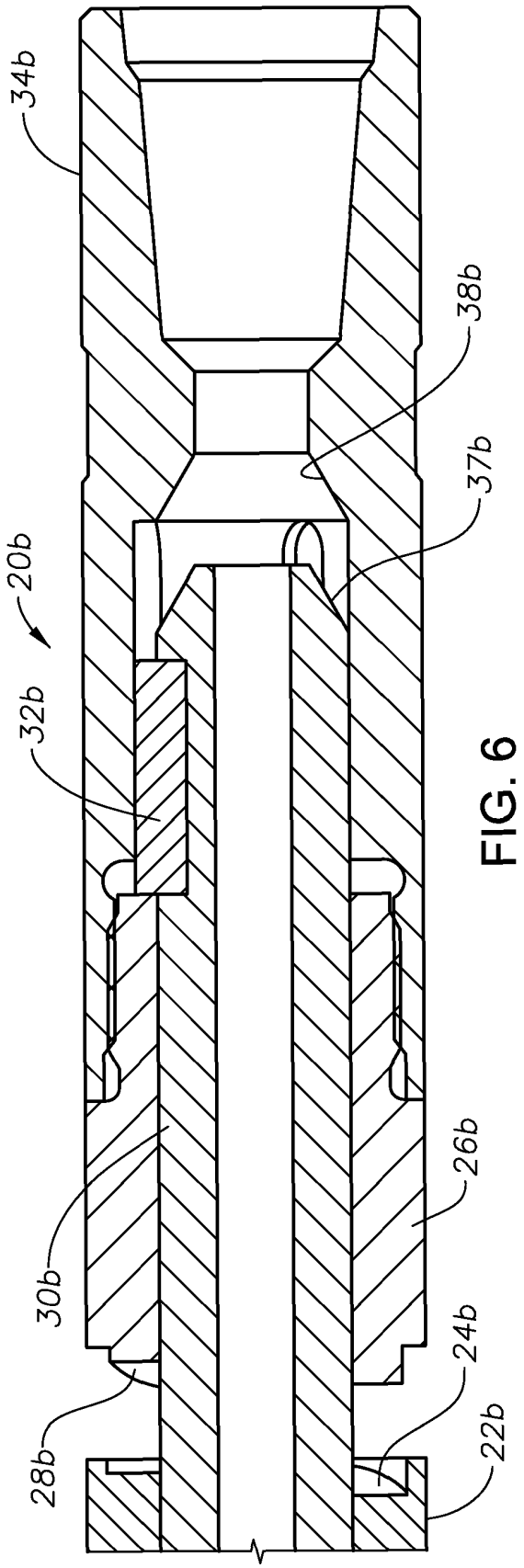
34b
38b
37b
20b
32b
26b
30b
24b
28b
22b

FIG. 6

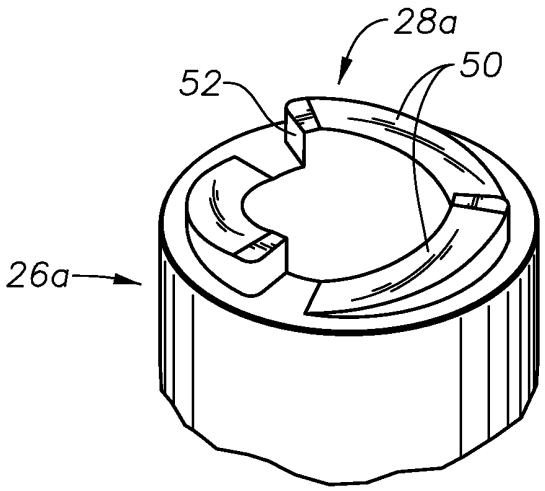

FIG. 7A

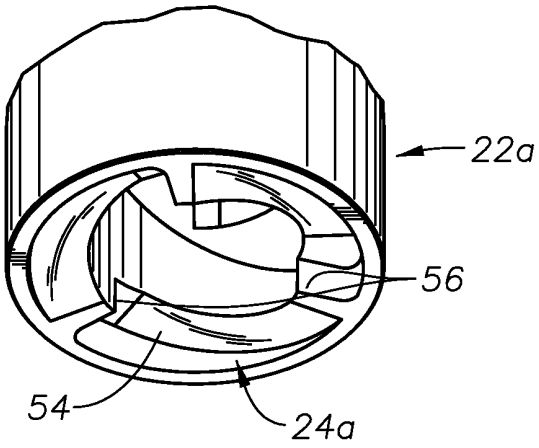

FIG. 8

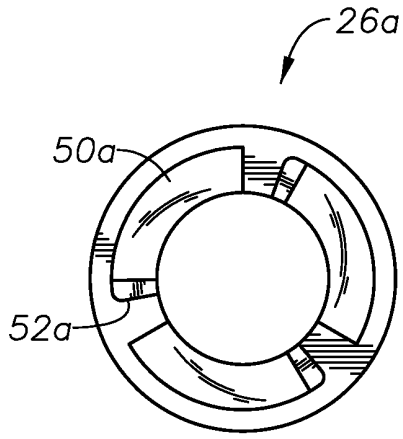

FIG. 7B

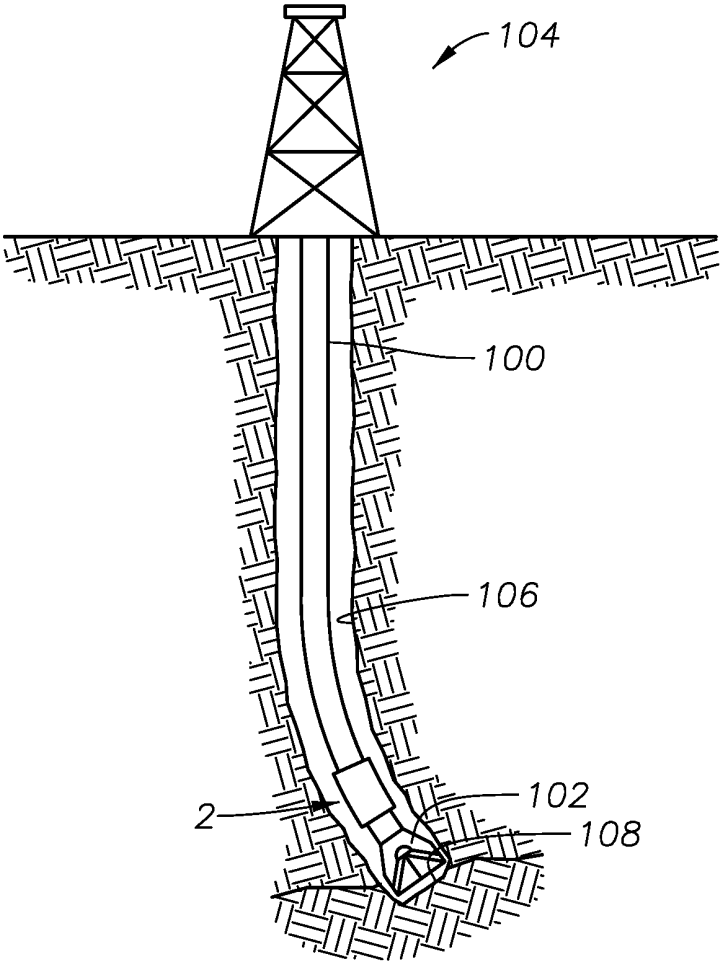

FIG. 9

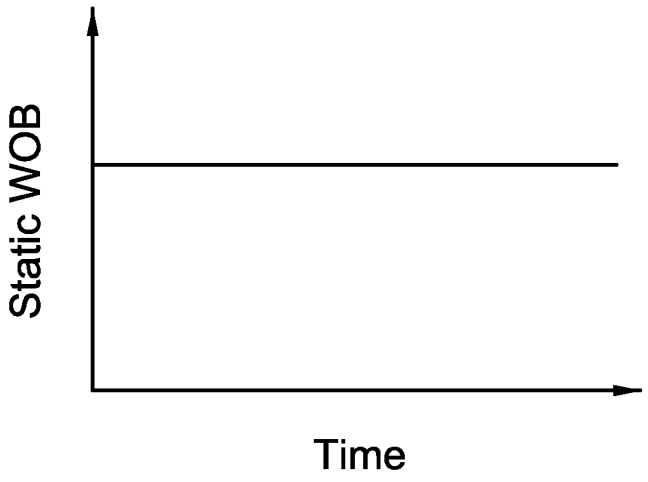

FIG. 10A

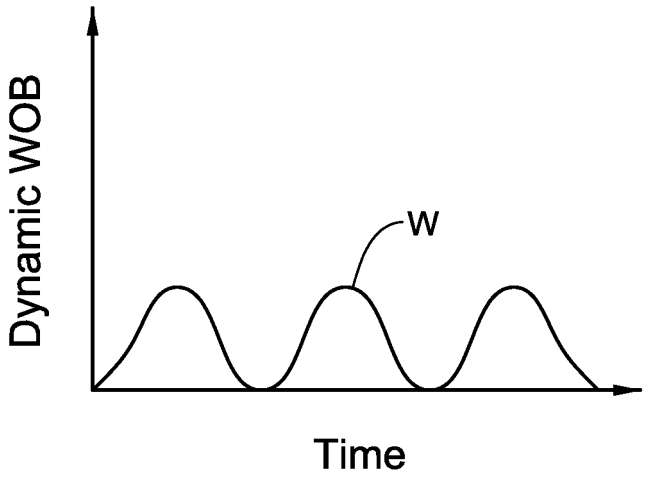

FIG. 10B

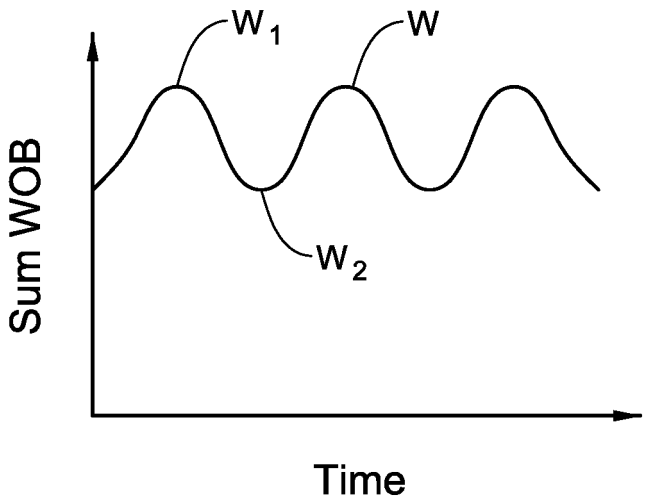

FIG. 10C

REFERENCES CITED IN THE DESCRIPTION

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