



(11)

EP 3 137 713 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:
14.10.2020 Bulletin 2020/42

(51) Int Cl.:
E21B 10/32 ^(2006.01) **E21B 29/06** ^(2006.01)
E21B 7/28 ^(2006.01) **E21B 29/00** ^(2006.01)

(21) Application number: **15785449.8**

(86) International application number:
PCT/US2015/028821

(22) Date of filing: **01.05.2015**

(87) International publication number:
WO 2015/168575 (05.11.2015 Gazette 2015/44)

(54) **CUTTING TOOL WITH EXPANDABLE CUTTER BASES AND NOSE SECTION CUTTING CAPABILITY**

SCHNEIDWERKZEUG MIT EXPANDIERBAREN SCHNEIDBASISELEMENTEN UND FÄHIGKEIT ZUM SCHNEIDEN DER NASENPARTIE

OUTIL DE COUPE AVEC BASES DE COUPE EXTENSIBLES ET APTITUDE À LA COUPE D'UNE PARTIE DE NEZ

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

(30) Priority: **01.05.2014 US 201461986950 P**

(43) Date of publication of application:
08.03.2017 Bulletin 2017/10

(73) Proprietor: **ABRADO, INC.**
Houston, TX 77084 (US)

(72) Inventor: **RUTTLEY, David, J.**
Marrero, LA 70072 (US)

(74) Representative: **Miller, James Lionel Woolverton
et al
Kilburn & Strode LLP
Lacon London
84 Theobalds Road
London WC1X 8NL (GB)**

(56) References cited:
WO-A1-2013/126752 WO-A2-2014/025763
WO-A2-2014/025763 US-A- 4 618 009
US-A- 4 809 793 US-A- 5 012 863
US-A- 5 150 755 US-A- 5 370 183
US-A- 6 070 677 US-A- 6 070 677
US-A1- 2003 155 155 US-A1- 2010 258 354

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 3 137 713 B1

Description

Background

[0001] Various tools have been developed for downhole cutting or severing of casing strings in wellbores, and for cutting or milling window sections in casing strings. Generally, such tools have comprised a main body with multiple hinged arms or blades, which are rotated outwardly into contact with the casing (by hydraulic or other means) when the tool is in position downhole. Usually, fluid is pumped down through the drillstring and through the tool to actuate the mechanism and rotate the blades outward. Once the blades are rotated outwardly, rotation of the drillstring (and tool) causes the cutting surfaces on the blades to cut through the casing string. Fluids are pumped through the system to lift the cuttings to the surface. Known tools, however, cannot efficiently cut or sever multiple, cemented-together casing strings, and in particular cannot efficiently cut "windows" in such strings; by the term "window" is meant the cutting or milling of a section (e.g. 60.1m [20 feet]) of the casing string, as opposed to simply severing same. In addition, known tools tend to form long, connected metal shavings which must be lifted from the wellbore by the fluid flow, else same become nested together downhole and potentially cause the drillstring to become stuck.

[0002] WO 2014/025763 A2 discloses an apparatus for cutting wellbore casing downhole comprising the features of the preamble of claim 1.

[0003] US 4 809 793 A discloses an enhanced diameter clean-out tool and method.

Summary of the Invention

[0004] According to a first aspect of the present invention, there is provided an apparatus for cutting wellbore casing according to Claim 1.

[0005] According to a second aspect of the present invention, there is provided a method of milling a casing string having a cement sheath on an interior wall thereof according to independent Claim 10.

Brief Description of the Drawings

[0006]

Fig. 1 is a side view of an exemplary tool embodying the principles of the present invention, particularly the cutter base/cutter combination, with the cutter bases in their retracted position.

Fig. 2 is another side view of an exemplary tool embodying the principles of the present invention, corresponding to the tool in Fig. 1, showing the cutter bases in their extended position.

Fig. 3 is a side view of the tool with cutter bases extended, and the tool in position to mill a section of casing.

Figs. 4 - 7 are side views of the tool, similar to those shown in Figs. 1 - 3, with the tool in successive positions of opening.

Fig. 8 is a side view of the tool in an open position, and in position in a casing string, and removing a cement sheath in the lowermost casing string.

Fig. 9 is a side view in partial cross section of the tool, showing additional detail of the operating mechanism, cutter bases, linkage arms, and cutters.

Fig. 10 is a view similar to Fig. 9, with the cutter bases in a partially open position.

Fig. 11 is another view similar to Fig. 9, with the cutter bases in a fully open position.

Fig. 12 is a cross section view of the operating mechanism of the tool, showing detail of the operating piston, fluid flow paths, and uppermost linkage arms.

Fig. 13 is another cross section view of the operating mechanism of the tool, showing detail of the operating piston, fluid flow paths, and uppermost linkage arms.

Fig. 14 is a cross section view, looking down the bore of the tool, showing additional detail regarding the flow path through the linkage arms, with the linkage arms in an open position.

Fig. 15 is a cross section view, looking down the bore of the tool, showing additional detail regarding the flow path through the linkage arms, with the linkage arms in a closed position.

Fig. 16 is a cross section view of an alternative embodiment of the positioning arm operating mechanism not forming part of the invention,

Description of the Presently Preferred Embodiment(s)

[0007] While a number of embodiments are possible, within the scope of the invention, with reference to the drawings some of the presently preferred embodiments can be described.

[0008] As shown in Fig. 1, the cutting tool 10 comprises a main body 20, typically having a means for connection to a tubular string, referred to herein as a drillstring 100, said means for connection preferably being a threaded connection 22 at the upper end of the tool. Preferably, a safety joint SJ 110 (shown) is installed above cutting tool 10, to provide a means for detachment from the tool should it get stuck. As is well known in the art, cutting tool 10 is run downhole into a tubular or casing string on a drillstring. Main body 20 has a bore 26 (which can be seen in Fig. 9) which runs through at least a portion of the length of main body 20, sufficiently far down to route fluid to the positioning arm area. By forcing fluid to exit the tool in the vicinity of positioning arms 50 and the recesses 28 in main body into which cutter bases 30 retract, fluid flow tends to keep these surfaces flushed and relatively free of cuttings and debris, described in more detail below.

[0009] As can be seen in the figures, especially Figs.

9 - 13, attached to main body 20 by a plurality of linkage or positioning arms 50 are cutter bases 30. In the embodiment shown in the drawings, cutting tool 10 has two cutter bases 30, but other numbers are possible within the scope of the invention. Positioning arms 50 are substantially of equal length, so it is understood that when cutter bases 30 are in an extended position as in Fig. 2, cutter bases 30 are substantially parallel to the longitudinal axis of main body 20. Positioning arms 50 are hingedly attached to both main body 20 and to cutter base 30. It is to be understood that the invention encompasses different numbers of positioning arms; generally, a minimum of two are required (one actuated arm and at least one additional arm), but a greater number may be used depending upon the particular tool dimensions.

[0010] Cutting tool 10 comprises a means for moving cutter bases 30 from a first, retracted position, generally within main body 20 and not protruding significantly therefrom, as shown in Figs. 1 and 4; to a second, extended position, wherein cutter bases 30 are partially or fully extended from the body, as seen in Fig. 2. This means for moving cutter bases may comprise an operating mechanism generally utilizing fluid pumped down the bore of the drillstring and main body 20 to actuate said operating mechanism. While not confining the current invention to any particular operating mechanism, one suitable mechanism is that disclosed in USP 7063155, owned by the assignee of this invention. Referring also to Figs. 9 - 13, generally, suitable operating mechanisms employ a piston 21 disposed in the bore of main body 20. The piston itself has a bore 21A of smaller diameter than the bore 26 in which it is disposed; therefore, fluid pumped down bore 26 of main body 20 forces the piston downward, pushing on a heel portion of an positioning arm 50 and causing it to rotate about a pin 52. It is understood that only one of positioning arms 50 per cutter base 30 need be actuated; generally the uppermost of positioning arms 50 on each cutter base 30 is actuated. For clarity, cutter bases 30 and some of the plurality of positioning arms 50 are omitted; the internal operating piston and a pair of operating arms 50 are shown, with heel portions 50A noted.

[0011] An alternative embodiment not forming part of the invention of the operating mechanism, shown in Fig. 16, comprises meshed gear teeth 200, 300 on piston 21 and positioning arms 50, respectively, in lieu of piston 21 bearing on heel portions 50A of positioning arms 50. As can be readily understood, movement of piston 21 causes positioning arms 50 to rotate around pins 52, causing cutter bases 30 to move inwardly and outwardly as previously described.

[0012] Referring to the drawings, cutter bases 30 comprise a plurality of cutters 40 mounted thereon (for space and clarity, not all of cutters 40 are so annotated). While various embodiments of cutters maybe used, one suitable embodiment uses a metal base or cutter plate which is attached to cutter base 30 by welding or similar means; on the cutter plate is attached a plurality of metal cutting

surfaces, such as carbide buttons or inserts, or hardened buttons of other materials, or other means known in the art; alternatively the cutter plates may be covered with carbide or other suitable hardened surface, or a combination of hardened material buttons and carbide or similar materials. A variety of cutting surfaces are suitable, as long as they present a hardened surface to the upward-facing casing edge to permit milling of same. Further detail regarding acceptable cutting surfaces is set forth below.

[0013] As can be seen in Figs. 2 and 3, cutters 40 are preferably arranged in a plurality of vertically spaced apart rows along the length of cutter base 30. To facilitate milling in a downward direction, with conventional right-hand rotation of the drillstring, cutters 40 may be angled or inclined, wherein an upper end of cutters 40 is inclined in a direction of rotation of cutting tool 10. The number, position, and spacing of cutters 40 maybe varied to suit particular applications. With cutters 40 positioned in a plurality of vertically spaced apart, horizontally aligned rows, as shown in the figures, it can be appreciated that as milling progresses, and a row of cutters wears out, the diameter of the cutters decreases such that the next row of cutters above moves downward into contact with the casing surface. In this manner, a fresh cutting surface is presented to the casing edge being milled. It can be appreciated that the multiple rows of cutters permit the tool to remain in the hole for an extended period, thereby greatly reducing time spent in pulling and re-dressing the cutting tool. By way of example, each row of cutters may be approximately 2.54 cm (1") apart (vertically) from the adjacent row.

[0014] Generally, cutter bases 30 are sized so as to fit generally within the radius of main body 30 when retracted, as in Figs. 1, 4. The dimensions of positioning arms 50 and cutter bases 30 yield sufficient outward radius to position cutters 40 over the edge of casing 70 in order to mill same, as can be seen in Fig. 3. Dimensions of cutter base 30 are therefore dependent upon the size of casing 70 being milled, and upon the dimensions of main body 20 and positioning arms 50. Likewise, the dimensions of cutters 40 in a radially outward direction may be adjusted as necessary to suit particular jobs.

[0015] Fig. 3 shows cutting tool 10 in an operating position. A section of casing 70 is shown in which a window section 72 has already been milled. Cutter bases 30 are fully extended on positioning arms 50, so as to bring the outer surface of cutter bases 30 to or nearly to the inner wall of casing 70, and the lower, cutting surface of cutters 40 against the edge of casing 70. It is understood that, as well known in the art, Fig. 3 shows cutting tool 10 in a downhole position, run downhole on a drillstring (not shown), and being rotated in a conventional, right hand direction. Fluid is also being pumped through the drillstring and through cutting tool 10, and circulated back uphole.

[0016] With fluid circulation ongoing, thereby extending cutter bases 30 and cutters 40 to the position shown

in Fig. 3, cutting tool 10 is lowered so that cutters 40 engage the upper surface of casing 70. The drillstring and cutting tool 10 are rotated while weight is applied to cutting tool 10, resulting in casing 70 being milled away. Milling continues as cutters 40 are gradually worn away, since as described above once a given row or set of cutters is sufficiently worn to move down inside the casing inner diameter, the next set of cutters moves into cutting position and cutting continues.

[0017] Yet another attribute of cutting tool 10 is the centering and stabilizing aspect of cutter bases 30 in conjunction with the positioning arms 50. Preferably, a section of cutter bases 30 has no cutters 40 mounted thereon, as noted in certain of the figures as stabilizing section 32. As is readily understood with reference to Fig. 3, when cutter bases 30 are in their extended position, placing them into or nearly into contact with the inner wall of casing 70, then main body 20 is centered within casing 70 and stabilized therein, and cutters 40 are properly positioned over the edge of casing 70 for optimum cutting. A second stabilizing section 32 may be provided at the upper end of each of cutter bases 30, in order to stabilize and centralize the tool while pulling it in an uphole direction.

[0018] Another preferred attribute of cutting tool 10 is that the dimensions of positioning arms 50 and cutter bases 30 are such as to enable cutter bases 30 to bear against and be supported by main body 20, when cutter bases 30 are in their second, extended position; this is shown at the location noted as 31 in Figs. 2 and 3. This attribute provides significant support to cutter bases 30, and consequently cutters 40, as weight is applied to cutting tool 10 during the cutting tooling process. A jetted sub, as seen in Fig. 5, maybe provided above cutting tool 10 to direct fluid flow in a desired direction and onto desired parts of the tool.

Configuration of nose section of cutter bases; addition of hardened cutting surfaces

[0019] Figs. 1 - 8 show an attribute of the cutting tool which yields additional capability to its use. Cutting tool 10, and more specifically cutter bases 30, comprise a tapered nose section 34 at their lower end. The lower end of main body 20 is formed in a rounded point to roughly correspond to the shape of tapered nose section 34. A hardened cutting surface, represented by 34A as labeled in Fig. 1, is provided on tapered nose section 34. Hardened cutting surface 34A may be of one or more suitable materials, for example tungsten carbide, hardened steel, polycrystalline diamond compact buttons, etc., all as known in the relevant art.

[0020] Those skilled in the art will recognize that tapered nose section 34 yields significant added utility to cutting tool 10, as the tool is capable of cutting and/or milling through obstacles disposed below it in a wellbore. The particular shape and configuration of the nose section taper can be modified to suit particular needs. The

type, location, and placement of hardened cutting surface 34A can likewise be modified to suit particular applications.

Partial opening of tool to clear cement sheath

[0021] Fig. 8 illustrates one possible application or use of the tapered nose sections 34. In Fig. 8, cutting tool 10 is shown in a partially open state; that is, cutter bases 30 are expanded from their initial, retracted position, but are not at the maximum expansion due to cutter bases 30 contacting the inner wall of casing 70. A common situation is one wherein a cement sheath 74 is present on the inner wall of casing 70, typically as a result of the cementing of a smaller casing string which has already been removed from within casing 70. By positioning cutting tool 10 within casing 70 as in Fig. 8, and commencing fluid flow (to expand cutter bases 30 to the position shown) and lowering cutting tool 10, tapered nose section 34, along with hardened cutting surface 34A, can remove substantially all of cement sheath 74. This enables cutting tool 10 to be properly centered within casing 70, and for cutters 40 to cut/mill casing 70 as desired.

Modification of positioning arms to direct fluid flow

[0022] In a presently preferred embodiment, the heel portions 50A of positioning arms 50 are modified so as to direct fluid flow in a desired direction, depending upon the operating position of cutting tool 10. In Fig. 13, cutting tool 10 is in a first, retracted position, wherein cutter bases are retracted. Positioning arms 50 are rotated to the position shown in Fig. 13. Piston 21 is in an upper position, as fluid flow through bore 26 has not commenced. Piston 21 itself has a bore 21A, through which fluid flows. A seal element 21B (seen in Fig. 12) provides a seal so as to force piston 21 downward with fluid flow. Fluid flow through piston bore 21A may be split as can be seen in Fig. 13, with a portion flowing substantially straight down (the Directly Downhole Flow) and a portion being diverted through flow passages 26C (the Diverted Portion). As can be recognized, depending upon the size and shape of heel portions 50A of positioning arms 50, fluid flow in a directly downhole direction can be stopped or diminished. In a preferred embodiment, the shape of heel portion 50A is modified, whether in the initial manufacture or post-manufacture by grinding, etc., to remove the inner corner sections, to produce an angled surface, depicted as 50B in Fig. 14. As can be understood from Fig. 14, which shows positioning arms 50 in an expanded position (i.e. cutting tool 10 is open, as in Fig. 12), a fluid path substantially directly downhole and through positioning arms 50 is created, denoted by the circle 50C. This enables fluid circulation down through the lowermost end of cutting tool 10, which is particularly beneficial when cutting with the tapered nose sections 34. Fig. 15 shows the tool in a closed position (as in Fig. 13), with positioning arms 50 retracted.

Use of pins to align and guide operating piston, in lieu of alignment blocks

[0023] Piston 21 is disposed in bore 26, so as to move longitudinally in the bore in response to fluid flow. While piston 21 is aligned in bore 26 to an extent by its shape, and by seal assembly 21B (which provides a fluid seal around piston 21 in bore 26), additional alignment is desired for the smaller diameter section 21D of piston 21. Earlier known designs utilized alignment blocks positioned within bore 26. The presently preferred embodiment of the present invention uses a pair of pins 21C (only one pin shown for clarity), inserted through holes 21E in main body 20. Pins 21C are positioned so as to closely constrain piston 21, and more specifically smaller diameter section 21D, from side to side movement. Pins 21C are more easily fitted, removed and replaced than are alignment blocks.

Method of use of the cutting tool

[0024] An exemplary method of use of cutting tool 10 with expandable cutter bases 30 can now be described. A main body 20, cutter bases 30, and positioning arms 50, with multiple cutters attached to each cutter base 30, are selected with dimensions appropriate for the size casing that is to be cut. A relatively short downhole window is first cut in the tubular in interest, with a two-arm casing cutter or conventional cutting tool, or with cutting tool 10 when configured for that task. As seen in Fig. 3, a window 72 of sufficient length that cutter bases 30 can fit therein is generally desired.

[0025] The next step is to locate cutting tool 10 within window 72. Although various methods are possible, one preferred method is to lower cutting tool 10 to a depth known to be slightly below window 72. Fluid circulation is then started, which will move cutter bases 30 (and cutters 40) outward, into contact with the casing wall. Cutting tool 10 is then pulled uphole, while cutters 40 are in contact with the casing wall. When cutting tool 10 is positioned within casing window 72 such that the lowermost cutters are above the casing edge, cutter bases 30 can fully extend and multiple indicators will be noted at the surface, including a decrease in drag, change in pump pressure, decrease in torque, etc. Now, the stabilizing section 32 of cutter bases 30 will be positioned against the wall of the casing, and cutters 40 will be positioned over the casing edge; this is the position seen in Figs. 3 and 5. Fluid circulation continues so as to maintain the proper positioning of the cutter bases and cutters. Rotation of the cutting tool 10 is commenced, and a desired amount of weight is applied to the cutting tool, to force the lowermost cutter edges against the upward-facing casing edge and consequently commence cutting or milling of the casing. It is to be understood that the sequence of steps set forth above is only one possible method of use; same may be changed as required, including but not limited to the sequence or order of the different op-

erations, additional steps maybe added, steps maybe omitted, insofar these changes fall within the scope of claim 10.

Conclusion

[0026] While the preceding description contains many specificities, it is to be understood that same are presented only to describe some of the presently preferred embodiments of the invention, and not by way of limitation. Changes can be made to various aspects of the invention, without departing from the scope thereof, as defined by the appended claims. For example, dimensions of the various components of the tool can be varied to suit particular jobs; the number of cutter bases can be varied; the number and positioning of cutters per cutter base can be varied; size and shape of the cutters can vary; and methods of use can be varied.

[0027] Therefore, the scope of the invention is to be determined not by the illustrative examples set forth above, but by the appended claims.

Claims

1. An apparatus for cutting wellbore casing (70) downhole, comprising:

a main body (20) comprising a longitudinal bore (26) and a plurality of elongated cutter bases (30) movably attached thereto and each having a tapered nose section (34) on a lower end thereof, said cutter bases attached to said main body by a plurality of positioning arms (50) hingedly connected thereto, said positioning arms being of substantially equal length so that said cutter bases remain substantially parallel to a longitudinal axis of said main body when moved between a first retracted position and a second extended position;

a plurality of cutters (40) attached to an upper section of each of said cutter bases, whereby a lower section of said cutter bases without cutters comprises a stabilizer section (32);

an operating mechanism for moving said cutter bases from said first retracted position to said second extended position, said operating mechanism comprising a sliding piston (21) disposed in said bore of said main body and movable by fluid flow through said bore of said main body, said piston having an upper section with a diameter closely fitting a diameter of said main body bore and a seal element (21B) between said upper section of said piston and said bore, and a lower section with a reduced diameter, said piston positioned so as to engage a heel section (50A) of said positioning arms and bear down on same so as to rotate said positioning arms

- outwardly and move said elongated cutter bases from said first position to said second position, said piston further having a longitudinal bore (21A) therethrough; **characterised in that:** the lower end of the main body is formed in a rounded point corresponding to the shape of the tapered nose sections, said tapered nose sections comprising a hardened cutting surface (34A) thereon.
2. The apparatus of claim 1, wherein said heel sections (50A) are shaped, such that a fluid path downhole through said main body bore (26) is created when said positioning arms are in an extended position, and wherein said piston comprises a plurality of angled flow passages (26C) such that a portion of fluid flow through said piston bore (21A) flows through said fluid path through said positioning arms, and a portion of fluid flow is angled outwardly onto said positioning arms.
 3. The apparatus of claim 1, further comprising a pair of pins (52) disposed in said main body (20) proximal said lower section of said piston (21) within said main body bore (26), so as to align said lower piston section within said main body bore.
 4. The apparatus of claim 3, wherein said cutters (40) are elongated along said cutter bases (30) and positioned such that an upper end of said cutters is inclined in a direction of rotation of said apparatus.
 5. The apparatus of claim 4, wherein said cutters (40) comprise carbide covered cutting surfaces.
 6. The apparatus of claim 4, wherein said cutters (40) comprise carbide buttons.
 7. The apparatus of claim 4, wherein said cutters (40) comprise polycrystalline diamond compact inserts.
 8. The apparatus of claim 1, further comprising a jetted sub and a safety joint positioned above said main body (20).
 9. The apparatus of claim 1, wherein said positioning arms (50) and cutter bases (30) are dimensioned so that said positioning arms and said cutter bases, when said cutter bases are in said second extended position, bear against said main body (20).
 10. A method of milling a casing string having a cement sheath (74) on an interior wall thereof, comprising the steps of:
 - a. milling a window (72) in a desired downhole location in said casing string, leaving an upwardly facing casing edge;

- b. providing an apparatus comprising: a main body (20) comprising a longitudinal bore (26) and a plurality of elongated cutter bases (30) movably attached thereto, said cutter bases attached to said main body by a plurality of positioning arms (50) hingedly connected thereto, said positioning arms being of substantially equal length so that said cutter bases remain substantially parallel to a longitudinal axis of said main body when moved between a first retracted position and a second extended position; a plurality of cutters (40) attached to an upper section of each of said cutter bases, whereby a lower section of said cutter bases without cutters comprises a stabilizer section (32); a means for moving said cutter bases from said first retracted position to said second extended position, said means comprising a sliding piston (21) disposed in said bore of said main body and movable by fluid flow through said bore of said main body, said piston having an upper section with a diameter closely fitting a diameter of said main body bore and a seal element (21B) between said upper section of said piston and said bore, and a lower section with a reduced diameter, said piston positioned so as to engage a heel section (50A) of said positioning arms and bear down on same so as to rotate said positioning arms outwardly and move said elongated cutter bases from said first position to said second position, said piston further having a longitudinal bore (21A) therethrough; each of said cutter bases having a tapered nose section (34) on a lower end, said tapered nose section comprising a hardened cutting surface (34A) thereon, the lower end of the main body being formed in a rounded point corresponding to the shape of the tapered nose section;
- c. lowering said apparatus downhole on a drillstring and positioning said apparatus so that said cutters are within said window, with said stabilizer section of said cutter bases below said window;
- d. pumping fluid down said drillstring so as to move said cutter bases outward so that said stabilizer section of said cutter bases contact said inner wall of said casing;
- e. rotating and lowering said apparatus so as to contact said cement sheath with said cutting surfaces on said tapered nose of said cutter bases and remove said cement sheath, and continuing to rotate and lower said apparatus until said cutters contact said upwardly facing casing edge;
- f. rotating and lowering said apparatus, while pumping fluid flow through said apparatus, while cutting said casing with said cutters and removing any cement sheath on said inner casing wall with said tapered nose cutting surface.

Patentansprüche

1. Vorrichtung zum Schneiden einer Bohrlochverrohrung (70) in einem Bohrloch, umfassend:

einen Hauptkörper (20) mit einer Längsbohrung (26) und mehreren länglichen Schneidbasiselementen (30), die bewegbar daran befestigt sind und jeweils einen sich verjüngenden Nasenabschnitt (34) an einem unteren Ende davon aufweisen, wobei die Schneidbasiselemente am Hauptkörper durch mehrere gelenkig damit verbundene Positionierungsarme (50) befestigt sind, wobei die Positionierungsarme von im Wesentlichen gleicher Länge sind, sodass die Schneidbasiselemente im Wesentlichen parallel zu einer Längsachse des Hauptkörpers bleiben, wenn sie zwischen einer ersten eingefahrenen Position und einer zweiten ausgefahrenen Position bewegt werden;

mehrere Schneidelemente (40), die an einem oberen Abschnitt jedes der Schneidbasiselemente befestigt sind, wobei ein unterer Abschnitt der Schneidbasiselemente ohne Schneidelemente einen Stabilisatorabschnitt (32) umfasst;

einen Betätigungsmechanismus zum Bewegen der Schneidbasiselemente aus der ersten eingefahrenen Position in die zweite ausgefahrene Position, wobei der Betätigungsmechanismus einen Gleitkolben (21) umfasst, der in der Bohrung des Hauptkörpers angeordnet und durch einen Fluidstrom durch die Bohrung des Hauptkörpers bewegbar ist, wobei der Kolben einen oberen Abschnitt mit einem Durchmesser, der eng an einen Durchmesser der Hauptkörperbohrung angepasst ist, ein Dichtungselement (21B) zwischen dem oberen Abschnitt des Kolbens und der Bohrung und einen unteren Abschnitt mit einem reduzierten Durchmesser aufweist, wobei der Kolben so positioniert ist, dass er mit einem Fersenabschnitt (50A) der Positionierungsarme in Eingriff steht und auf diesen drückt, um die Positionierungsarme nach außen zu drehen und die länglichen Schneidbasiselemente aus der ersten Position in die zweite Position zu bewegen, wobei der Kolben ferner eine Längsbohrung (21A) durch ihn hindurch aufweist; **dadurch gekennzeichnet, dass:**

das untere Ende des Hauptkörpers in einer abgerundeten Spitze ausgebildet ist, die der Form der sich verjüngenden Nasenabschnitte entspricht, wobei die sich verjüngenden Nasenabschnitte eine gehärtete Schneidfläche (34A) daran aufweisen.

2. Vorrichtung nach Anspruch 1, wobei die Fersenabschnitte (50A) so geformt sind, dass ein Fluidweg im

Bohrloch durch die Hauptkörperbohrung (26) erzeugt wird, wenn sich die Positionierungsarme in einer ausgefahrenen Position befinden, und wobei der Kolben mehrere abgewinkelte Strömungskanäle (26C) umfasst, sodass ein Teil des Fluidstroms durch die Kolbenbohrung (21A) durch den Fluidweg durch die Positionierungsarme strömt und ein Teil des Fluidstroms nach außen auf die Positionierungsarme abgewinkelt ist.

3. Vorrichtung nach Anspruch 1, ferner umfassend ein Paar Stifte (52), die im Hauptkörper (20) proximal zum unteren Abschnitt des Kolbens (21) innerhalb der Hauptkörperbohrung (26) so angeordnet sind, dass sie den unteren Kolbenabschnitt innerhalb der Hauptkörperbohrung ausrichten.

4. Vorrichtung nach Anspruch 3, wobei die Schneidelemente (40) entlang der Schneidbasiselemente (30) langgestreckt und so positioniert sind, dass ein oberes Ende der Schneidelemente in einer Drehrichtung der Vorrichtung geneigt ist.

5. Vorrichtung nach Anspruch 4, wobei die Schneidelemente (40) mit Hartmetall beschichtete Schneidflächen umfassen.

6. Vorrichtung nach Anspruch 4, wobei die Schneidelemente (40) Hartmetallknöpfe umfassen.

7. Vorrichtung nach Anspruch 4, wobei die Schneidelemente (40) polykristalline Diamantkompakteinsätze umfassen.

8. Vorrichtung nach Anspruch 1, ferner umfassend ein Ausstoßzwischenstück und eine Sicherheitsverbindung, die über dem Hauptkörper (20) positioniert ist.

9. Vorrichtung nach Anspruch 1, wobei die Positionierungsarme (50) und die Schneidbasiselemente (30) so dimensioniert sind, dass die Positionierungsarme und die Schneidbasiselemente, wenn sich die Schneidbasiselemente in der zweiten ausgefahrenen Position befinden, gegen den Hauptkörper (20) anliegen.

10. Verfahren zum Fräsen eines Verrohrungsstrangs mit einer Zementhülle (74) an einer Innenwand desselben, umfassend die folgenden Schritte:

a. Fräsen eines Fensters (72) an einer gewünschten Stelle im Bohrloch im Verrohrungsstrang, wobei eine nach oben gerichtete Verrohrungskante verbleibt;

b. Bereitstellen einer Vorrichtung, die Folgendes umfasst: einen Hauptkörper (20), der eine Längsbohrung (26) und mehrere bewegbar daran befestigte längliche Schneidbasiselemente

(30) umfasst, wobei die Schneidbasiselemente am Hauptkörper durch mehrere gelenkig damit verbundene Positionierungsarme (50) befestigt sind, wobei die Positionierungsarme von im Wesentlichen gleicher Länge sind, sodass die Schneidbasiselemente im Wesentlichen parallel zu einer Längsachse des Hauptkörpers bleiben, wenn sie zwischen einer ersten eingefahrenen Position und einer zweiten ausgefahrenen Position bewegt werden;
 mehrere Schneidelemente (40), die an einem oberen Abschnitt jedes der Schneidbasiselemente befestigt sind, wobei ein unterer Abschnitt der Schneidbasiselemente ohne Schneidelemente einen Stabilisatorabschnitt (32) umfasst; ein Mittel zum Bewegen der Schneidbasiselemente aus der ersten eingefahrenen Position in die zweite ausgeführte Position, wobei das Mittel einen Gleitkolben (21) umfasst, der in der Bohrung des Hauptkörpers angeordnet und durch einen Fluidstrom durch die Bohrung des Hauptkörpers bewegbar ist, wobei der Kolben einen oberen Abschnitt mit einem Durchmesser, der eng an einen Durchmesser der Hauptkörperbohrung angepasst ist, ein Dichtungselement (21B) zwischen dem oberen Abschnitt des Kolbens und der Bohrung und einen unteren Abschnitt mit einem reduzierten Durchmesser aufweist, wobei der Kolben so positioniert ist, dass er mit einem Fersenabschnitt (50A) der Positionierungsarme in Eingriff steht und auf diesen drückt, um die Positionierungsarme nach außen zu drehen und die länglichen Schneidbasiselemente aus der ersten Position in die zweite Position zu bewegen, wobei der Kolben ferner eine Längsbohrung (21A) durch ihn hindurch aufweist;
 wobei jedes der Schneidbasiselemente einen sich verjüngenden Nasenabschnitt (34) an einem unteren Ende aufweist, wobei der sich verjüngende Nasenabschnitt eine gehärtete Schneidfläche (34A) daran aufweist, wobei das untere Ende des Hauptkörpers in einer abgerundeten Spitze ausgebildet ist, die der Form des sich verjüngenden Nasenabschnitts entspricht;
 c. Absenken der Vorrichtung im Bohrloch auf einen Bohrstrang und Positionieren der Vorrichtung, so dass sich die Schneidelemente innerhalb des Fensters befinden, wobei sich der Stabilisatorabschnitt der Schneidbasiselemente unterhalb des Fensters befindet;
 d. Pumpen von Fluid durch den Bohrstrang, um die Schneidbasiselemente nach außen zu bewegen, sodass der Stabilisatorabschnitt der Schneidbasiselemente mit der Innenwand der Verrohrung in Kontakt steht;
 e. Drehen und Absenken der Vorrichtung, um

die Zementhülle mit den Schneidflächen an der sich verjüngenden Nase der Schneidbasiselemente in Kontakt zu bringen und die Zementhülle zu entfernen, und Fortsetzen des Drehens und Absenkens der Vorrichtung, bis die Schneidelemente mit der nach oben gewandten Verrohrungskante in Kontakt kommen;

f. Drehen und Absenken der Vorrichtung, während ein Fluidstrom durch die Vorrichtung gepumpt wird, während das Gehäuse mit den Schneidelementen geschnitten wird und jede Zementhülle an der Verrohrungsinnenwand mit der Schneidfläche der sich verjüngenden Nase entfernt wird.

Revendications

1. Appareil pour couper le tubage (70) de puits de forage en fond de trou, comprenant :

un corps principal (20) comprenant un alésage longitudinal (26) et une pluralité de bases de coupe allongées (30) fixées de manière mobile à celui-ci et ayant chacune une section de nez conique (34) sur une extrémité inférieure de celle-ci, lesdites bases de coupe étant fixées audit corps principal par une pluralité de bras de positionnement (50) reliés de manière articulée à celui-ci, lesdits bras de positionnement étant de longueur sensiblement égale de sorte que lesdites bases de coupe restent sensiblement parallèles à un axe longitudinal dudit corps principal lorsqu'elles sont déplacées entre une première position rétractée et une seconde position étendue ;

une pluralité d'éléments de coupe (40) fixés à une section supérieure de chacune desdites bases de coupe, moyennant quoi une section inférieure desdites bases de coupe sans éléments de coupe comprend une section stabilisatrice (32) ;

un mécanisme d'actionnement pour déplacer lesdites bases de coupe de ladite première position rétractée à ladite seconde position étendue, ledit mécanisme d'actionnement comprenant un piston coulissant (21) disposé dans ledit alésage dudit corps principal et mobile par écoulement de fluide à travers ledit alésage dudit corps principal, ledit piston ayant une section supérieure dont le diamètre est étroitement adapté à un diamètre dudit alésage du corps principal et un élément d'étanchéité (21B) entre ladite section supérieure dudit piston et ledit alésage, et une section inférieure de diamètre réduit, ledit piston étant positionné de manière à s'engager dans une section de talon (50A) desdits bras de positionnement et à s'appuyer sur

- celle-ci de manière à faire tourner lesdits bras de positionnement vers l'extérieur et à déplacer lesdites bases de coupe allongées de ladite première position à ladite seconde position, ledit piston étant en outre traversé par un alésage longitudinal (21A) ; **caractérisé en ce que** : l'extrémité inférieure du corps principal est formée en une pointe arrondie correspondant à la forme des sections de nez coniques, lesdites sections de nez coniques comprenant une surface de coupe durcie (34A) sur celles-ci.
2. Appareil selon la revendication 1, dans lequel lesdites sections de talon (50A) sont formées, de telle sorte qu'un trajet de fluide en fond de trou à travers ledit alésage (26) de corps principal est créé lorsque lesdits bras de positionnement sont dans une position étendue, et dans lequel ledit piston comprend une pluralité de passages d'écoulement inclinés (26C) de telle sorte qu'une partie de l'écoulement de fluide à travers ledit alésage de piston (21A) s'écoule à travers ledit trajet de fluide à travers lesdits bras de positionnement, et qu'une partie de l'écoulement de fluide est inclinée vers l'extérieur sur lesdits bras de positionnement.
 3. Appareil selon la revendication 1, comprenant en outre une paire de broches (52) disposées dans ledit corps principal (20) à proximité de ladite section inférieure dudit piston (21) dans ledit alésage (26) de corps principal, de manière à aligner ladite section inférieure de piston dans ledit alésage de corps principal.
 4. Appareil selon la revendication 3, dans lequel lesdits éléments de coupe (40) sont allongés le long desdites bases de coupe (30) et positionnés de telle sorte qu'une extrémité supérieure desdits éléments de coupe est inclinée dans un sens de rotation dudit appareil.
 5. Appareil selon la revendication 4, dans lequel lesdits éléments de coupe (40) comprennent des surfaces de coupe recouvertes de carbure.
 6. Appareil selon la revendication 4, dans lequel lesdits éléments de coupe (40) comprennent des boutons en carbure.
 7. Appareil selon la revendication 4, dans lequel lesdits éléments de coupe (40) comprennent des trépan compactes à diamant polycristallin.
 8. Appareil selon la revendication 1, comprenant en outre un raccord à jet et un joint de sécurité positionnés au-dessus dudit corps principal (20).
 9. Appareil selon la revendication 1, dans lequel lesdits bras de positionnement (50) et lesdites bases de coupe (30) sont dimensionnés de sorte que lesdits bras de positionnement et lesdites bases de coupe, lorsque lesdites bases de coupe sont dans ladite seconde position étendue, s'appuient contre ledit corps principal (20).
 10. Procédé de broyage d'une colonne de tubage ayant une gaine de ciment (74) sur une paroi intérieure de celle-ci, comprenant les étapes suivantes :
 - a. le broyage d'une fenêtre (72) à un endroit souhaité du fond de trou dans ladite colonne de tubage, en laissant un bord du tubage tourné vers le haut ;
 - b. la fourniture d'un appareil comprenant : un corps principal (20) comprenant un alésage longitudinal (26) et une pluralité de bases de coupe allongées (30) fixées de manière mobile à celui-ci, lesdites bases de coupe étant fixées audit corps principal par une pluralité de bras de positionnement (50) reliés de manière articulée à celui-ci, lesdits bras de positionnement étant de longueur sensiblement égale de sorte que lesdites bases de coupe restent sensiblement parallèles à un axe longitudinal dudit corps principal lorsqu'elles sont déplacées entre une première position rétractée et une seconde position étendue ; une pluralité d'éléments de coupe (40) fixés à une section supérieure de chacune desdites bases de coupe, moyennant quoi une section inférieure desdites bases de coupe sans éléments de coupe comprend une section stabilisatrice (32) ; un moyen pour déplacer lesdites bases de coupe de ladite première position rétractée à ladite seconde position étendue, ledit moyen comprenant un piston coulissant (21) disposé dans ledit alésage dudit corps principal et mobile par écoulement de fluide à travers ledit alésage dudit corps principal, ledit piston ayant une section supérieure dont le diamètre est étroitement adapté à un diamètre dudit alésage du corps principal et un élément d'étanchéité (21B) entre ladite section supérieure dudit piston et ledit alésage, et une section inférieure de diamètre réduit, ledit piston étant positionné de manière à s'engager dans une section de talon (50A) desdits bras de positionnement et à s'appuyer sur celle-ci de manière à faire tourner lesdits bras de positionnement vers l'extérieur et à déplacer lesdites bases de coupe allongées de ladite première position à ladite seconde position, ledit piston étant en outre traversé par un alésage longitudinal (21A) ; chacune desdites bases de coupe ayant une section de nez conique (34) sur une extrémité

inférieure, ladite section de nez conique comprenant une surface de coupe durcie (34A) sur celle-ci, l'extrémité inférieure du corps principal étant formée en une pointe arrondie correspondant à la forme de la section de nez conique ; 5

c. l'abaissement dudit appareil en fond de trou sur une colonne de forage et le positionnement dudit appareil de sorte que lesdits éléments de coupe se trouvent à l'intérieur de ladite fenêtre, avec ladite section stabilisatrice desdites bases de coupe en dessous de ladite fenêtre ; 10

d. le pompage du fluide vers le bas de ladite colonne de forage de manière à déplacer lesdites bases de coupe vers l'extérieur de sorte que ladite section stabilisatrice desdites bases de coupe soit en contact avec ladite paroi intérieure dudit tubage ; 15

e. la rotation et l'abaissement dudit appareil de manière à mettre en contact ladite gaine de ciment avec lesdites surfaces de coupe sur ledit nez conique desdites bases de coupe et le retrait de ladite gaine de ciment, et la poursuite de la rotation et de l'abaissement dudit appareil jusqu'à ce que lesdits éléments de coupe entrent en contact avec ledit bord du tubage orienté vers le haut ; 20 25

f. la rotation et l'abaissement dudit appareil, tout en pompant le flux de fluide à travers ledit appareil, tout en coupant ledit tubage avec lesdits éléments de coupe et en enlevant toute gaine de ciment sur ladite paroi intérieure du tubage avec ladite surface de coupe à nez conique. 30

35

40

45

50

55

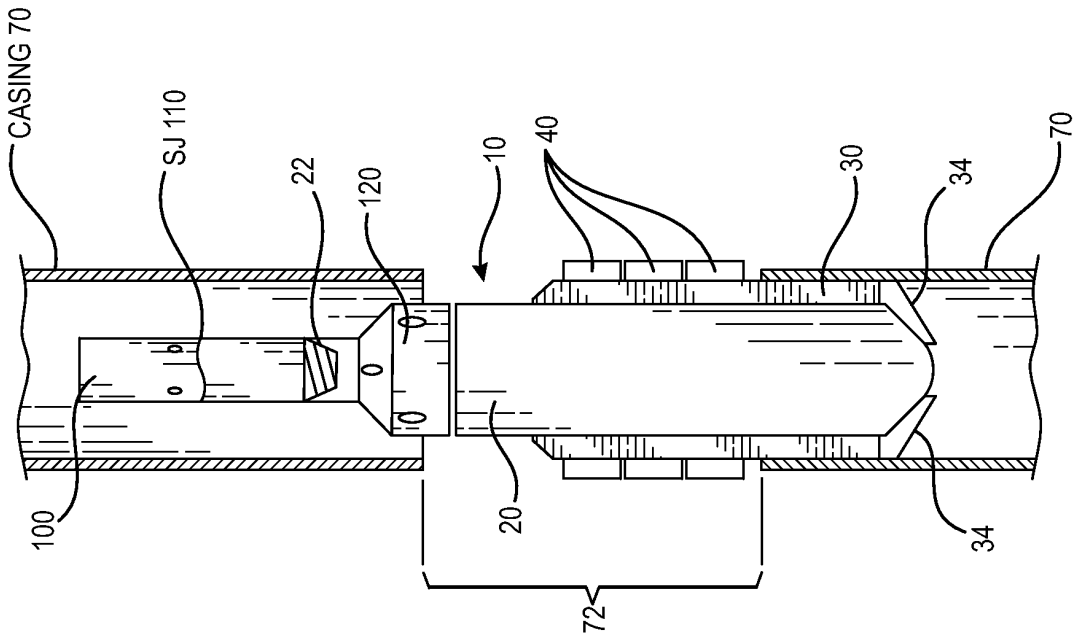


FIG. 1

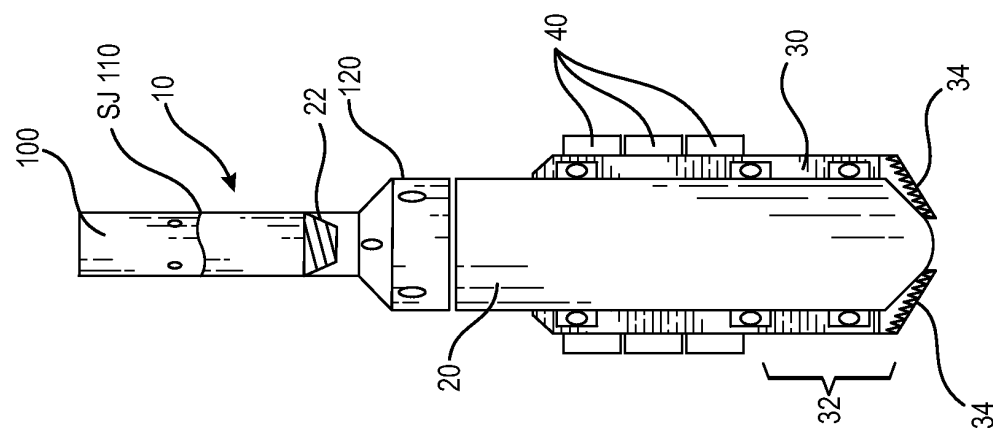


FIG. 2

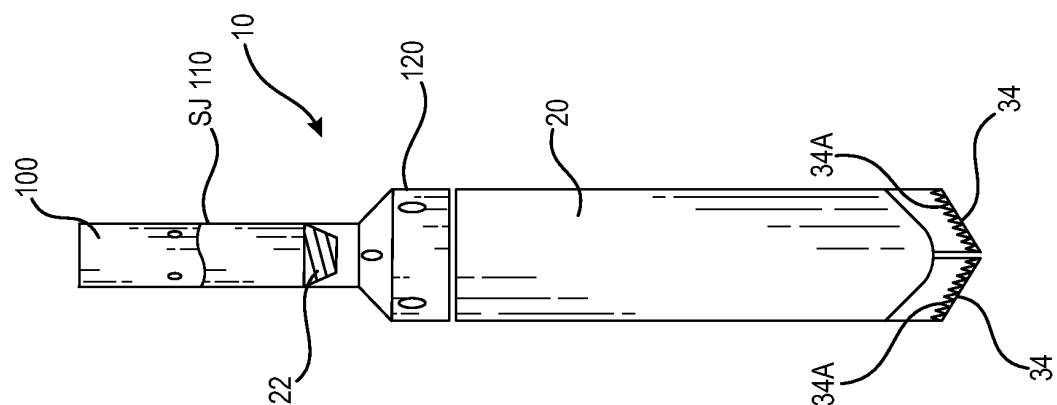


FIG. 3

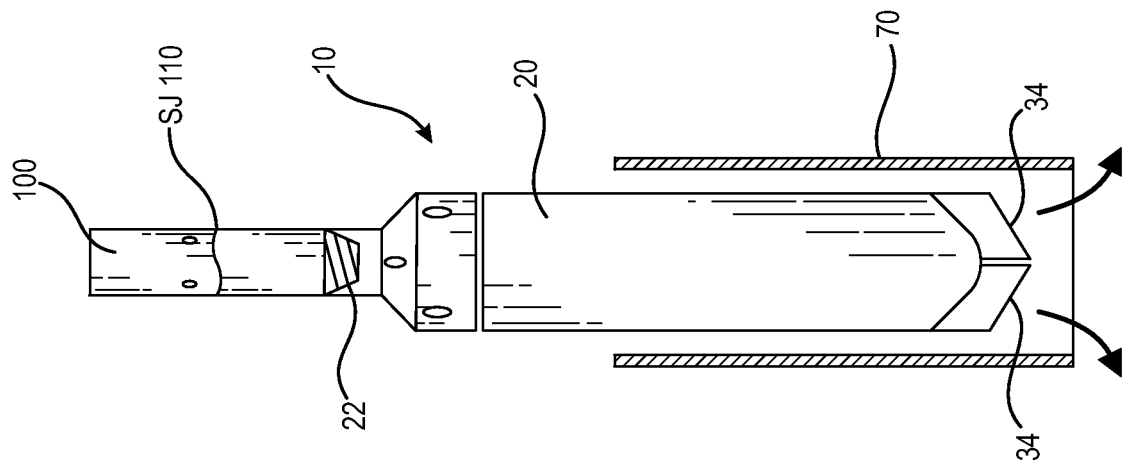


FIG. 4

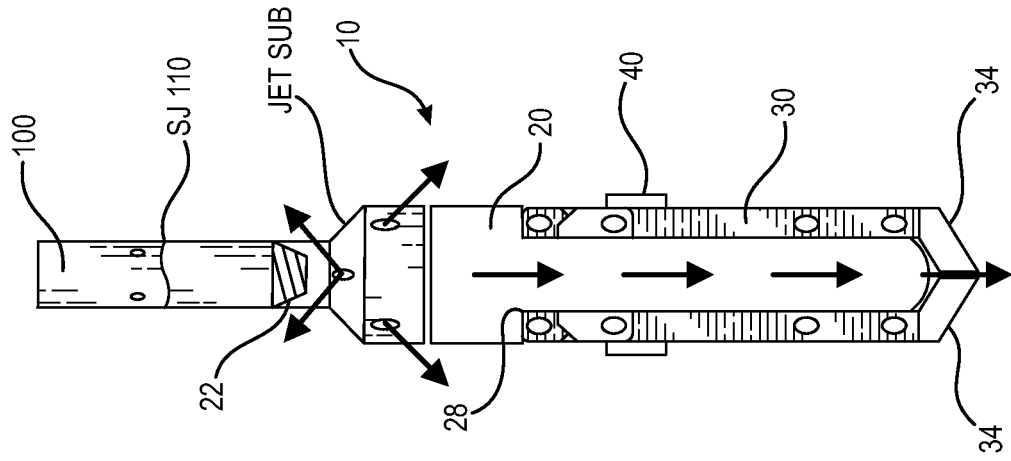


FIG. 5

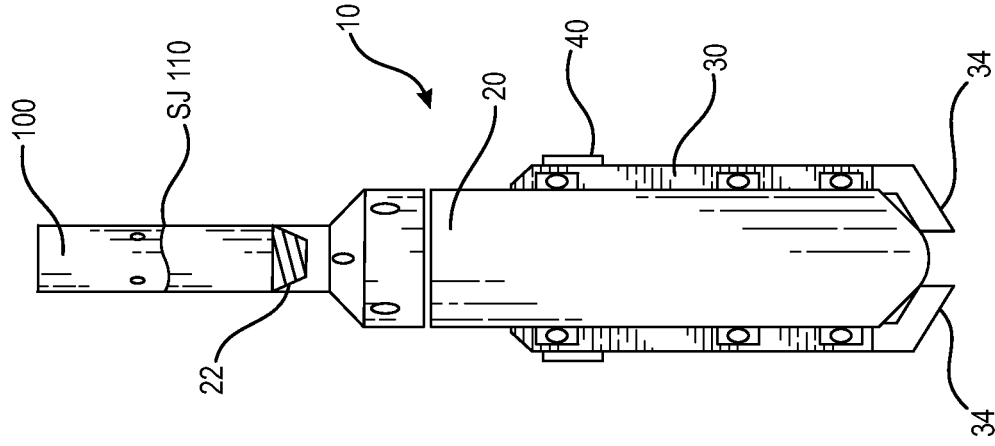


FIG. 6

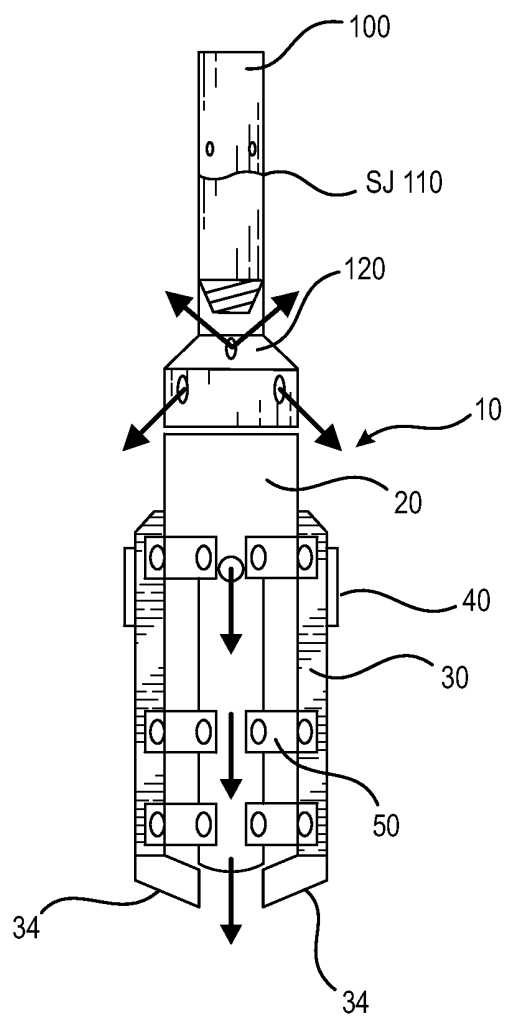


FIG. 7

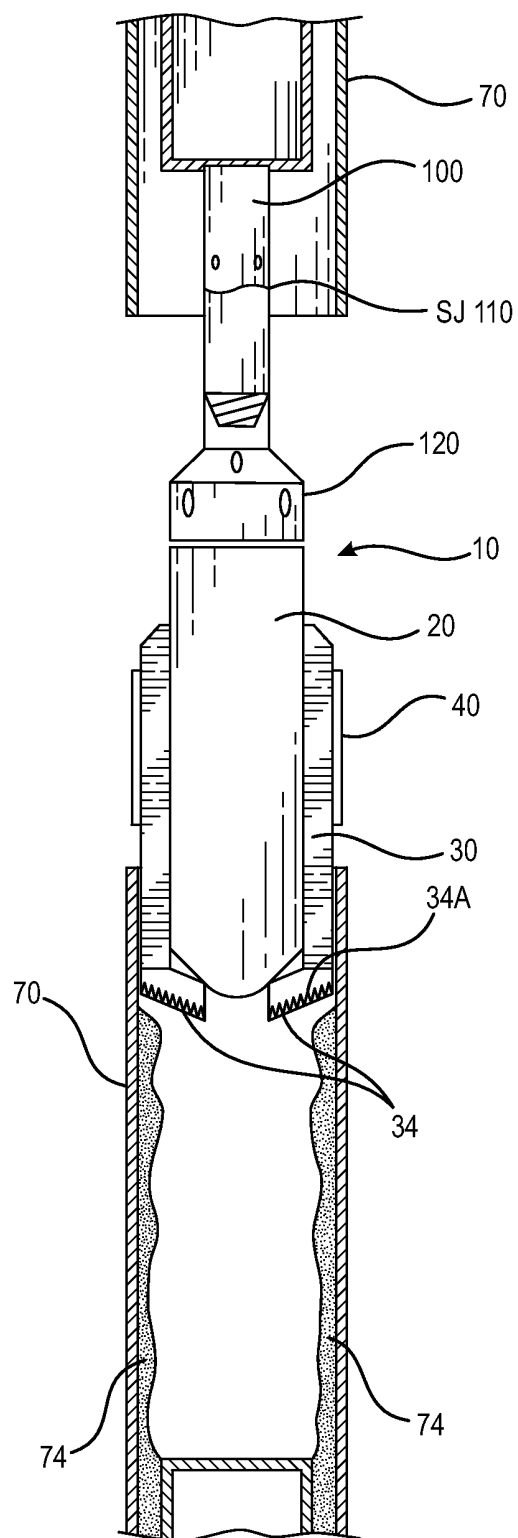


FIG. 8

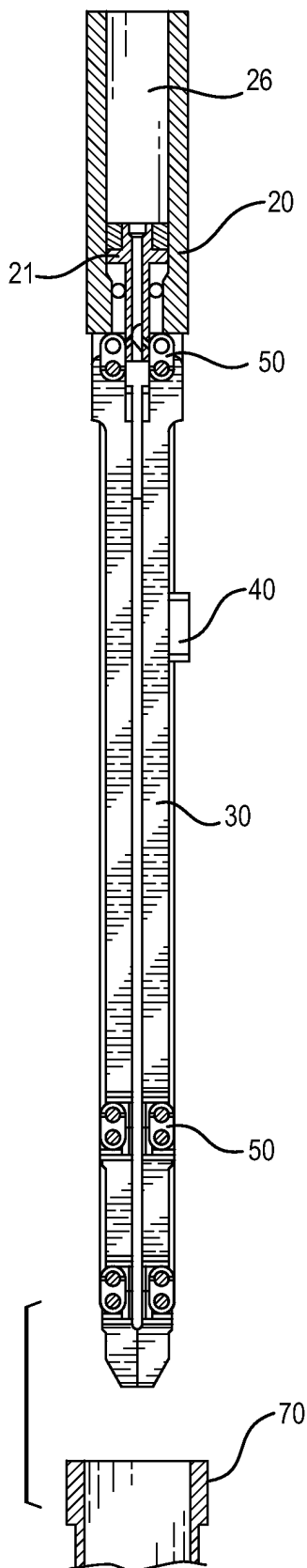


FIG. 9

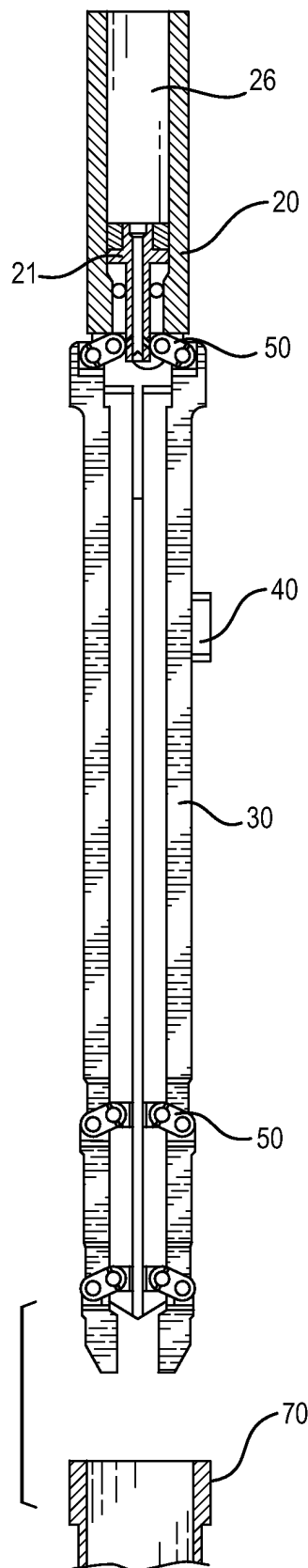


FIG. 10

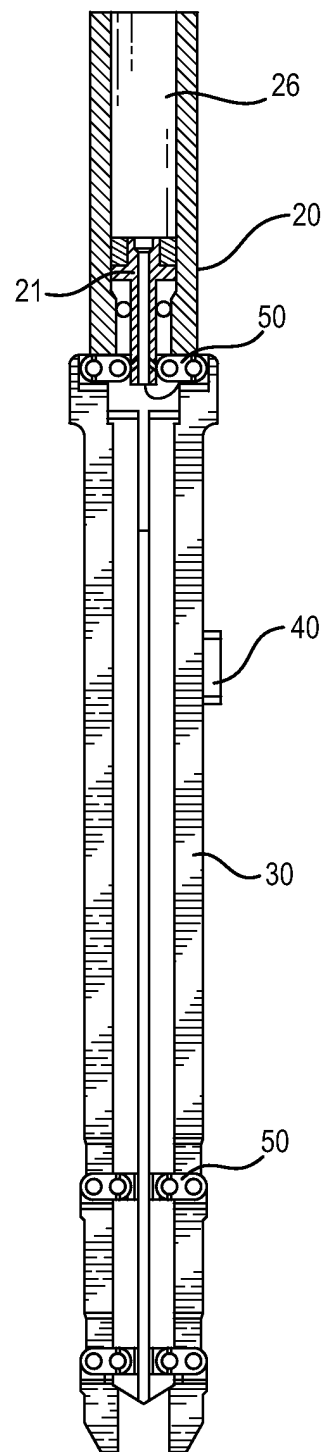


FIG. 11

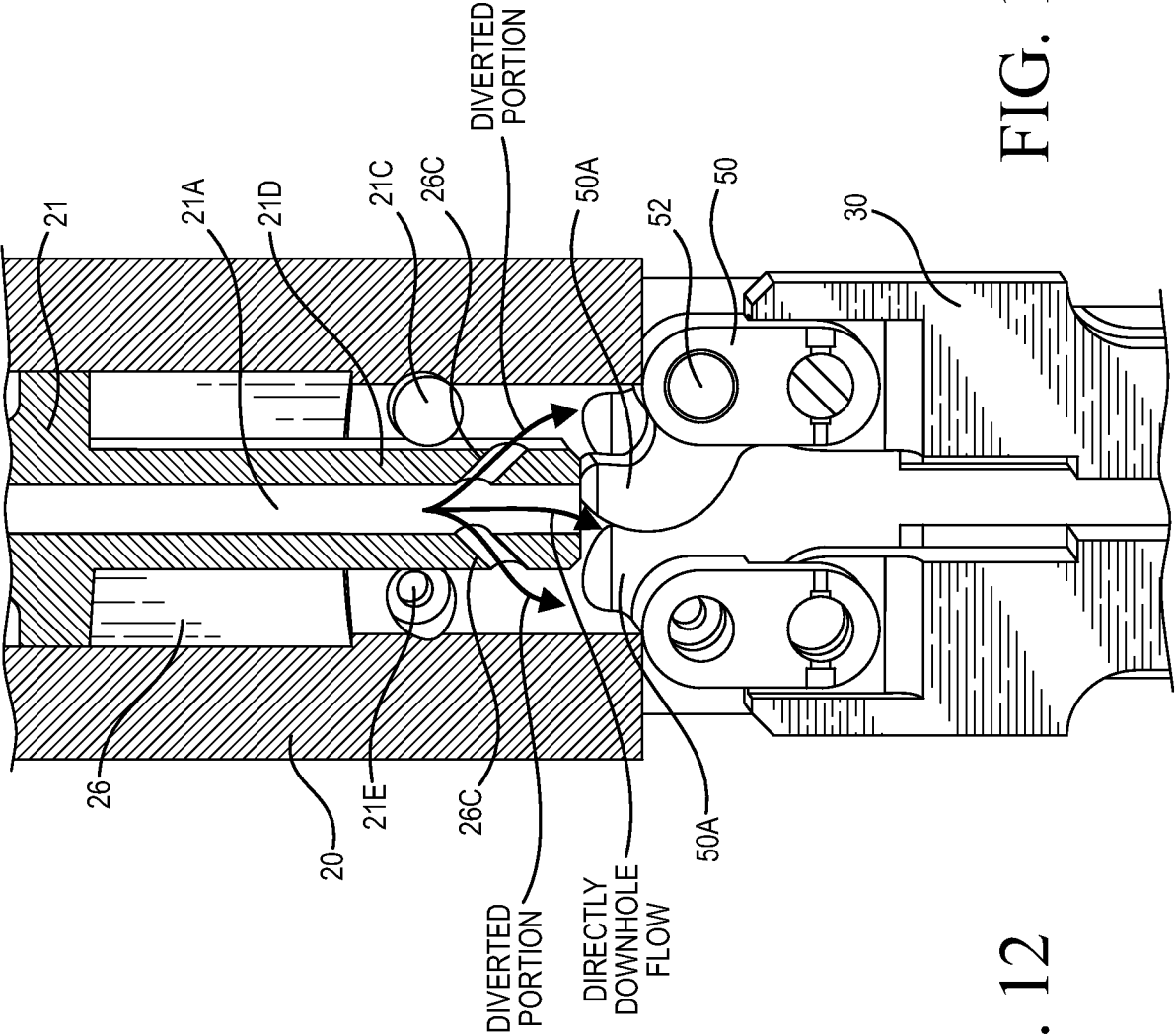


FIG. 12

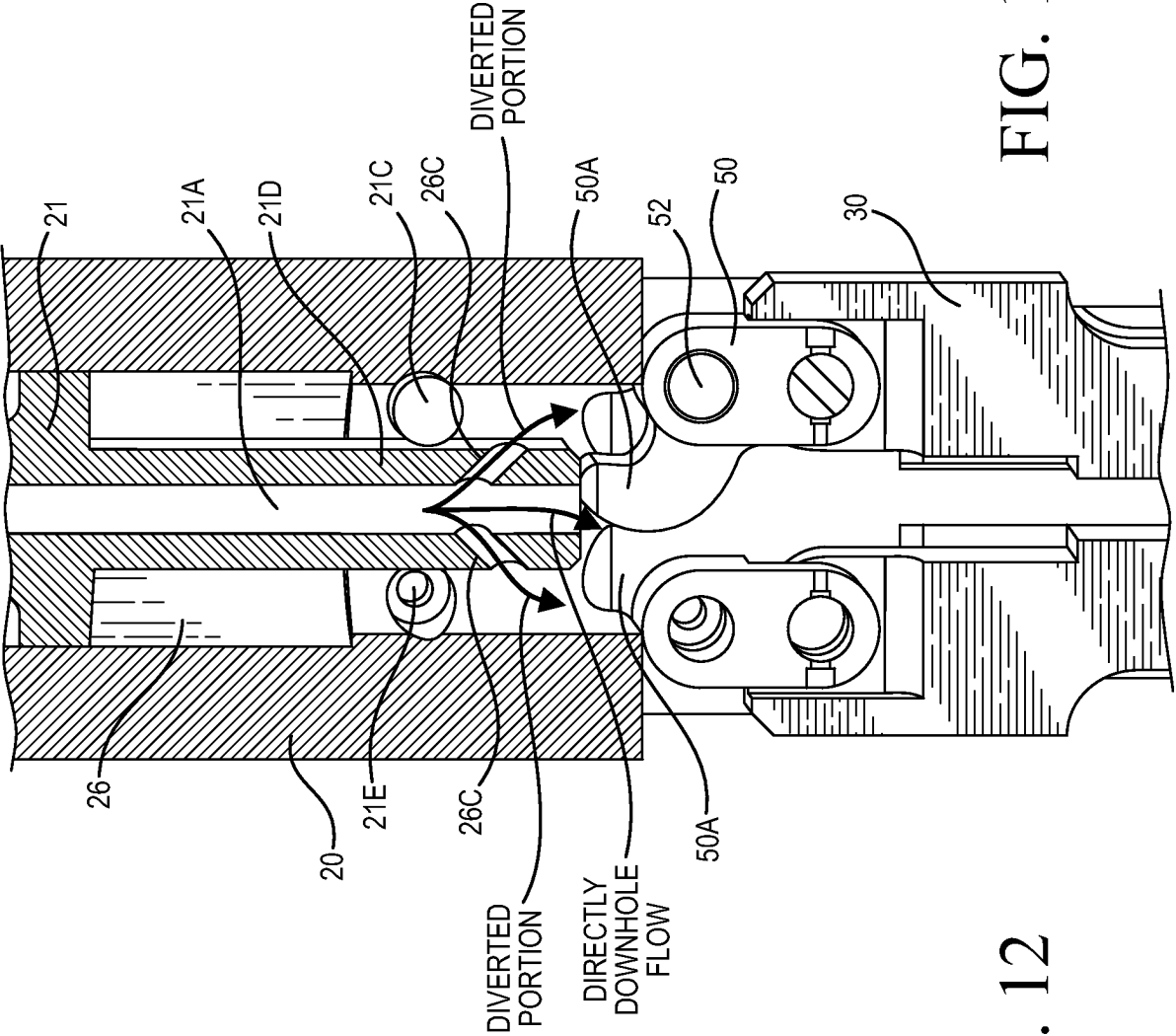


FIG. 13

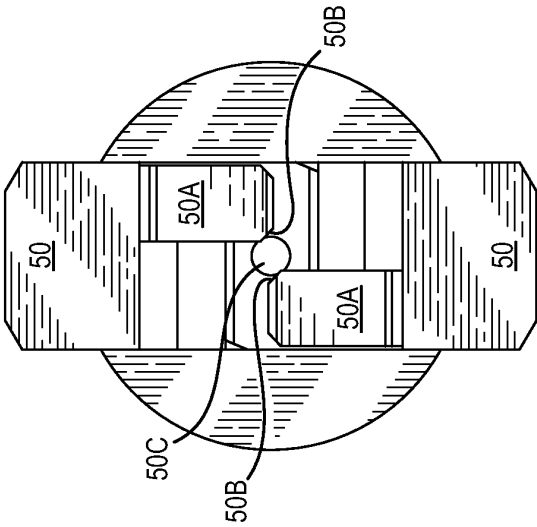


FIG. 14

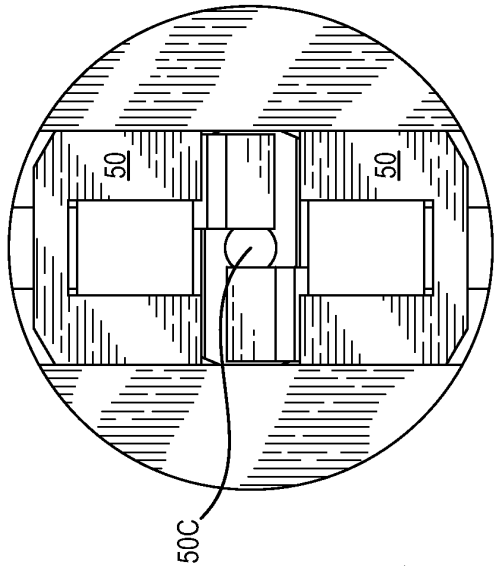


FIG. 15

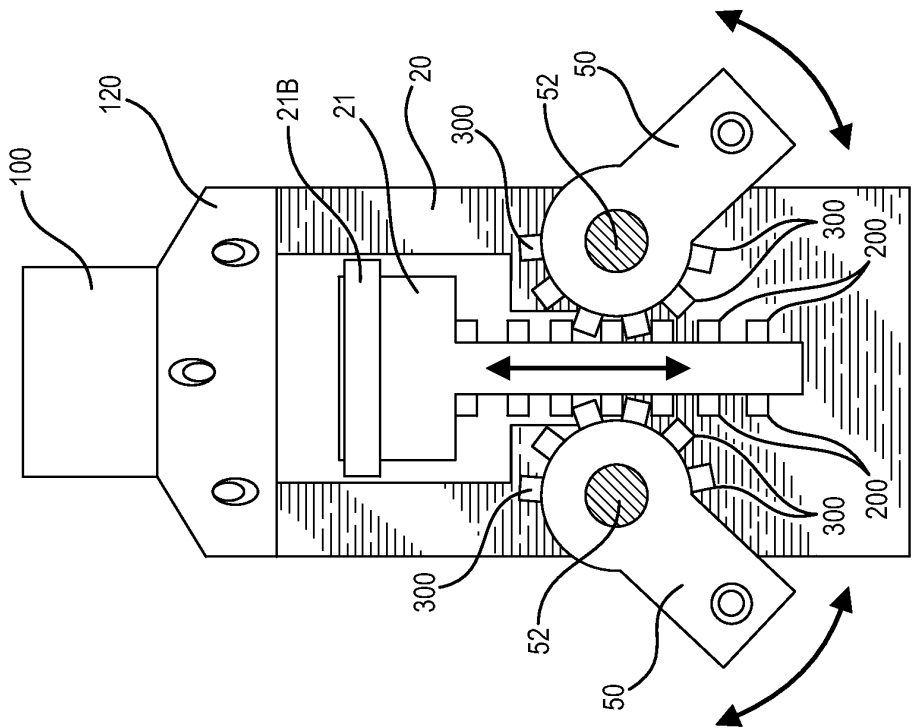


FIG. 16

REFERENCES CITED IN THE DESCRIPTION

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

Patent documents cited in the description

- WO 2014025763 A2 [0002]
- US 4809793 A [0003]
- US P7063155 B [0010]