(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
3 March 2005 (03.03.2005)

PCT

(10) International Publication Number
WO 2005/019598 A1

(51) International Patent Classification[7]: E21B 41/00

(21) International Application Number:
PCT/US2004/026690

(22) International Filing Date: 17 August 2004 (17.08.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/496,151 19 August 2003 (19.08.2003) US

(71) Applicant: BAKER HUGHES INCORPORATED [US/US]; 3900 Essex Lane, Suite 1200, Houston, TX 77027 (US).

(72) Inventor: MURRAY, Douglas, J.; 5922 Culross Close, Humble, TX 77346 (US).

(74) Agents: CARSON, Matt et al.; 9100 Emmott Road, Houston, TX 77040 (US).

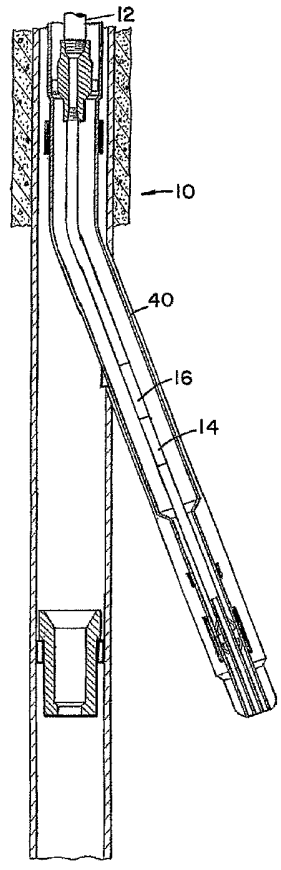
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

[Continued on next page]

(54) Title: METHODS FOR NAVIGATING AND FOR POSITIONING DEVICES IN A BOREHOLE SYSTEM



(57) Abstract: Disclosed is a method for navigating a wellbore including running a string (12) into the wellbore. The string includes an orientation measurement device (14) and an operationally associated telemetry device (16) wherein the string is configured to allow through passage of well equipment. Method includes gathering orientation data with orientation measurement device and telemetering data to a remote location. Further disclosed is a method for running, setting and cementing a well structure including running the well structure into a borehole on a string including an orientation measurement device configured to allow through passage of well equipment and a telemetry device in operable communication with the orientation measurement device. Method includes gathering data on orientation, telemetering the data to a remote location and setting the well structure. Further disclosed is a running string including a length of tubing, having an orientation measurement device and telemetry device, configured to allow through passage of well equipment.

WO 2005/019598 A1

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHODS FOR NAVIGATING AND FOR POSITIONING DEVICES IN A BOREHOLE SYSTEM

BACKGROUND

[0001] In the hydrocarbon recovery industry, like other industries, maximum efficiency and gain for minimum input is an ever present goal. Some of the areas in which efficiency could be improved in the hydrocarbon industry is in navigating the increasingly complex multilateral wellbore environment and in placing downhole devices in desired positions and orientations relative to the boreholes. Current technology employs many different means for locating and orienting devices and often employs multiple runs to ensure proper placement. As will be appreciated this means rig time, equipment usage, personnel, etc. and is therefore costly.

[0002] Beyond cost there is also a lack of certainty about where a tool is in a labyrinth of multilateral boreholes for a longer period of time than would be desirable.

[0003] It would benefit the art to reduce rig time, increase certainty and accuracy of device placements and reduce costs of well completion or re-entry.

SUMMARY

[0004] Disclosed herein is a method for navigating a wellbore including running a string into the wellbore. The string includes an orientation measurement device and an operationally associated telemetry device wherein the string is configured to allow through passage of well equipment. The method includes gathering orientation data with the orientation measurement device and telemetering the data to a remote location.

[0005] Further disclosed herein is a method for positioning a junction. The method includes running a string having a junction mounted thereon and having an orientation measurement device and a telemetry device mounted thereon wherein the string is configured to allow through passage of well equipment. The method includes gathering data regarding orientation of the junction as the junction nears a selected depth and installing the junction.

[0006] Further disclosed herein is a method for running, setting and cementing a well structure including running the well structure into a borehole on a string including an orientation measurement device configured to allow through passage of

well equipment and a telemetry device in operable communication with the orientation measurement device. The method further includes gathering data on orientation of the orientation measurement device, which data is correlated to orientation of the well structure, telemetering the data to a remote location and setting the well structure in a desired orientation.

[0007] Further disclosed herein is a running string including a length of tubing, wherein an orientation measurement device and telemetry device is in operable communication with the tubing, the string being configured to allow through passage of well equipment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Referring now to the drawings wherein like elements are numbered alike in the several Figures:

[0009] Figure 1 is a schematic view of a multilateral wellbore with a string therein having orientation and telemetry devices included;

[0010] Figure 1A is a schematic view of an angleable device;

[0011] Figure 2 is a schematic representation of an angleable sub;

[0012] Figure 2A is a schematic representation of an alternate embodiment;

[0013] Figure 2B is a schematic representation of another alternate embodiment;

[0014] Figure 3 is a schematic illustration of a junction being run to a setting location on a string with orientation and telemetry devices; and

[0015] Figure 4 is a perspective schematic view of an alternate embodiment;

[0016] Figure 4A is a view of Figure 4 taken from line 4A-4A;

[0017] Figure 4B is an alternate arrangement of the 4A view; and

[0018] Figure 5 is another alternate embodiment.

DETAILED DESCRIPTION

[0019] In a first embodiment of the method disclosed herein, reference to Figure 1 being made, a string is steerable through a multilateral wellbore system 10. The method includes assembling a string 12 with a bent or selectively angleable sub 18 for causing the string to enter a particular pathway. In the case of a bent sub, the string will enter a pathway when aligned therewith and in the case of an angleable sub, when the sub is angled toward that pathway selectively. The string also includes

an orientation measurement device 14 having one or more sensors therein such as those found in a commercially available MWD device such as a Baker Hughes Navi-Trak MWD device in order to determine orientation of a known fixed point on the tool relative to gravity, magnetic north, or other parsible environmental constant. Upon building the string it is known what the relative orientation of the bent sub 18 is to the orientation device. Therefore with knowledge by measurement of the orientation of the orientation device 14, the orientation of the bent sub 18 is easily calculable. The bent sub may be reoriented such as by rotation of a string upon which it is mounted to achieve a desirable result, that result being to enter a target lateral or primary bore at each junction encountered by the string. It should also be appreciated that a kickover device is employable to selectively kick the advancing string over to a desired leg. Kickovers may be spring type, hydraulic, etc. such as in Baker Hughes commercially available AutoTrak system.

[0020] The orientation sub further is configured to take other data while running which may be used for many purposes but specifically with respect to this method is employed to verify location of the orientation sub in the wellbore. Such data includes original drilling and well data, the parameters of which, when encountered again do indeed verify location. Orientation with respect to some constant and well logging information very effectively enable steering in a multilateral wellbore system providing that information is made available to a control center 20 capable of rotating the bent joint or causing the angleable joint to re-configure. Such control center may be a downhole control center such as a processor or may be a surface location proximate the well head (not shown) or more remote.

[0021] Delivering data gathered by orientation device 14 to the control center 20 is effected by telemetering device 16. Telemetering device 16 may employ a wireless or wired form of communication. Wireless forms of communication include ultrasonic transmissions, electromagnetic (EM) transmissions, pressure pulse telemetering. "Wired forms" as intended to include electrical, optic, etc. Data transmissions may be from periodic to continuous as desired. The foregoing provides for efficient, rapid and confident steering of a string through a wellbore.

[0022] Referring to Figure 2, an alternate embodiment is disclosed which orients a junction or other well structure for deployment. Junction 30 may be of any type; the particular type of junction is not dispositive of the effectiveness of the method. It is notable however that the method is employable for junctions ranging

from level 3 to level 6 junctions of the TAML system of classification. In the illustrated embodiment, a level 6 junction is to be installed at a lateral borehole. Junction 30 is run in the hole on a string which includes and places within or downhole of the junction 30, an orientation measurement device configured for through passage of another downhole tool (not shown) such as a tripping ball, completion string, etc.

[0023] The string 12 is run in the hole and orientation measurements taken as in the previous embodiment. Rotation is imparted to the string as necessary to properly orient the junction for deployment. The employment of the components as noted significantly improves the likelihood of achieving a correct orientation of the junction in a single advancing movement of the string. In the event conditions downhole prevent correct orientation the first time, the string may be picked up and the process repeated as would be done in the prior art, however, in the using the method and devices disclosed herein, the orientation measurement device and telemetry device allow for pickup and re-rotation to be more precise thereby enhancing resultant placement.

[0024] As in the foregoing embodiment, orientation telemetry may be commenced when the junction is nearing target depth, may be periodic , may be continuous, or any other frequency or timing the particular installation or application requires or may be benefited from.

[0025] It is desirable to place the orientation measurement device as indicated in Figure 2 or Figure 2A because it provides a slightly earlier indication of misalignment. This facilitates realignment while the string is still running further downhole. Such is advantageous because it is less effective to rotate a junction without axial movement simultaneously. By placing the orientation measurement device downhole of or within the junction as stated, positioning/orientation thereof is more precise and simpler in operation. This is not to preclude however a placement above the junction, as illustrated in Figure 2B.

[0026] Referring to Figure 3, another embodiment hereof is discussed. In this embodiment the string 12 having orientation measurement device 14 and telemetry device 16 as set forth and utilized with respect to the foregoing embodiments is employed to assist the orientation and deployment, including running, setting and cementing of a hook liner hanger system 40 or other liner hanger system. In such a string, the orientation measurement device 14 may be mounted as part of the liner

immediately above or below the hook hanger or as part of the running string. Operation and telemetry of the orientation of the string is selectable as in the foregoing embodiments.

[0027] Because the orientation measurement device as used herein has a through bore as noted above, setting and cementing operations can be undertaken conventionally without additional runs in the well.

[0028] It is further contemplated herein to configure embodiments such that the orientation 14 and telemetry 16 devices are mounted in locations that provide the benefit of the devices as described above but are also not within the pathway of the tubing string. More particularly and referring to Figures 4, 4A, 4B and 5, one of ordinary skill will appreciate the locations of orientation 14 and telemetry 16 devices as appurtenant structures to the string 12 or junction 30. Since orientation 14 and telemetry 16 devices do not exist within the string, there is more leighway regarding their construction while not impacting well equipment movement through the string.

[0029] In the Figure 4 embodiment, dead space in a splitter arrangement is employed to house the orientation and telemetry devices. This space is about 90° to the leg #1 and leg #2 as shown. Figure 4A is an end view of the Figure 4 device and illustrates both the orientation and telemetry devices in one of the dead spaces available. It will be appreciated that this could also be on the other dead space shown at 15. Figure 4B is an alternative arrangement where both of the previous dead spaces are used, one for each of the orientation 14 and the telemetry 16 devices. They may be located as shown or reversed with no distinction in effectiveness. Figure 5 illustrates an alternative where the orientation 14 and telemetry 16 devices are appended to string 12. Again, the devices are not an impingement on well equipment run through the tubing but still achieve the desired results.

[0030] While preferred embodiments have been shown and described, modifications and substitutions may be made thereto without departing from the spirit and scope of the invention. Accordingly, it is to be understood that the present invention has been described by way of illustrations and not limitation.

What is claimed is:

Claim 1. A method for navigating a wellbore comprising:

running a string into the wellbore, the string including an orientation measurement device and an operationally associated telemetry device, wherein the string is configured to allow through passage of well equipment;

gathering orientation data with the orientation measurement device; and

telemetering the data to a remote location.

Claim 2. A method for navigating a wellbore as claimed in claim 1 wherein said configuration includes through passage of well equipment through the orientation measurement device and the telemetry device.

Claim 3. A method for navigating a wellbore as claimed in claim 1 wherein the orientation measurement device and telemetry device are appended alongside the string.

Claim 4. A method for navigating a wellbore as claimed in claim 1 wherein said telemetering is wireless.

Claim 5. A method for navigating a wellbore as claimed in claim 1 wherein said telemetering is electrical.

Claim 6. A method for navigating a wellbore as claimed in claim 1 wherein said telemetering is continuous.

Claim 7. A method for navigating a wellbore as claimed in claim 1 wherein said orientation data gathering is continuous.

Claim 8. A method for navigating a wellbore as claimed in claim 1 wherein said string further includes a selectively actuatable pushover tool.

Claim 9. A method for navigating a wellbore as claimed in claim 8 wherein said pushover tool is electrical.

Claim 10. A method for navigating a wellbore as claimed in claim 8 wherein said pushover tool is hydraulic.

Claim 11. A method for positioning a junction comprising:

running a string having a junction mounted therein and having an orientation measurement device and a telemetry device mounted thereon and wherein the string is configured to allow through passage of well equipment;

gathering data regarding orientation of the junction as the junction nears a selected depth; and

installing said junction.

Claim 12. A method for positioning a junction as claimed in claim 11 wherein said configuration includes through passage of well equipment through the orientation measurement device and the telemetry device.

Claim 13. A method for positioning a junction as claimed in claim 11 wherein the orientation measurement device and telemetry device are appended alongside the string.

Claim 14. A method for positioning a junction as claimed in claim 11 wherein said method includes rotating said junction a desired orientation.

Claim 15. A method for positioning a junction as claimed in claim 14 wherein said rotating is carried out while said string is running in.

Claim 16. A method for running setting and cementing a well structure comprising:

running the well structure into a borehole on a string configured to allow passage of well equipment, the string further including an orientation measurement device and a telemetry device in operable communication with the orientation measurement device;

gathering data on orientation of the orientation measurement device, which data is correlated to orientation of the well structure;

telemetering the data to a remote location; and

setting the well structure in a desired orientation.

Claim 17. A method for running setting and cementing a well structure as claimed in claim 16 wherein said method further includes running well equipment through said orientation measurement device.

Claim 18. A method for running setting and cementing a well structure as claimed in claim 17 wherein said well equipment is associated with releasing the well structure from the string.

Claim 19. A method for running setting and cementing a well structure as claimed in claim 17 wherein said well equipment is associated with cementing the well structure into the borehole.

Claim 20. A method for running setting and cementing a well structure as claimed in claim 17 wherein said well equipment is a completion string.

Claim 21. A method for running setting and cementing a well structure as claimed in claim 17 wherein said well equipment is a tripping ball.

Claim 22. A string comprising:

a length of tubing;

an orientation measurement device in operable communication with the tubing; and

a telemetry device in operable communication with the tubing, said string being configured to allow through passage of well equipment.

Claim 23. A string as claimed in claim 22 wherein said orientation measurement device and telemetry device allow passage therethrough of said well equipment.

Claim 24. A string as claimed in claim 22 wherein said orientation measurement device and telemetry device are configured to mount aside said string.

Claim 25. A string as claimed in claim 22 wherein said running string further includes a kickover device.

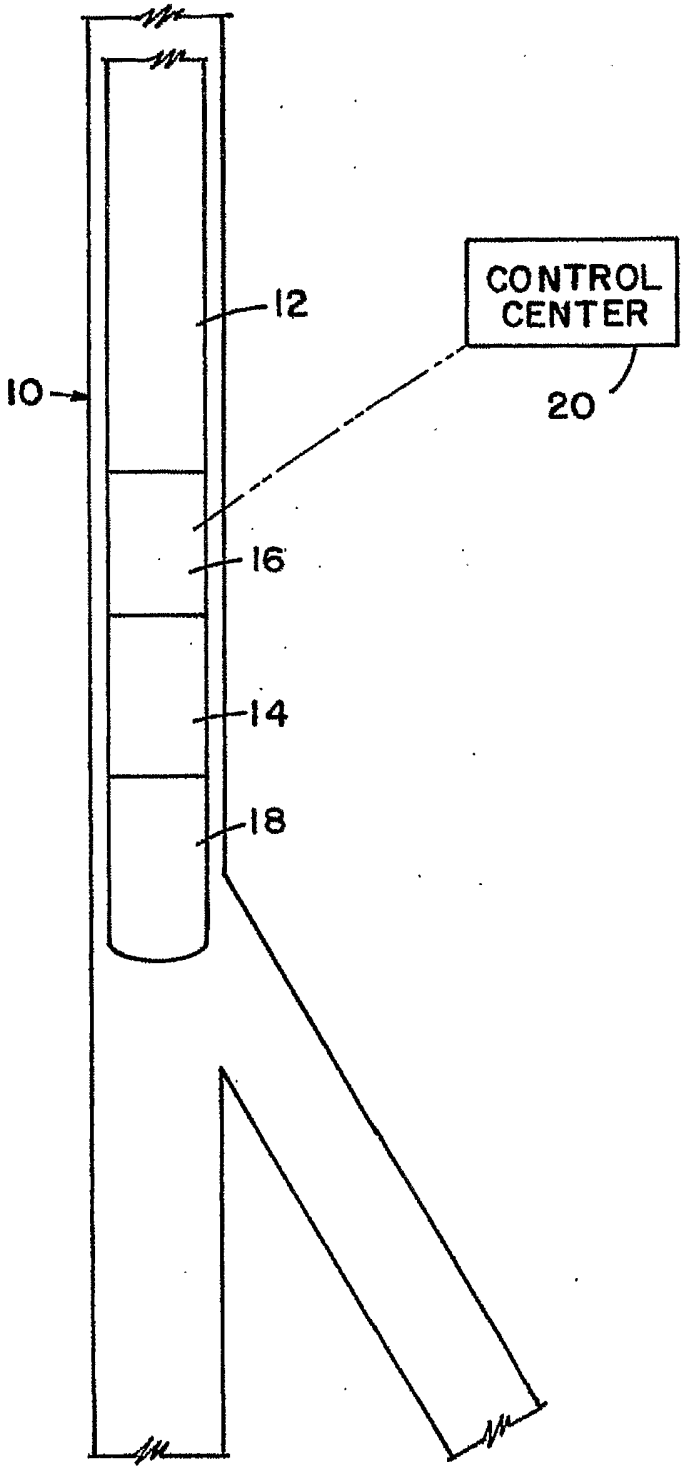


FIG. 1

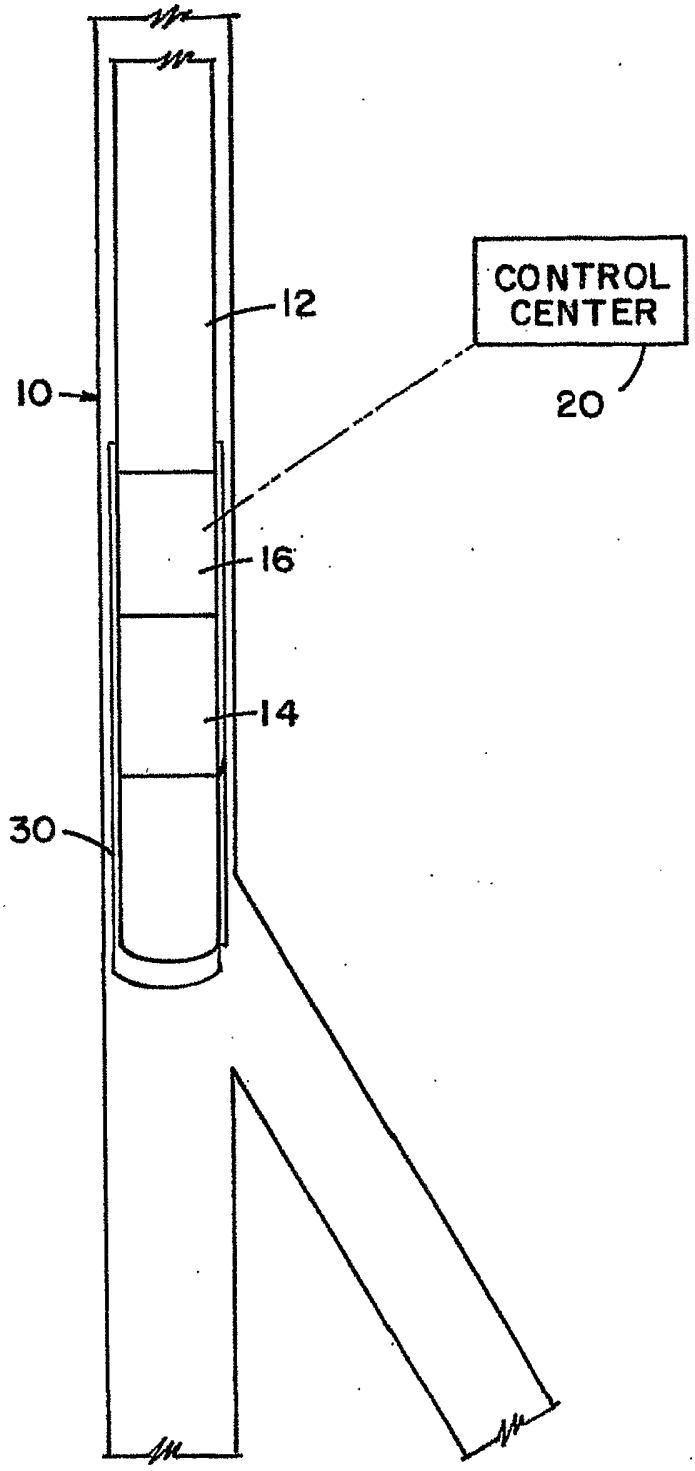


FIG. 2

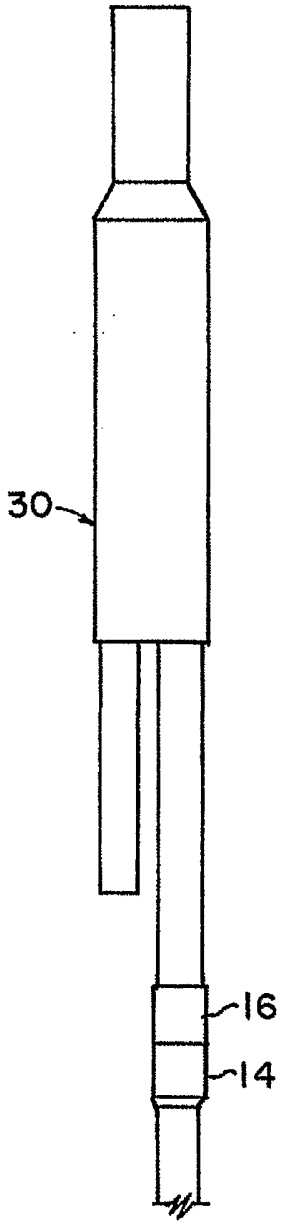


FIG. 2A

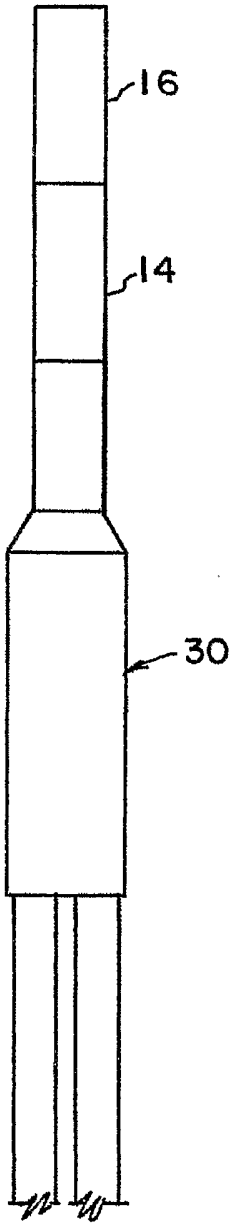


FIG. 2B

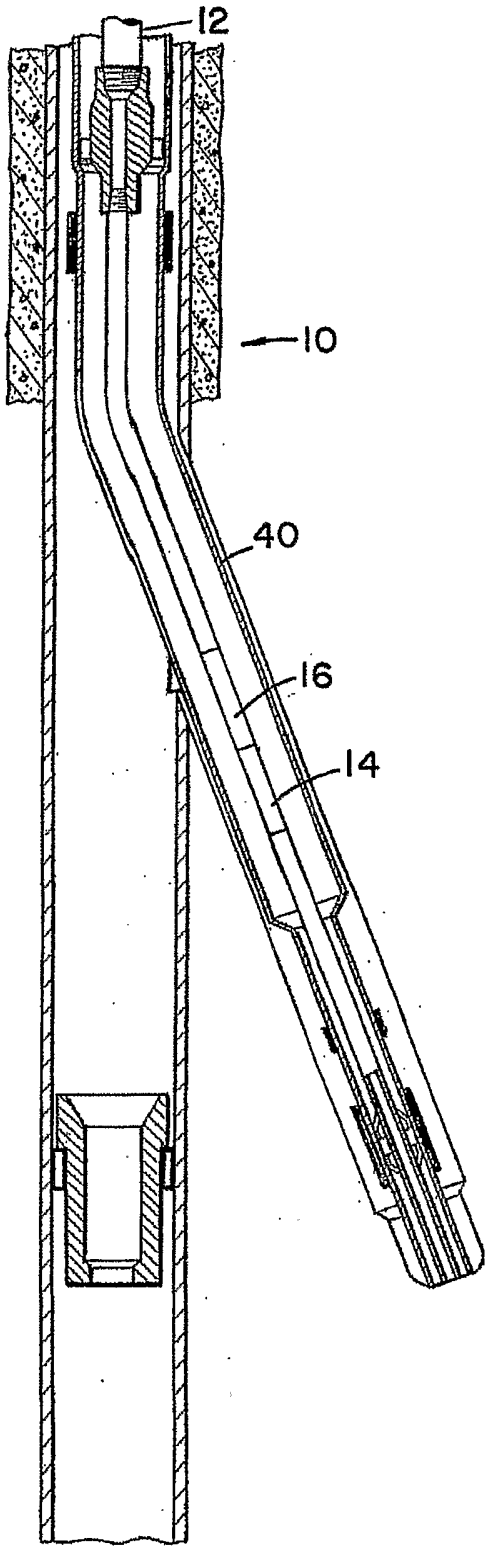


FIG. 3

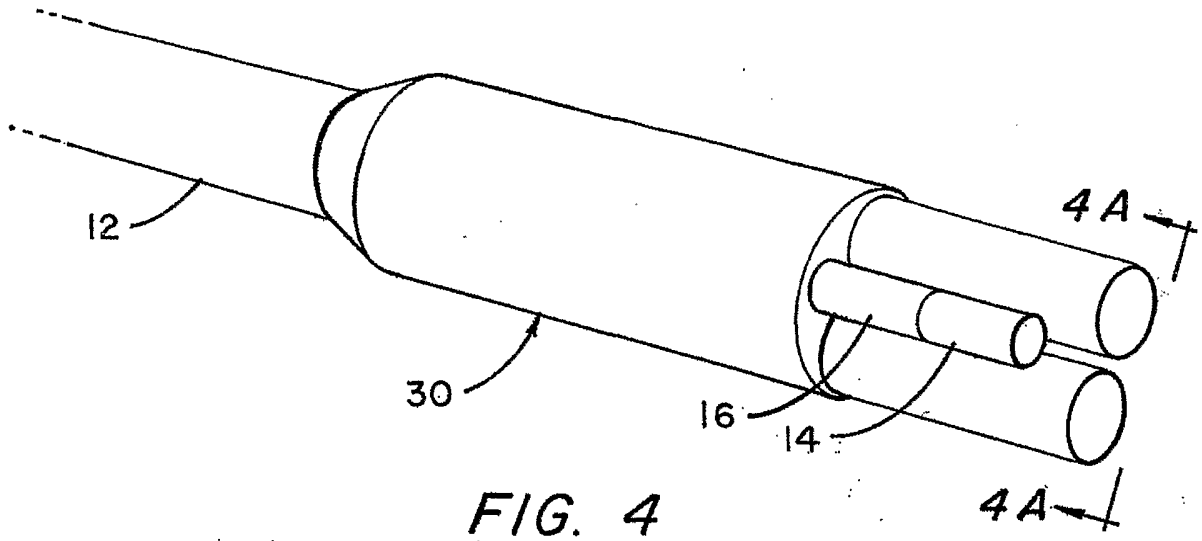


FIG. 4

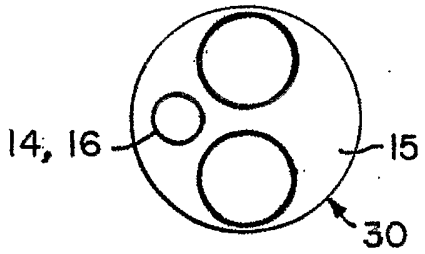


FIG. 4A

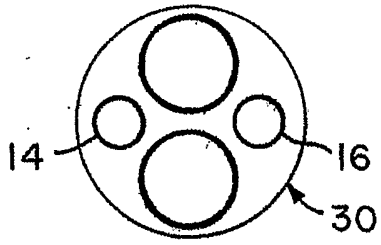


FIG. 4B

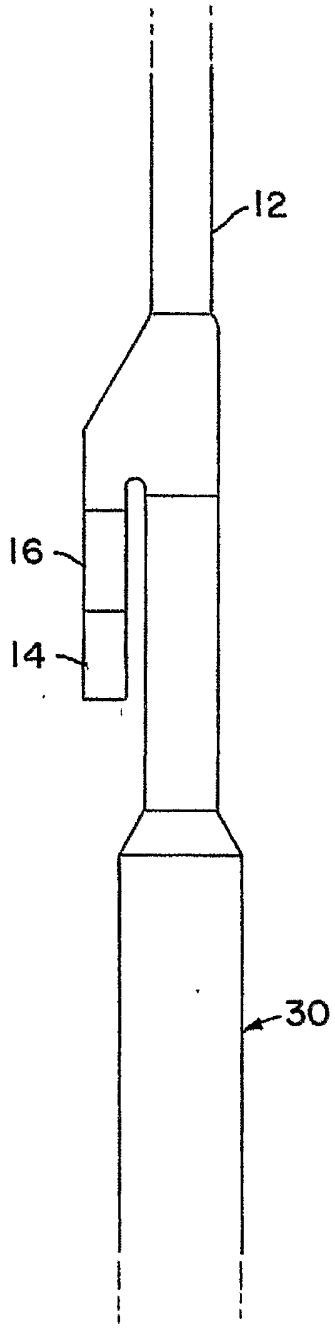


FIG. 5

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2004/026690

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21B41/00

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)
IPC 7 E21B

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 472 048 A (KENNEDY BRIAN S ET AL) 5 December 1995 (1995-12-05) column 1, lines 22,23; figures 2,3 column 3, lines 64-67 column 10, lines 20-26 column 24, lines 22,23,28-30 column 26, lines 9-15,33-35,50-53,58-60	1,11,16, 22
A	US 2001/042621 A1 (LEISING LAWRENCE J) 22 November 2001 (2001-11-22) the whole document	1-25
A	US 6 527 067 B1 (RAVENSBERGEN JOHN E ET AL) 4 March 2003 (2003-03-04) the whole document	1-24

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"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	Date of mailing of the international search report
1 December 2004	21/12/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Georgescu, M

Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US2004/026690

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5472048 A	05-12-1995	CA 2140235 A1	27-07-1995
		DK 9195 A	27-07-1995
		GB 2285999 A ,B	02-08-1995
		NO 950260 A	27-07-1995
US 2001042621 A1	22-11-2001	US 6349768 B1	26-02-2002
		AU 7842800 A	30-04-2001
		CA 2385757 A1	05-04-2001
		EG 22540 A	31-03-2003
		GB 2372274 A ,B	21-08-2002
		NO 20021497 A	22-05-2002
		WO 0123706 A1	05-04-2001
US 6527067 B1	04-03-2003	CA 2314856 A1	04-02-2001
		GB 2353547 A ,B	28-02-2001