

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
29 December 2005 (29.12.2005)

PCT

(10) International Publication Number
WO 2005/124091 A1

(51) International Patent Classification⁷: **E21B 7/20**, 43/08

(21) International Application Number:

PCT/US2005/020938

(22) International Filing Date: 14 June 2005 (14.06.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/579,818 14 June 2004 (14.06.2004) US

(71) Applicant (for all designated States except US): **BAKER HUGHES INCORPORATED** [US/US]; 3900 Essex Lane, Suite 1200, Houston, TX 77027 (US).

(72) Inventor: **RICHARD, Bennett**; 4542 Windy Hollow, Kingwood, TX 77345 (US).

(74) Agents: **RIDDLE, J., Albert** et al.; Baker Hughes Incorporated, 3900 Essex Lane, Suite 1200, Houston, TX 77027 (US).

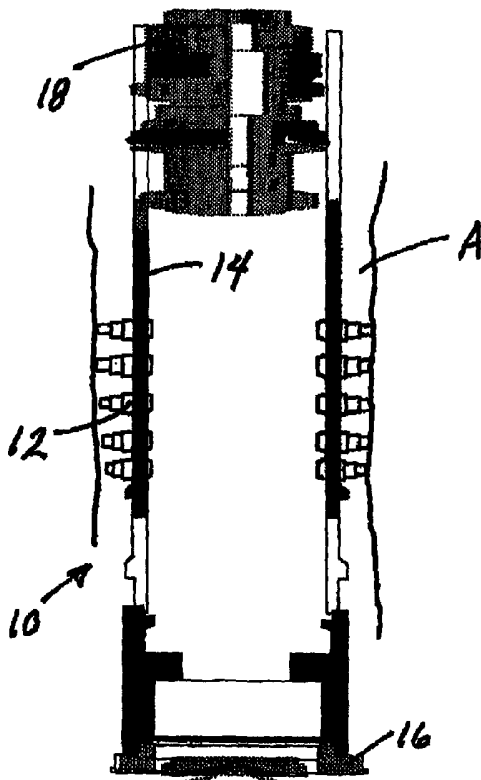
(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK,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

[Continued on next page]

(54) Title: ONE TRIP WELL APPARATUS WITH SAND CONTROL

(57) Abstract: An apparatus and method for drilling a well bore, placing a liner, cementing and perforating the liner, and injecting or producing fluid, sand-free, through the perforations. The liner has a plurality of outwardly extendable elements for perforation and sand control. The tool also can have a drilling apparatus, a cementing apparatus, a steering apparatus and a formation evaluation apparatus.





FR, GB, GR, HU, IE, IS, 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).

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.

Published:

— *with international search report*

TITLE OF THE INVENTION

One Trip Well Apparatus with Sand Control

CROSS REFERENCE TO RELATED APPLICATIONS

5 This application relies upon U.S. Provisional Patent Application No. 60/579,818,
filed on 06/14/2004, and entitled "One Trip Well Apparatus with Sand Control."

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

10	Not Applicable
----	----------------

BACKGROUND OF THE INVENTION

Field of the Invention - The present invention is in the field of apparatus and methods used in drilling and completing an oil or gas well, and producing hydrocarbons from the well or injecting fluids into the well.

Background Art - In the drilling and completion of oil and gas wells, it is common to drill a well bore, position a liner in the well bore, cement the liner in place, perforate the liner at a desired depth, and provide for the sand free production of hydrocarbons from the well or the injection of fluids into the well. These operations are typically performed in several steps, requiring multiple trips into and out of the well bore with the work string. Since rig time is expensive, it would be helpful to be able to perform all of these operations with fewer trips into the well bore.

BRIEF SUMMARY OF THE INVENTION

25 The present invention provides a tool and method for drilling a well bore, placing and perforating a well bore liner, cementing the liner in place, and producing or injecting fluids, sand-free. The apparatus includes a tubular liner having a plurality of radially outwardly extendable tubular elements, with a drilling apparatus for drilling a well bore below the liner, a cementing apparatus for cementing the liner in place, and a temporarily
30 blocked sand control medium in the outwardly extendable elements for selectively

controlling the sand-free injection or production of fluids through the extendable elements. The drilling apparatus can be concentric to the production liner back to surface, concentric to several nested liners or attached to the top of the production liner with a release mechanism known by those skilled in the art.

5 One embodiment of the apparatus has a drilling shoe formed or mounted at the lower end of the liner. In this embodiment, the liner is attached to a rotatable drill string, and the cementing apparatus, of a type known in the art, is incorporated in the drill string. After drilling, the drill string provides a conduit for the cement and for the fluids produced from or injected into the well if production tubing is not a requirement.

10 Another embodiment of the apparatus has a drill bit which is driven by a downhole motor. In this embodiment, the drill bit and downhole motor drill the well bore, with the liner mounted thereto, and with the drill bit extendable below the liner. After drilling, the drill bit and the downhole motor can be released from the liner and withdrawn from the well bore. Also, in this embodiment, the cementing apparatus, again
15 of a type known in the art, can be lowered into the well, after withdrawal of the drill bit and the downhole motor. In this embodiment, a separate tubular can provide a conduit for the cement and for the fluids produced from or injected into the well.

 In either embodiment, the outwardly extendable tubular elements in the liner are filled with a sand control medium, such as a gravel pack material. The outwardly
20 extendable tubular elements are also initially blocked by a blocking medium, such as a wax material, which initially prevents fluid flow through the outwardly extendable elements. Alternatively, rather than a wax material, the blocking medium can be a biodegradable material, such as a biodegradable polymer, or a frangible disk. After the liner is in place in the well bore, the outwardly extendable tubular elements are extended
25 into contact with the wall of the well bore in the desired formation, after which the liner is cemented in place and the blocking medium is removed from the outwardly extendable tubular elements. Removal of a wax blocking medium can be accomplished by application of heat or a fluid to the wax material to dissolve it. Removal of a biodegradable blocking medium can be by biodegradation of the blocking medium in the
30 presence of downhole fluids or other fluids, at downhole temperatures, thereby dissolving

the blocking medium. Removal of a frangible disk can be by fracturing of the disk with increased fluid pressure. After removal of the blocking medium, fluids can be produced from the formation or injected into the formation, through the outwardly extendable tubular elements.

5 The liner with the outwardly extendable tubular elements can be the innermost tubular in a nested string of tubulars. During drilling, the liner extends downwardly from the nested string into the well bore. The assembly can also be provided with a steering capability and a formation evaluation capability, both of which features are separately known in the art.

10

The novel features of this invention, as well as the invention itself, will be best understood from the attached drawings, taken along with the following description, in which similar reference characters refer to similar parts, and in which:

15 BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

Figure 1 is a longitudinal section view of a first embodiment of the apparatus of the present invention, in the run-in condition;

Figure 2 is a longitudinal section view of the apparatus in Figure 1, showing the extendable tubular elements extended outwardly and the liner cemented in place;

20 Figures 3A, 3B, and 3C are side views of a typical outwardly extendable tubular element incorporated in the apparatus of the present invention;

Figure 4 is a longitudinal section view of a second embodiment of the apparatus of the present invention.

25 DETAILED DESCRIPTION OF THE INVENTION

As shown in Figure 1, in one embodiment, the tool 10 of the present invention includes a liner 14, which has a plurality of outwardly extendable tubular elements 12. All of these outwardly extendable elements 12 are shown retracted radially into the liner 14 of the tool 10, in the run-in position. A drilling tool 16, such as a drillable shoe, is
30 mounted to the lower end of the liner 14. The liner 14 is mounted on a drill string DS,

which can be rotated by a drilling rig (not shown). A cementing apparatus 18, of any type known in the art, can be incorporated in the drill string DS below the liner 14.

As the liner 14 is rotated, the drilling tool 16 drills a well bore to the desired depth. The liner 14 can be incorporated within a nested string of tubulars (not shown). In this case, as the liner 14 and the drilling tool 16 progress into the well bore, the nested string of tubulars follows, creating an extended casing string in the well bore.

As shown in Figure 2, once the liner 14 is at the desired depth, the outwardly extendable elements 12 are extended radially outwardly from the body of the tool 10 to contact the underground formation, such as by the application of hydraulic pressure from the fluid flowing through the tool 10. If any of the elements 12 fail to fully extend upon application of this hydraulic pressure, they can be mechanically extended by the passage of a tapered plug (not shown) through the body of the tool 10, as is known in the art, but this requires a separate trip. After extension of the outwardly extendable elements 12 to contact the formation, cementing the liner in place can be accomplished by pumping cement into the annulus between the liner 14 and the well bore, with the cementing apparatus 18, as is known in the art.

Figures 3A, 3B, and 3C show the extension of a typical extendable tubular element 12. Figure 3A shows the extendable element 12 in the withdrawn condition, as it is configured when the tool 10 is in its run-in configuration. Figure 3B shows the extendable element 12 with a first extension 20 extended to contact the wall of a full gauge well bore, as normally drilled. Figure 3C shows the extendable element 12 with a second extension 22 extended as may be necessary to contact the wall of a washed out well bore.

It can be seen that the tubular elements 12 have an open central bore for the passage of fluid. As also shown in Figure 3C, the tubular elements 12 have a sand control medium 24 incorporated therein. The sand control medium 24 prevents intrusion of sand or other particulate matter from the formation into the tool body. The tubular elements 12 can have any type of built-in sand control medium 24 therein, including any gravel pack material known in the art, metallic beads, or a mechanical screening element.

The tubular elements 12 also have a blocking medium 26 therein, such as a wax material, a polymer material, a frangible disk, or any combination thereof. As originally constituted, the blocking medium blocks any fluid flow through the outwardly extendable elements. The blocking medium 26 is next to the inside of the liner 14, to provide a pressure barrier enabling the hydraulic extension of the tubular elements 12. Where a wax material is used as the blocking medium 26, the wax can be susceptible to removal by the application of heat or exposure to a fluid which can dissolve the wax. Where a polymer material is used as the blocking medium 26, it can be a material which is biodegradable in fluids which may be found in the well bore, or which can be pumped into the well bore. A polymer material could also be chosen which is susceptible to removal by the application of heat. Where a frangible disk is chosen for the blocking medium, it can be designed to rupture upon application of a given fluid pressure.

Once the liner 14 has reached the desired depth and the tubular elements 12 have been extended to contact the bore hole wall. Cement can then be pumped via the cementing apparatus 18 to fill the annulus between the liner 14 and the bore hole wall. The blocking medium 26 is removed in a fashion depending upon which type of blocking medium is used. Thereafter, hydrocarbon fluids can be produced from the formation through the outwardly extendable elements 12, or fluid can be injected into the formation through the outwardly extendable elements 12.

Figure 4 shows a second embodiment of the tool 100 of the present invention. In this embodiment, the liner 140 does not rotate for the purpose of drilling the well bore. Instead, the liner 140 is lowered into the well bore while the bore is being drilled by a downhole motor 28, on a work string WS. The liner 140 can be attached to the work string WS by a releasable connector 32. The downhole motor 28 drives a drilling tool 30 extending below the lower end of the liner 140. The drilling tool 30 can include a hole opener if desired. Directional drilling apparatus and formation evaluation equipment can be incorporated in the work string WS, as is known in the art. Further, the liner 140, as in the first embodiment, can be incorporated in a nested string of tubulars (not shown). In this embodiment, after drilling and placement of the liner 140, and after extension of the outwardly extendable tubular elements 12, the downhole motor and the drilling tool 30

can be removed. Then, a cementing apparatus can be introduced, for cementing the liner 140 in place, as described above, or cementing can be done with the work string WS and the drill string DS in place. Thereafter, hydrocarbon fluids can be produced from the formation through the outwardly extendable elements 12, or fluid can be injected into the
5 formation through the outwardly extendable elements 12.

While the particular invention as herein shown and disclosed in detail is fully capable of obtaining the objects and providing the advantages hereinbefore stated, it is to be understood that this disclosure is merely illustrative of the presently preferred
10 embodiments of the invention and that no limitations are intended other than as described in the appended claims.

CLAIMS

I claim:

- 1 1. An apparatus for one trip drilling and completion of a well, comprising:
2 a liner having at least one outwardly telescoping tubular element, said telescoping
3 tubular element being selectively extendable outwardly to contact a well
4 bore;
5 a drilling apparatus adapted to drill a well bore in advance of said liner;
6 a sand control medium within said telescoping tubular elements; and
7 a temporary blocking medium within said telescoping tubular elements, said
8 blocking medium being adapted to initially block fluid flow through said
9 telescoping tubular elements and to subsequently allow fluid flow through
10 said telescoping tubular elements.
- 1 2. The apparatus recited in claim 1, further comprising an apparatus adapted
2 to pump a sealing material through said liner to seal said liner in place in a well bore.
- 1 3. The apparatus recited in claim 3, wherein said sealing material is cement.
- 1 4. The apparatus recited in claim 2, wherein said liner is mounted to a
2 rotatable drill string.

1 5. The apparatus recited in claim 4, wherein:
2 said sealing apparatus is incorporated within said drill string; and
3 said drilling apparatus comprises a drilling tool mounted to a lower end of said
4 liner.

1 6. The apparatus recited in claim 2, wherein:
2 said liner is mounted to a production string; and
3 said drilling apparatus comprises a drilling tool driven by a downhole motor.

1 7. The apparatus recited in claim 6, wherein:
2 said drilling tool is adapted to pass through, and extend below, said liner; and
3 said sealing apparatus is adapted to pass through said production string after
4 removal of said drilling apparatus.

1 8. The apparatus recited in claim 1, wherein said sand control medium
2 comprises a gravel pack material.

1 9. The apparatus recited in claim 1, wherein said temporary blocking medium
2 comprises a wax material, said wax material being removable by application of an agent
3 selected from the following: an acid, a hydrocarbon, or heat.

1 10. The apparatus recited in claim 1, wherein said temporary blocking medium
2 comprises a polymer material, said polymer material being removable by biodegradation.

1 11. The apparatus recited in claim 1, wherein said temporary blocking medium
2 comprises a frangible disk.

1 12. A method for one trip drilling and completion of a well, comprising:
2 providing a liner having at least one outwardly telescoping tubular element, with a
3 sand control medium and a temporary blocking medium within said
4 telescoping tubular element;
5 providing a drilling apparatus;
6 drilling a well bore in advance of said liner with said drilling apparatus;
7 selectively extending said telescoping tubular element outwardly to contact the
8 well bore; and
9 passing fluid through said telescoping tubular element.

1 13. The method recited in claim 12, further comprising:
2 initially blocking fluid flow through said telescoping tubular element with said
3 blocking medium; and
4 removing said blocking medium to subsequently allow fluid flow through said
5 telescoping tubular element.

1 14. The method recited in claim 12, further comprising:
2 providing a cementing apparatus; and
3 pumping cement through said liner with said cementing apparatus to cement said
4 liner in place in the well bore.

1 15. The method recited in claim 12, wherein:
2 said liner is mounted to a rotatable drill string and said drilling apparatus
3 comprises a drilling tool mounted to a lower end of said liner; and
4 said drilling comprises rotating said liner and said drilling tool with said drill
5 string.

1 16. The method recited in claim 12, wherein:
2 said liner is mounted to a production string and said drilling apparatus comprises a
3 drilling tool driven by a downhole motor.

1 17. The method recited in claim 16, wherein:
2 said drilling comprises passing said drilling tool through said liner and rotating
3 said drilling tool with said downhole motor.

1 18. The method recited in claim 17, further comprising removing said drilling
2 apparatus from said production string after said drilling, and lowering said cementing
3 apparatus through said production string prior to pumping said cement.

1 19. The method recited in claim 12, wherein:
2 said temporary blocking medium comprises a wax material; and
3 said removal of said blocking medium comprises dissolving said wax material by
4 application of an acid, a hydrocarbon, or heat.

1 20. The method recited in claim 12, wherein:
2 said temporary blocking medium comprises a polymer material; and
3 said removal of said blocking medium comprises biodegradation of said polymer
4 material.

1 21. The method recited in claim 12, wherein:
2 said temporary blocking medium comprises a frangible disk; and
3 said removal of said blocking medium comprises rupturing of said frangible disk.

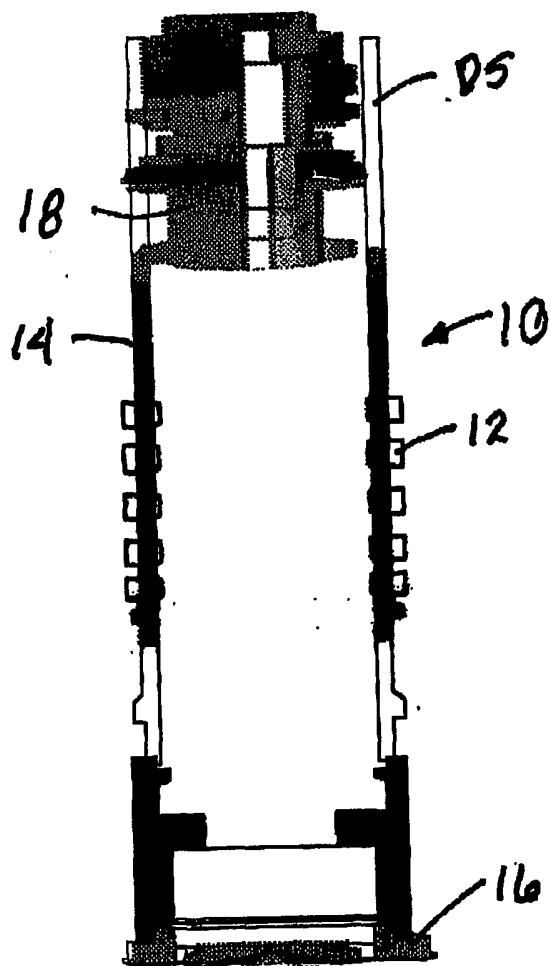


FIG. 1

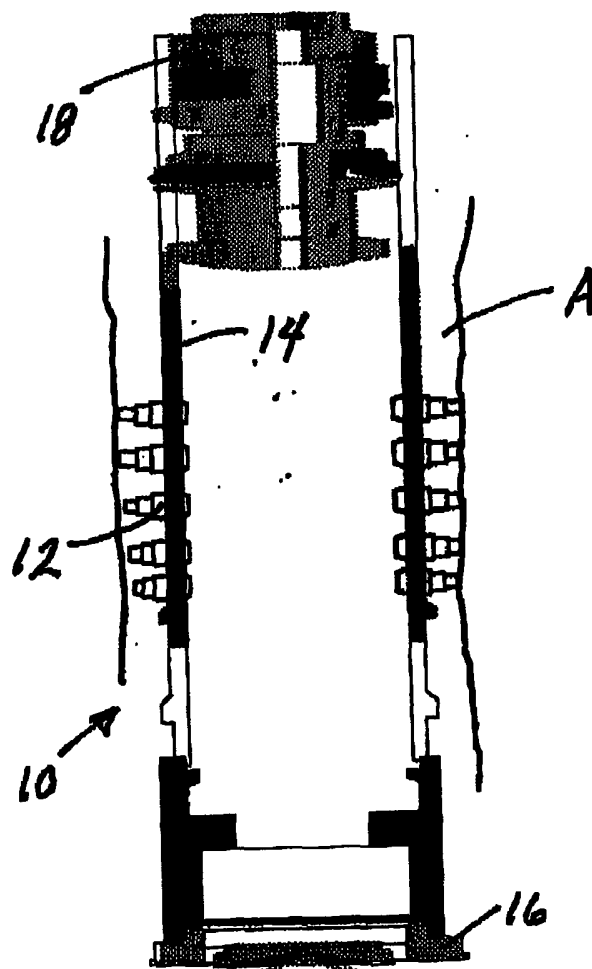


FIG. 2

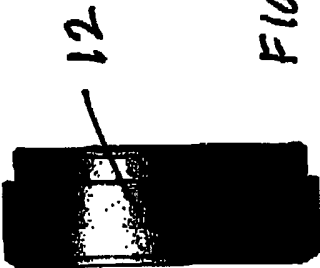


FIG. 3A

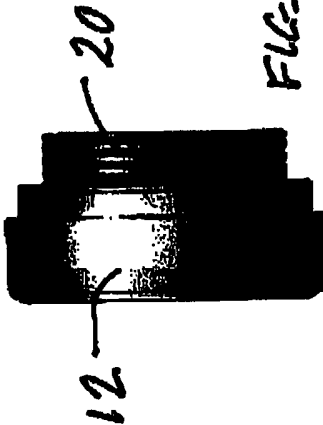


FIG. 3B

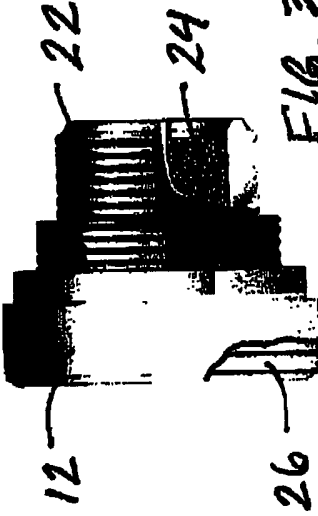


FIG. 3C

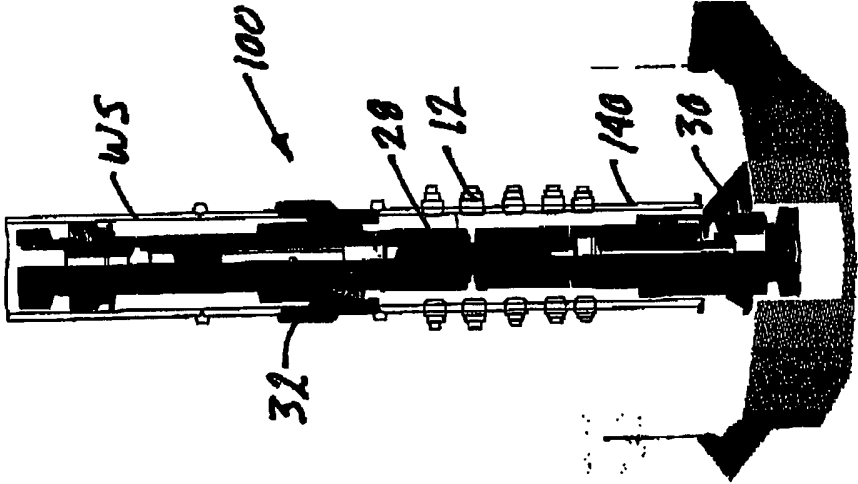


FIG. 4

INTERNATIONAL SEARCH REPORT

In International Application No
PCT/US2005/020938

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21B7/20 E21B43/08

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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 320 178 A (CORNETTE ET AL) 14 June 1994 (1994-06-14) the whole document	1-21
Y	WO 96/26350 A (BAKER HUGHES INCORPORATED) 29 August 1996 (1996-08-29) claims 1-10 figures 3-5	1-21
A	DE 100 31 663 A1 (HOCHTIEF AG) 16 August 2001 (2001-08-16) claims 1,4,6,7 figure 3	1,12
A	WO 03/052238 A (SAND CONTROL, INC; JOHNSON, MICHAEL, H) 26 June 2003 (2003-06-26) the whole document	1,12
	----- -/--	

☒ 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

30 August 2005

Date of mailing of the international search report

06/09/2005

Name and mailing address of the ISA

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

Authorized officer

Schouten, A

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2005/020938

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 228 518 A (WILSON ET AL) 20 July 1993 (1993-07-20) the whole document -----	1,12
A	US 5 842 528 A (JOHNSON ET AL) 1 December 1998 (1998-12-01) the whole document -----	1,12

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US2005/020938

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5320178	A	14-06-1994	NONE	
WO 9626350	A	29-08-1996	AU 5096096 A WO 9626350 A1 US 5829520 A	11-09-1996 29-08-1996 03-11-1998
DE 10031663	A1	16-08-2001	NONE	
WO 03052238	A	26-06-2003	AU 2002361794 A1 CA 2471261 A1 EP 1461510 A1 WO 03052238 A1	30-06-2003 26-06-2003 29-09-2004 26-06-2003
US 5228518	A	20-07-1993	AU 2644392 A CA 2117086 A1 EP 0604526 A1 NO 940920 A US 5379838 A US 5346016 A WO 9306333 A1	27-04-1993 01-04-1993 06-07-1994 23-03-1994 10-01-1995 13-09-1994 01-04-1993
US 5842528	A	01-12-1998	EP 0713951 A2 NO 954689 A US 5667023 A	29-05-1996 23-05-1996 16-09-1997