



(51) International Patent Classification:

E21B 47/00 (2006.01) *G01V 1/40* (2006.01)
E21B 23/00 (2006.01) *G01V 1/46* (2006.01)

(21) International Application Number:

PCT/US2016/031955

(22) International Filing Date:

12 May 2016 (12.05.2016)

(25) Filing Language:

English

(26) Publication Language:

English

(71) Applicant: **HALLIBURTON ENERGY SERVICES, INC.** [US/US]; 3000 N. Sam Houston Parkway E., Houston, TX 77032-3219 (US).

(72) Inventors: **PARK, Brian, V.**; 1514 Robins Forest Drive, Spring, TX (US). **JAASKELAINEN, Mikko**; 4011 Bell Hollow Lane, Katy, TX 77494 (US).

(74) Agent: **PEACOCK, Gregg, A.** et al.; Gilliam IP PLLC, 7200 N. Mopac, Suite 440, Austin, TX 78731 (US).

(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA,

LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:

— *with international search report (Art. 21(3))*

(54) Title: SYSTEM AND METHOD FOR LAUNCHING AND RETRIEVING WIRELINE EAT SENSORS

(57) Abstract: A device and method is described for either launching or retrieving wireline electro acoustic technology (EAT) sensor assemblies downhole.

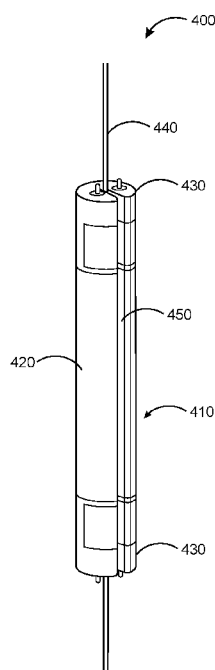


FIG. 4

Title**System and Method for Launching and Retrieving Wireline EAT Sensors**

5

Background

Deployment of optical fiber using wireline techniques has become increasingly common for distributed acoustic sensing (DAS) and Distributed Temperature Sensing (DTS) systems. It is however
10 desirable to have various other physical parameters measured along the well bore, and current retrievable logging systems may utilize point sensors at the distal end of the fiber based wireline cable where parameters are logged and data stored in a memory tool or communicated to the surface using optical fiber(s) or electrical
15 conductors. The drawback with this approach is that only one point can be logged at any given time.

There is a need for an easily deployable system of distributed sensing for a variety of important parameters in downhole applications.

20

Brief Description of the Drawings

Figure 1 illustrates a typical surface equipment configuration for rigging
5 up a wireline.

Figure 2 illustrates a single EAT launcher section.

Figure 3 illustrates a stack of EAT launchers.
10

Figure 4 illustrates an EAT sensor assembly.

Figure 5 illustrates one end section of an EAT sensor assembly as
proposed in this disclosure.
15

Figure 6 illustrates a complete EAT sensor assembly that includes both
an upper and lower set of cam grippers.

Figure 7 illustrates a hand held fixture for use in non-pressurized
20 installations.

Detailed Description

In the following detailed description, reference is made to accompanying
5 drawings that illustrate embodiments of the present disclosure. These
embodiments are described in sufficient detail to enable a person of
ordinary skill in the art to practice the disclosure without undue
experimentation. It should be understood, however, that the
embodiments and examples described herein are given by way of
10 illustration only, and not by way of limitation. Various substitutions,
modifications, additions, and rearrangements may be made without
departing from the spirit of the present disclosure. Therefore, the
description that follows is not to be taken in a limited sense, and the
scope of the present disclosure will be defined only by the final claims.

15

Description of EAT (Electro Acoustic Technology) Sensors

The EAT sensors and EAT sensing technology described in this
disclosure is a recently developed technology and has been described in
20 a recently published PCT application: WO2015020642A1.

EAT Sensors represent a new approach to fiber optic sensing in which
any number of downhole sensors, electronic or fiber optic based, can be
utilized to make the basic parameter measurements, but all of the
25 resulting information is converted at the measurement location into
perturbations or a strain applied to an optical fiber that is connected to an
interrogator that may be located at the surface of a downhole well. The
interrogator may routinely fire optical signal pulses downhole into the
optical fiber. As the pulses travel down the optical fiber back scattered
30 light is generated and is received by the interrogator.

The perturbations or strains introduced to the optical fiber at the location of the various EAT sensors can alter the back propagation of light and those effected light propagations can then provide data with respect to the signal that generated the perturbations.

5

The possible advantages from using the above described EAT systems in a variety of configurations may include using a variety of sensors, either electrical or fiber optic based, to measure for example a chemical concentration, a pH, a temperature, or a pressure and using a common
10 optical fiber connected to a surface interrogator to measure perturbation signals from each EAT sensor assembly location distributed along that common optical fiber and analyzing those signals to extract values of the parameters being measured. The approach can significantly reduce manufacturing complexity, reduce very expensive labor intensive
15 production with expensive equipment like splicers and fiber winders, improve reliability, and widen industry acceptance by allowing the use of sensing technologies of choice.

The proposed equipment consists of an EAT sensor assembly
20 configured to clamp to, and unclamp from, fiber based wireline, and a modular launcher/retriever at the surface which enables one or multiple EAT sensor assemblies to be attached to the wireline anywhere along its length as required.

25 The fiber wireline consists of single or multiple optical fibers encased in a single metal tube or a metal tube with a multiple strand wire braided around the tube. A typical fiber tube is .125" diameter and the stranded version can be ¼ to 5/8" diameter, depending on loading requirements, although other diameters may be used. Some wirelines may also have a
30 single insulated electrical conductor wire for powering equipment at the end of the fiber based wireline cable, such as a tractor for pulling the fiber based wireline cable in horizontal wells.

Figure 1, shown generally as **100**, illustrates a known configuration for surface equipment for rigging up wireline. It is mounted above the Christmas tree on a wellhead. It consists of a wireline unit **110** which
5 spools off the wireline from a spool; a lower sheave **120** and upper sheave **130** maintained in tension by springs **140** to locate the wireline above the well head; a stuffing box **150** through which the wireline passes which provides the main seal on the wireline to prevent well pressure from leaking out; a lubricator section or tool trap **160** which also
10 acts as storage for any tools that get lowered down the hole; a swab valve **170** and a master valve **180** which is used for shutting off well pressure so that the tooling can be removed. The lubricator is installed on top of the tree and tested, the tools placed in the lubricator and the lubricator pressurized to wellbore pressure. Then the top valves of the
15 tree are opened to enable the tools to fall or be pumped into the wellbore under pressure. To remove the tools, the reverse process is used: the tools are pulled up into the lubricator **160** under wellbore pressure, the tree valves are closed, the lubricator pressure is bled off, and then the lubricator **160** may be opened to remove the tools.

20

For the particular application proposed in this disclosure the lubricator section **160** of Figure 1 is replaced by a number of short length sections called EAT launchers, (illustrated in Figure 2, and shown generally as **200**). Each EAT launcher section consists of an external high pressure
25 housing **210**, an attachment means **270** at both ends of the external high pressure housing, which could be a bolted flange or a high pressure coupling, and a retractable launcher plate **220**, which is similar in operation to a knife gate valve, but is not used to seal pressure. Instead it holds an EAT sensor assembly in place and allows a fiber based
30 wireline cable to pass through. It has a V-cut **230** to clear the fiber based wireline cable and a wedge shape **240** to push open or close retractable pins on the EAT sensor assembly. The EAT sensor assembly sits on top

of the launcher plate. The length of the launcher pipe is the length of the EAT device plus the thickness of the launcher plate. Each EAT launcher contains one EAT sensor assembly. The stack of EAT launchers matches the number of EAT sensors required downhole. When the hand wheel **250** is rotated, the launcher plate is retracted from the bore. The rising stem **260** provides a visual indication of the launcher plate position since the stem and plate are connected and move together when the hand wheel is rotated.

10 The separate EAT launchers shown in Figure 2 can then be stacked together and mounted above the tree valves. This is illustrated in Figure 3, shown generally as **300**. In this example three EAT launchers **320**, **330**, **340** are stacked and topped of with a top cap **310** which constrains the top EAT sensor assembly **320** and enables the stuffing box to be
15 mounted. If instrumentation or equipment is mounted at the end of the wireline, then an additional lubricator or tool catcher can be mounted below the EAT launchers to contain the tools.

The EAT sensor assembly is shown in Figure 4, shown generally as **400**.
20 It consists of a center section that contains sensors, electronics, and batteries **410** in a pressure housing **420** and two identical end sections **430** that contain a set of extendable grippers (to be described) that grip the wireline fiber based wireline cable **440**. The center and end sections have a V groove **450** in them that allow the sensor assembly to be
25 centered on the wireline fiber based wireline cable **440**.

Each end of the EAT sensor assembly is shown generally as **500**. The end section **550** contains two identical grippers that consist of eccentric circular cams **510**. The contact face of the grippers is recessed to match
30 the diameter of the fiber based wireline cable **520**. The cams are connected to spring loaded pins **530** that extend out the top **550** of the sensor assembly. In their normal state, the springs push the pin up, thus

causing the cams **510** to extend into the space where the fiber based wireline cable is located, and make contact with the fiber based wireline cable **520**. The contact surface of the cams may be high friction material, such as rubber, urethane or the like. When the pins are depressed by
5 external means, the cams retract away from the fiber based wireline cable thus disconnecting the sensor assembly from the fiber based wireline cable.

Figure 6, shown generally as 600, illustrates a complete EAT sensor
10 assembly that includes both an upper **610** and lower **620** set of cam grippers. The lower set of cams is a mirror copy of the upper set of cams that includes again two grippers with eccentric circular cams connected to spring loaded pins that extend out of the lower end of the sensor assembly so that the clamping force of the lower cams acts in the
15 opposite direction from the upper cams.

The four cams of the upper and lower grip mechanisms work together to provide a very slip resistant and vibration resistant grip on the fiber based wireline cable. When forces try to pull the sensor assembly down
20 on the fiber based wireline cable, the top set of cams are pulled tighter into the fiber based wireline cable. When the forces try to push the sensor assembly up on the fiber based wireline cable, the lower cams grip the fiber based wireline cable tighter. Together, the pairs of cams prevent any push or pulling on the sensor assembly to move it. Vibration
25 only increases the grip.

Launch and Retrieval

In use, the EAT sensors can be launched as follows. The fiber based
30 wireline cable is unwound to a preselected depth. The fiber based wireline cable is stopped. The lowest launcher plate is retracted, which causes the gripper pins to extend at both ends and the cams to grip the

fiber based wireline cable. The fiber based wireline cable starts up again, taking the EAT with it.

5 The process is repeated for each EAT until all are deployed at their required positions.

Furthermore, in use the EAT sensor assemblies can be retrieved as follows. All launcher plates are retracted. The first EAT sensor assemblies returns to the top, where the top cap depresses the pins in
10 the top of the EAT and disconnects the top cams to disconnect from the fiber based wireline cable. The lower end stays connected until the launcher plate is extended, even if the fiber based wireline cable continues to slip through the cam locks. The launcher plate is wedge shaped in section so that it pushes the pins into the housing as it is
15 extended, and opens the cam locks. The EAT sensor assembly is now disconnected from the fiber based wireline cable at both ends and supported by the launch plate. The fiber based wireline cable can now continue to be retrieved.

20 The next EAT is stopped by the previously extended launcher plate, the spring loaded pins are compressed and the cams unlock from the fiber based wireline cable. The next lower launcher plate is extended and stores the EAT, and so on, until all EAT's are retrieved.

25 An additional embodiment (not shown) that can be added is that If the EAT is still transmitting, a sonic detector could be added, or a secondary fiber mounted to the outside the EAT launcher to detect its location using the DAS interrogator. This would confirm that the EAT has reached its home position. Alternatively a Hall effect switch or similar could detect
30 the presence of the EAT.

Acoustic transfer to the fiber based wireline cable.

Close coupling between the sensor assembly and the fiber based wireline cable is desired to ensure efficient transference of the acoustic signal to the fiber based wireline cable. This can be done by mounting the acoustic source directly in one of the locking cams. The source may be a piezo electric transducer (PET) or similar. Alternatively the PET can be mounted in the EAT enclosure close to the fiber based wireline cable, and a single cam may be used to push the fiber based wireline cable to provide good physical contact to an area designed to house the acoustic transducer used to communicate to the optical fiber inside the logging fiber based wireline cable.

Non Pressurized Installation

A bridge plug may be deployed in the well to seal off the well bore pressure, and the area above the bridge plug will then not have any pressure beyond the hydrostatic pressure of any fluid in the well bore. Where a non-pressurized installation occurs, the pressurized EAT launcher can be replaced by a hand held fixture that holds the EAT sensor assembly with the pins (**530** in figure 5) retracted, and thus with the cams open. This embodiment is illustrated in Figure 7, shown generally as **700**. The fixture **720**, with handle **730** and plunger **740** holds the EAT sensor assembly **710**. Top and bottom enclosures **720,760,770** of the fixture keep the pins retracted while the EAT sensor assembly is contained within the hand held open fixture **720**. The EAT sensor assembly **710** is placed up against the wireline **750** and pushed out of the fixture **720** with plunger **740**. Once out of the fixture the pins (**530** in figure 5) extend which closes the cams on the wireline **750** and the EAT sensor assembly then rides downhole with the wireline. For retrieval the same fixture is used in reverse to compress the pins and remove the EAT sensor assembly.

Addition of a Locking Arm

There are some applications, primarily seismic/micro-seismic applications and some logging operations in which it might be critical to have good contact of the EAT sensor package with the inner wall of the casing after it has reached its desired location. It has been shown that this can be accomplished by use of a locking arm (not shown) that pushes the EAT sensor package against the inner wall of the casing. The locking arm can be spring loaded to ensure reliable contact. There are a number of configurations of locking arms that can be used. These could be installed on the outside of the EAT sensor package and activated to deploy into a locked position against the casing wall once the EAT sensor is located at its desired position. Mechanical/hydraulic forces from the surface could initiate activation, avoiding the use of electronic control circuitry or electrical power and wiring, allowing for reliable use in temperature environments where electronics have a high risk of failure

Value Added Utility

The system and method described herein allows for simultaneous deployment of multiple point sensors deployed along a logging fiber based wireline cable to provide real-time data. The system may use electro acoustic technology (EAT) sensors that provide point measurement of oil well parameters such as pressure, temperature and e.g. seismic sensors with locking arms to couple to the casing wall/formation. The sensors can then be positioned as desired along the well and said logging fiber based wireline cable. The EAT sensors use the DAS fiber as a data transmission line by converting electrical signals to acoustic signals which excite the fiber and can be detected by an interrogator at the surface (not shown). The fiber acts as both a sensor for continuous monitoring over the entire length of the well, as well as a

transmission method for point sensing. Attaching the EAT sensors reliably to the fiber based wireline cable and launching them downhole requires novel equipment and methods which are described herein. Similarly, detaching the EAT sensor from the fiber based wireline cable and storing the EAT upon retrieval is also described, using the same apparatus. A hand held version for un-pressurized wellheads is also described.

The system and method described herein adds point measurement capability to DAS for dip ins, wireline monitoring of seismic, pressure, temperature, flow, etc. with real time display. The proposed solution will enable e.g. micro-seismic sensing in high temperature environment where some current tools fail given that some electronic boards (A/D converters, data acquisition boards, telemetry circuits etc.) can be limited in their ability limited temperatures. The proposed EAT technology can be built using high temperature electronics. The cost of this system will also be much lower given the reduction of down-hole electronics, and the reliability will improve over existing micro-seismic systems as there is no need to cut the fiber based wireline cable to manufacture connections suitable for down-hole deployment. The system will also be configurable on the fly to meet different well configurations.

Although certain embodiments and their advantages have been described herein in detail, it should be understood that various changes, substitutions and alterations could be made without departing from the coverage as defined by the appended claims. Moreover, the potential applications of the disclosed techniques is not intended to be limited to the particular embodiments of the processes, machines, manufactures, means, methods and steps described herein. As a person of ordinary skill in the art will readily appreciate from this disclosure, other processes, machines, manufactures, means, methods, or steps, presently existing or later to be developed that perform substantially the

same function or achieve substantially the same result as the corresponding embodiments described herein may be utilized. Accordingly, the appended claims are intended to include within their scope such processes, machines, manufactures, means, methods or
5 steps.

Claims

1. A system for launching and retrieving wireline electro acoustic
5 technology (EAT) sensors in downhole hydrocarbon well bores
comprising:
- a. at least one EAT launcher/retriever section comprising:
 - i. an external high pressure housing;
 - 10 ii. attachment means at each end of the external high
pressure housing;
 - iii. a wedge shaped internal retractable launcher plate
with a v-cut on one side to allow a fiber based
wireline cable to pass through the EAT launcher
section;
 - 15 b. an EAT sensor assembly for placement in each at least
one EAT launcher/retriever sections comprising:
 - i. a center section comprising sensors, electronics,
and batteries;
 - 20 ii. two identical end sections, each with a set of
extendable grippers for gripping a fiber based
wireline cable;
 - iii. wherein the center section and both end sections
have a V groove that allow the EAT sensor
25 assembly to be centered on the fiber based wireline
cable.
2. The system for launching and retrieving wireline electro acoustic
technology (EAT) sensors in downhole hydrocarbon well bores of
claim 1 wherein the attachment means at each end of the external
30 high pressure housing of the at least one EAT launcher section
may be a bolted flange or a high pressure coupling.

3. The system for launching and retrieving wireline electro acoustic technology (EAT) sensors in downhole hydrocarbon well bores of claim 1 further comprising a mechanism for retracting the internal retractable launcher plate.
- 5
4. The system for launching and retrieving wireline electro acoustic technology (EAT) sensors in downhole hydrocarbon well bores of claim 1 further comprising a surface distributed acoustic sensor (DAS) interrogator for detecting and interpreting the acoustic signals from the fiber based wireline cable.
- 10
5. The system for launching and retrieving wireline electro acoustic technology (EAT) sensors in downhole hydrocarbon well bores of claim 1 wherein the end sections of the EAT launcher/retriever have identical grippers comprising eccentric circular cams with contact faces recessed to match the diameter of the fiber based wireline cable, wherein the eccentric circular cams are connected to spring loaded pins that when extended out of the end sections of the EAT launcher/retriever and activate the eccentric circular cams to close onto the fiber based wireline cable.
- 15
- 20
6. A system for launching and retrieving wireline electro acoustic technology (EAT) sensors in downhole hydrocarbon well bores in non-pressurized installations comprising:
- 25
- a. a hand held open fixture for holding an EAT sensor assembly;
 - b. an EAT sensor assembly for placement in the hand held open fixture comprising:
 - i. a center section comprising sensors, electronics, and batteries;
- 30

- ii. two identical end sections, each with a set of extendable grippers for gripping a fiber based wireline cable; wherein the extendable grippers comprise eccentric circular cams with contact faces recessed to match the diameter of the fiber based wireline cable, and wherein the eccentric circular cams are connected to spring loaded pins that extend out of the end sections of the EAT sensor assembly;
- iii. wherein the center section and both end sections have a V groove that allow the EAT sensor assembly to be centered on the fiber based wireline cable;
- c. top and bottom plates on the hand held open fixture, each having a V groove that allow the hand held open fixture to be centered on the fiber based wireline cable;
- d. a handle for manually placing the EAT sensor assembly against the fiber based wireline cable; and
- e. a plunger for pushing the EAT sensor assembly out of the hand held open fixture, allowing the spring loaded pins to extend out of the end sections of the EAT sensor assembly and cause the eccentric circular cams to close onto the fiber based wireline cable.
7. A method for launching and retrieving wireline electro acoustic technology (EAT) sensors in downhole hydrocarbon well bores wherein the launching comprises:
- a. mounting one or more EAT launcher/retriever sections above a Christmas tree on a wellhead, the EAT launcher/retriever sections comprising;
- i. an external high pressure housing;

- ii. attachment means at each end of the external high pressure housing;
- iii. a wedge shaped internal retractable launcher plate with a v-cut on one side to allow a fiber based wireline cable to pass through the one or more EAT launcher sections; and
- iv. each one or more EAT launcher/retriever sections having an installed EAT sensor assembly comprising:
 - 1. a center section comprising sensors, electronics, and batteries;
 - 2. two identical end sections, each with a set of extendable grippers for gripping the fiber based wireline cable; wherein the extendable grippers comprise eccentric circular cams with contact faces recessed to match the diameter of the fiber based wireline cable, and wherein the eccentric circular cams are connected to spring loaded pins that extend out of the end sections of the EAT sensor assembly;
 - 3. wherein the center section and both end sections have a V groove that allow the EAT sensor assembly to be centered on the fiber based wireline cable.
- b. unwinding the fiber based wireline cable downhole to a preselected depth and then stopping it;
- c. retracting the internal retractable launcher plate of the lowest EAT launcher/retriever sections, causing the spring loaded pins to extend out of the end sections of the EAT sensor assembly, resulting in allowing the extendable grippers to grip the fiber based wireline cable;

- d. restarting the unwinding of the fiber based wireline cable, taking the installed EAT sensor assembly from that lowest EAT launcher/retriever section;
 - e. repeating steps b. thru d. until all of the EAT sensor assemblies are deployed at their required positions.
- 5
- 8. The method for launching and retrieving wireline electro acoustic technology (EAT) sensors in downhole hydrocarbon well bores of claim 7 wherein the retrieving comprises:
 - 10
 - a. retracting all of the internal retractable launcher plates;
 - b. re-winding the fiber based wireline cable toward the surface until the first EAT sensor assembly returns to the topmost EAT launcher/retriever;
 - c. re-inserting the internal retractable launcher plate of the
 - 15 topmost EAT launcher/retriever section, pushing the spring loaded pins back into the EAT sensor assembly and disconnecting the EAT sensor assembly from the fiber based wireline cable;
 - d. continuing to re-wind the fiber based wireline cable toward
 - 20 the surface, capturing each EAT sensor assembly in its EAT launcher/retriever section and re-inserting each launcher plate until all of the EAT sensor assemblies are retrieved.
- 25
- 9. A method for launching and retrieving wireline electro acoustic technology (EAT) sensors in downhole hydrocarbon well bores in a non-pressurized installation wherein the launching comprises:
 - a. using a hand held open fixture for holding an EAT sensor assembly;
 - 30 b. placing an EAT sensor assembly in the hand held open fixture, the EAT sensor assembly comprising:

- i. a center section comprising sensors, electronics, and batteries;
- ii. two identical end sections, each with a set of extendable grippers for gripping a fiber based wireline cable; wherein the extendable grippers comprise eccentric circular cams with contact faces recessed to match the diameter of the fiber based wireline cable, and wherein the eccentric circular cams are connected to spring loaded pins that extend out of the end sections of the EAT sensor assembly;
- iii. wherein the center section and both end sections have a V groove that allow the EAT sensor assembly to be centered on the fiber based wireline cable; and
- iv. wherein the spring loaded pins are held in a retracted position by the so that the extendable grippers are gripping the fiber based wireline cable;
- c. unwinding the fiber based wireline cable downhole to a preselected depth and then stopping it;
- d. placing the hand held open fixture and EAT sensor assembly against the fiber base wireline cable so that the fiber based wireline cable is centered in the V groove of the EAT sensor assembly;
- e. pushing the EAT sensor assembly out of the hand held open fixture to cause the spring loaded pins to extend out of the end sections of the EAT sensor assembly, resulting in allowing the extendable grippers to grip the fiber based wireline cable;
- f. restarting the unwinding of the fiber based wireline cable, taking the installed EAT sensor assembly further downhole.

- g. repeating steps c. thru f. until all of the EAT sensor assemblies are deployed at their required positions.

- 5 10. A method for launching and retrieving wireline electro acoustic technology (EAT) sensors in downhole hydrocarbon well bores in a non-pressurized installation wherein the retrieving comprises:
- 10 a. re-winding the fiber based wireline cable toward the surface until the first EAT sensor assembly returns to the surface;
 - 15 b. pushing the hand held open fixture over the EAT sensor assembly to enclose it and compress the spring loaded pins that extend out of the end sections of the EAT sensor assembly, thus releasing the grip of the extendable grippers on the fiber based wireline cable;
 - 20 c. remove the EAT sensor assembly from the hand held open fixture; and
 - 25 d. repeat for each remaining EAT sensor assemblies.
- 30 11. The system for launching and retrieving wireline electro acoustic technology (EAT) sensors in downhole hydrocarbon well bores of claim 1 wherein a locking arm is attached on the outside of the EAT sensor assembly and activated to deploy into a locked position against a casing wall of the downhole well bore.
12. The system for launching and retrieving wireline electro acoustic technology (EAT) sensors in downhole hydrocarbon well bores of claim 6 wherein a locking arm is attached on the outside of the EAT sensor assembly and activated to deploy into a locked position against a casing wall of the downhole well bore.

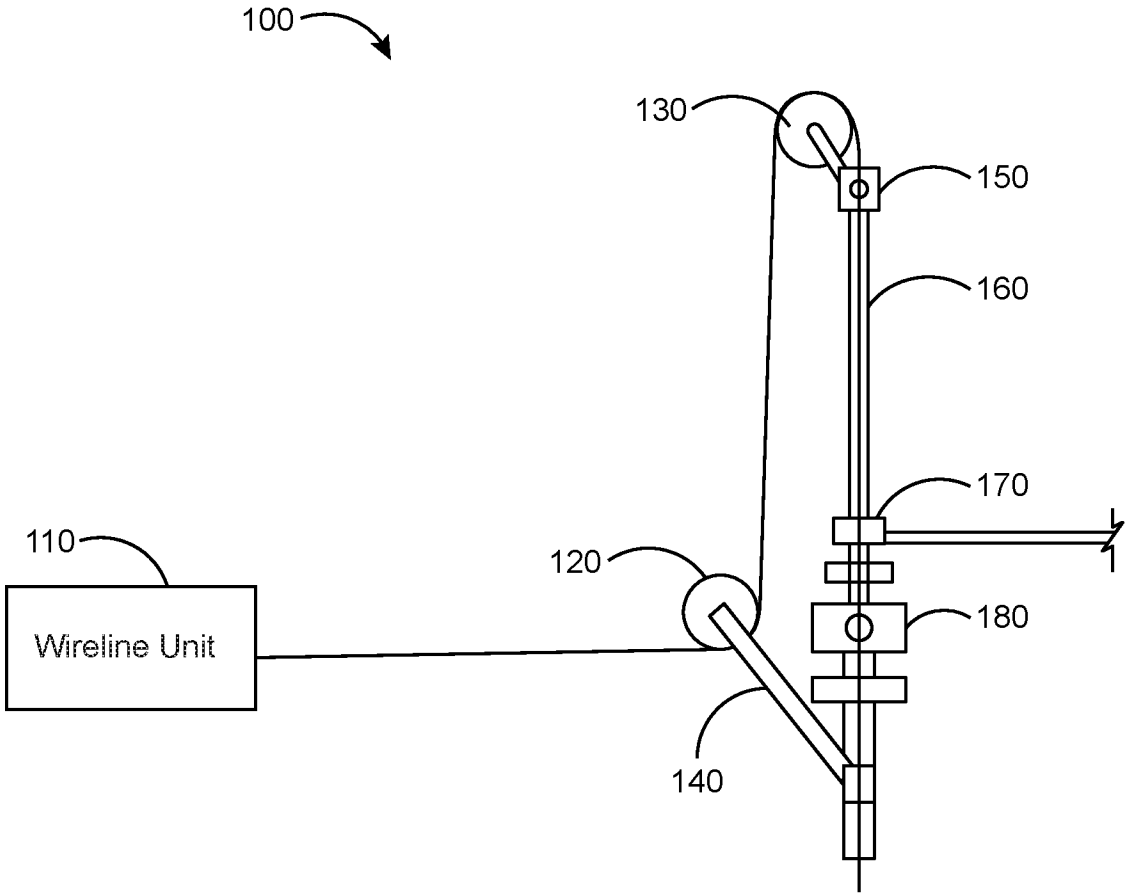


FIG. 1

2/7

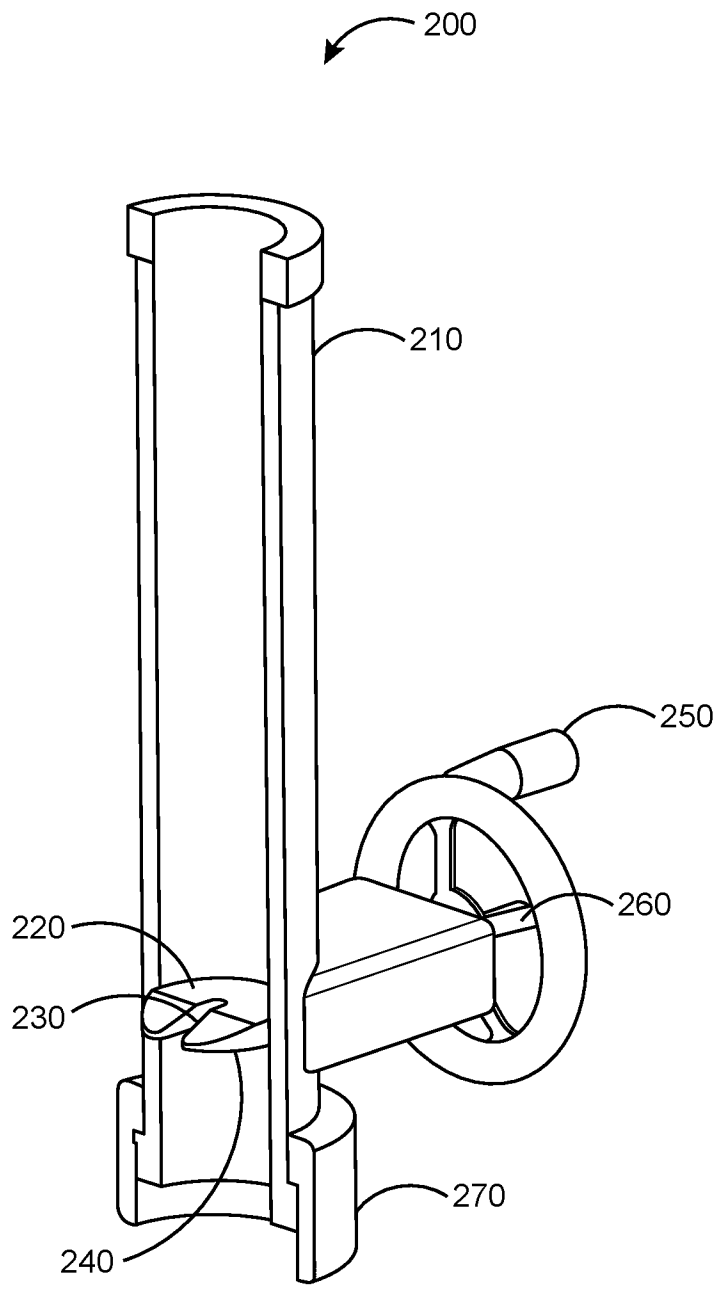


FIG. 2

3/7

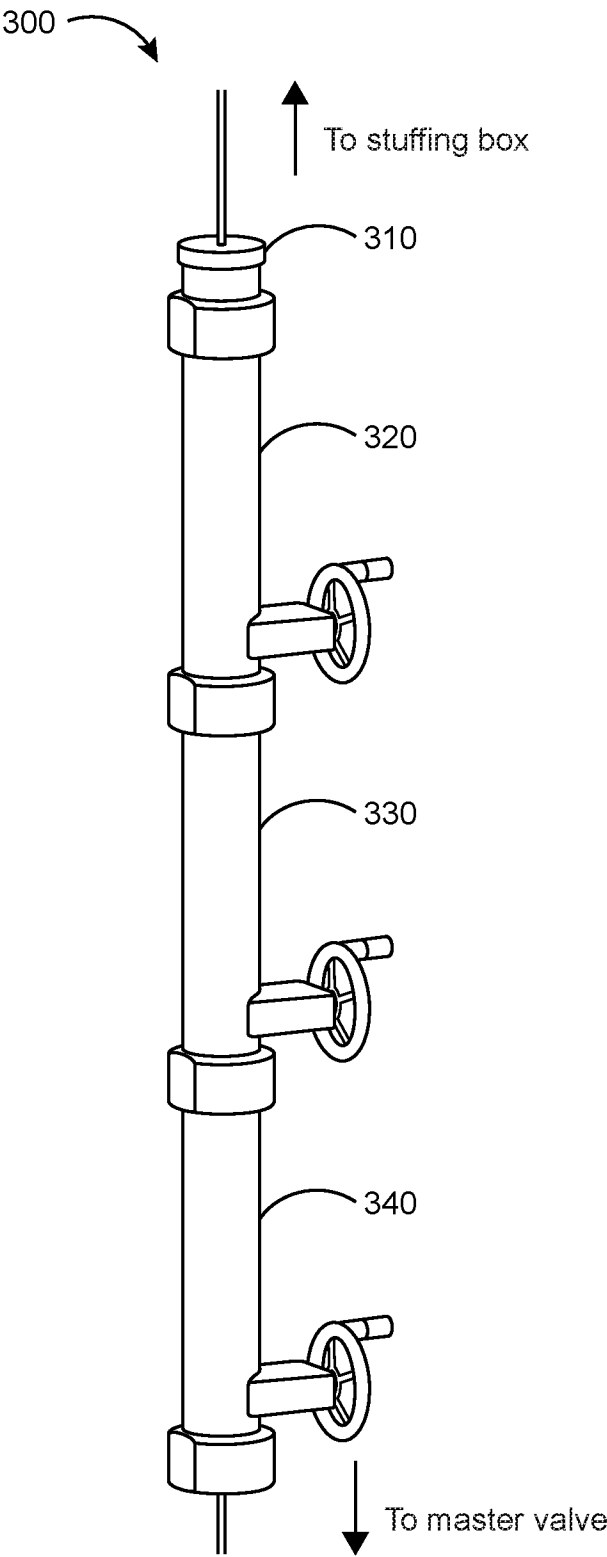


FIG. 3

4/7

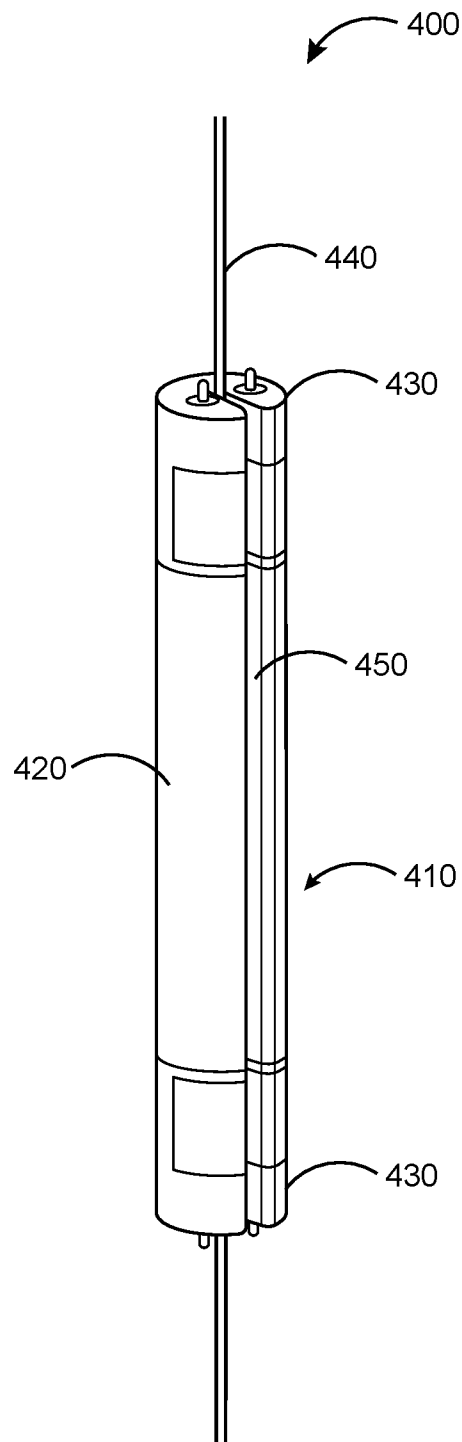


FIG. 4

5/7

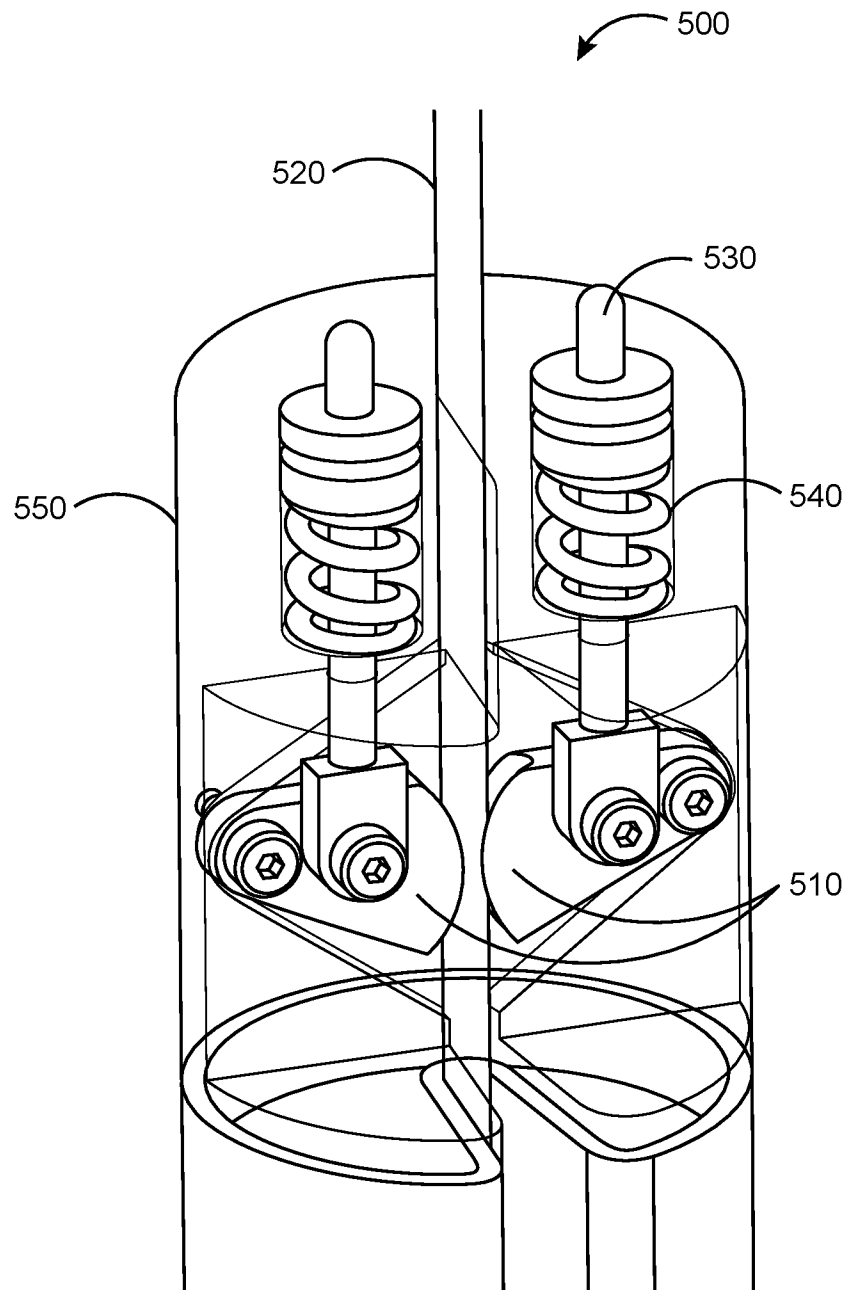


FIG. 5

6/7

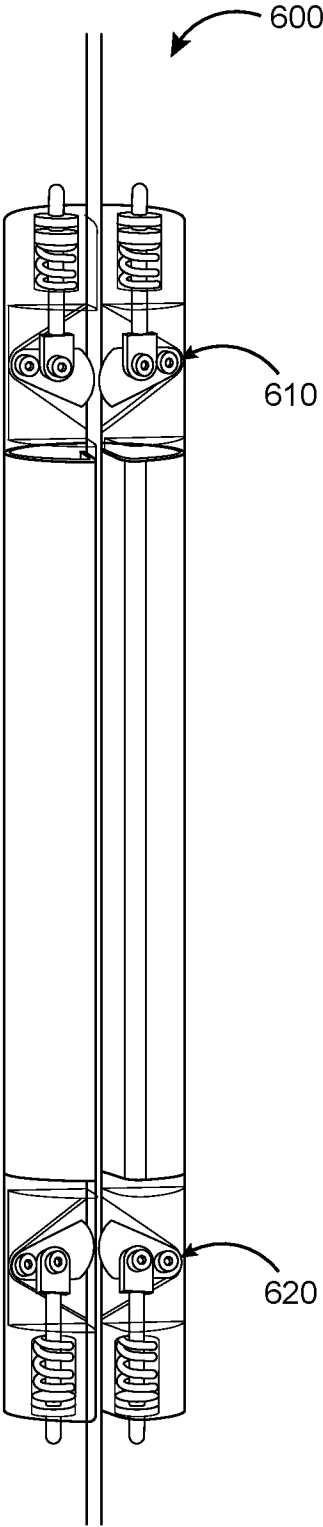


FIG. 6

7/7

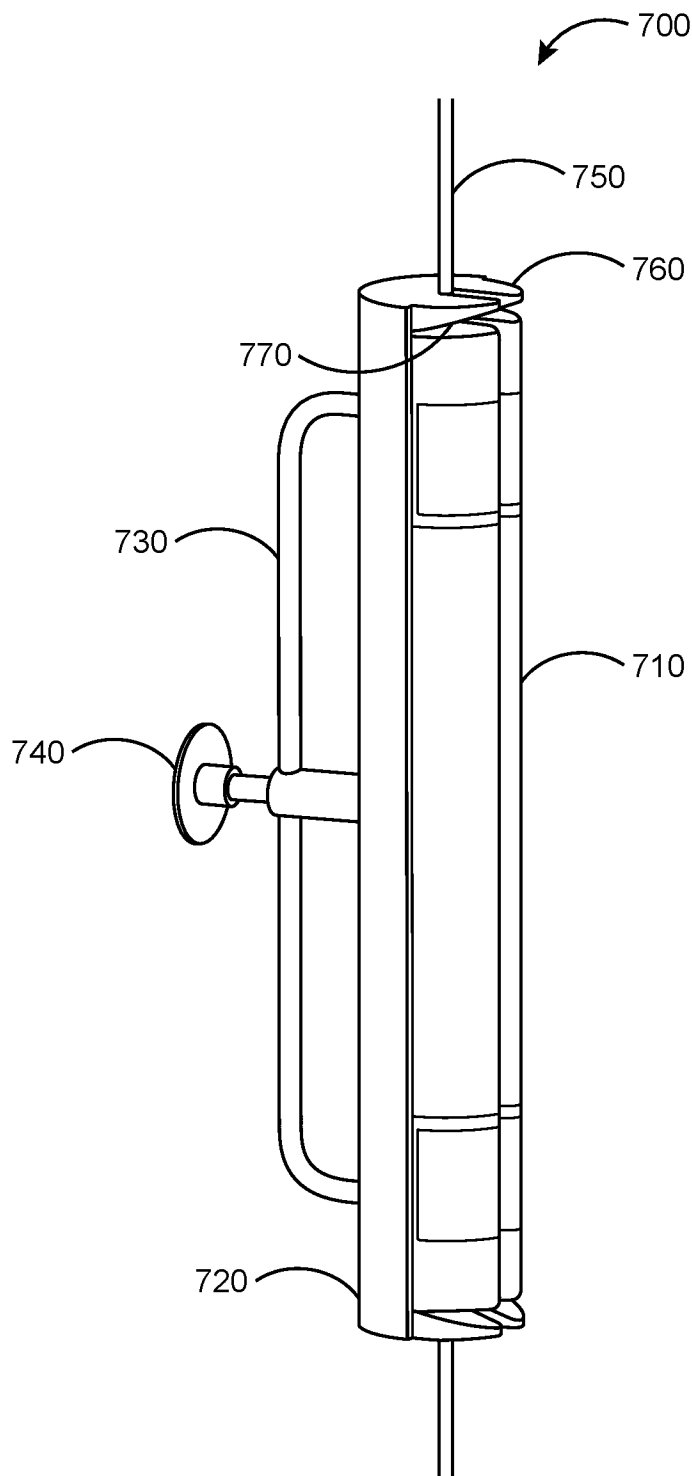


FIG. 7

A. CLASSIFICATION OF SUBJECT MATTER**E21B 47/00(2006.01)i, E21B 23/00(2006.01)i, G01V 1/40(2006.01)i, G01V 1/46(2006.01)i**

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

E21B 47/00; E21B 33/06; E21B 19/08; E21B 19/00; E21B 33/072; E21B 29/04; E21B 19/02; E21B 23/00; G01V 1/40; G01V 1/46

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & keywords: wellbore, electro acoustic technology (EAT) sensor assembly, EAT launcher/retriever section, wedge, and hand held open fixture

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2011-0174503 A1 (ELSAIED et al.) 21 July 2011 See paragraphs [0023]-[0031] and figures 3-7.	1-12
A	US 7963319 B2 (DAIGLE et al.) 21 June 2011 See column 2, line 65 - column 3, line 31 and figure 2A.	1-12
A	US 2007-0278435 A1 (WOOD, CARL) 06 December 2007 See paragraphs [0043]-[0050] and figures 1-2.	1-12
A	US 2008-0230216 A1 (ANGMAN, PER G.) 25 September 2008 See paragraphs [0019]-[0020] and figures 1-5.	1-12
A	US 6202764 B1 (ABLES et al.) 20 March 2001 See column 5, line 16 - column 6, line 54 and figures 4-8.	1-12



Further documents are listed in the continuation of Box C.



See patent family 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 application or patent 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

06 January 2017 (06.01.2017)

Date of mailing of the international search report

06 January 2017 (06.01.2017)

Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

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

Facsimile No. +82-42-481-8578

Authorized officer

HAN, JOONG SUB

Telephone No. +82-42-481-3578



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/031955

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011-0174503 A1	21/07/2011	EP 2149670 A1 US 8899338 B2 WO 2010-012487 A1	03/02/2010 02/12/2014 04/02/2010
US 7963319 B2	21/06/2011	CA 2689809 A1 CA 2689809 C EP 2206877 A2 EP 2206877 A3 EP 2206877 B1 US 2010-0170675 A1	08/07/2010 20/03/2012 14/07/2010 25/01/2012 23/10/2013 08/07/2010
US 2007-0278435 A1	06/12/2007	AT 519920 T AU 2007-202551 A1 AU 2007-202551 B2 CA 2590984 A1 CA 2590984 C DK 1865145 T3 EP 1865145 A1 EP 1865145 B1 EP 1865145 B9 NO 20072838 A SG 137835 A1 US 7611120 B2	15/08/2011 20/12/2007 10/01/2013 03/12/2007 03/08/2010 28/11/2011 12/12/2007 10/08/2011 14/03/2012 04/12/2007 28/12/2007 03/11/2009
US 2008-0230216 A1	25/09/2008	CA 2615543 A1 CA 2615543 C CA 2849129 A1 CA 2853268 A1 GB 2442697 A US 2007-0056722 A1 US 7575061 B2 US 7721798 B2 WO 2007-009246 A1 WO 2007-009248 A1	25/01/2007 17/06/2014 25/01/2007 25/01/2007 09/04/2008 15/03/2007 18/08/2009 25/05/2010 25/01/2007 25/01/2007
US 6202764 B1	20/03/2001	None	