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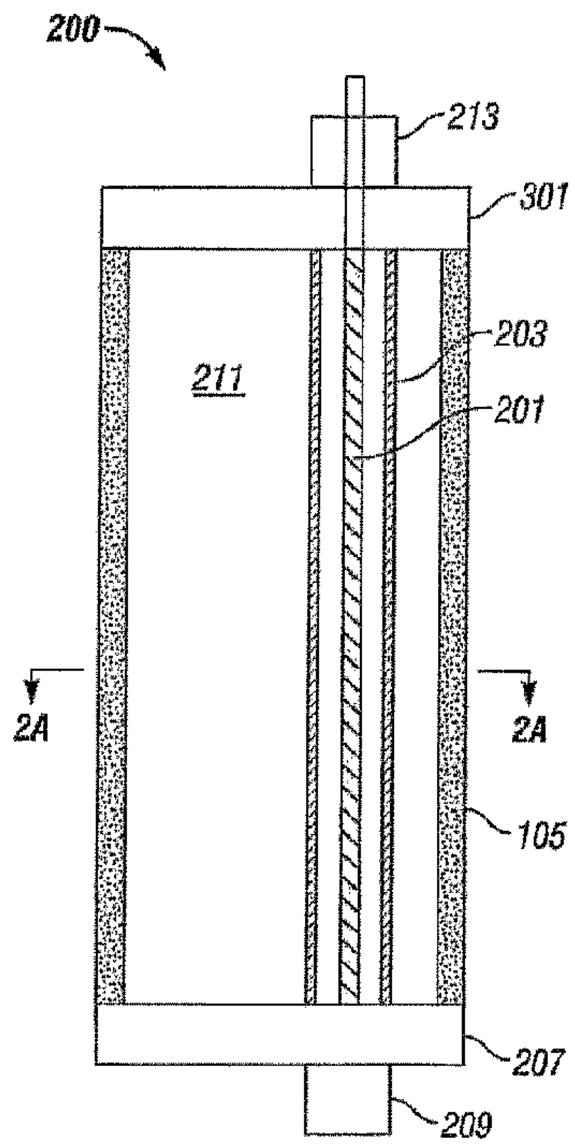
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(54) Titre : COLONNE DE PRODUCTION EQUIPEE DE FIBRES OPTIQUES ET PROCEDES DE FABRICATION ET D'UTILISATION

(54) Title: OPTICAL FIBER EQUIPPED TUBING AND METHODS OF MAKING AND USING



(57) Abrégé/Abstract:
The present invention relates to an optical fiber equipped tubing and methods of making and using the same. The optical fiber equipped tubing comprises a fiber optic tube deployed within a tubular, the fiber optic tube having at least one optical fiber disposed within a duct, the duct typically being a metallic metal compatible with wellbore environments. The present invention also relates to a method of making an optical fiber equipped tubing comprising pumping a fluid into a tubular and deploying a fiber optic tube into the tubular by propelling it in the flow of the pumped fluid. The present invention also provides a method of communicating in wellbore using a fiber optic tube disposed within a wellbore tubular. In certain embodiments, this communication may be combined with a wireless communication system at the surface. In certain embodiments, the tubular may be coiled tubing and the fiber optic tube may be deployed in the coiled tubing while the tubing is spooled on a reel or while the tubing is deployed in a wellbore.

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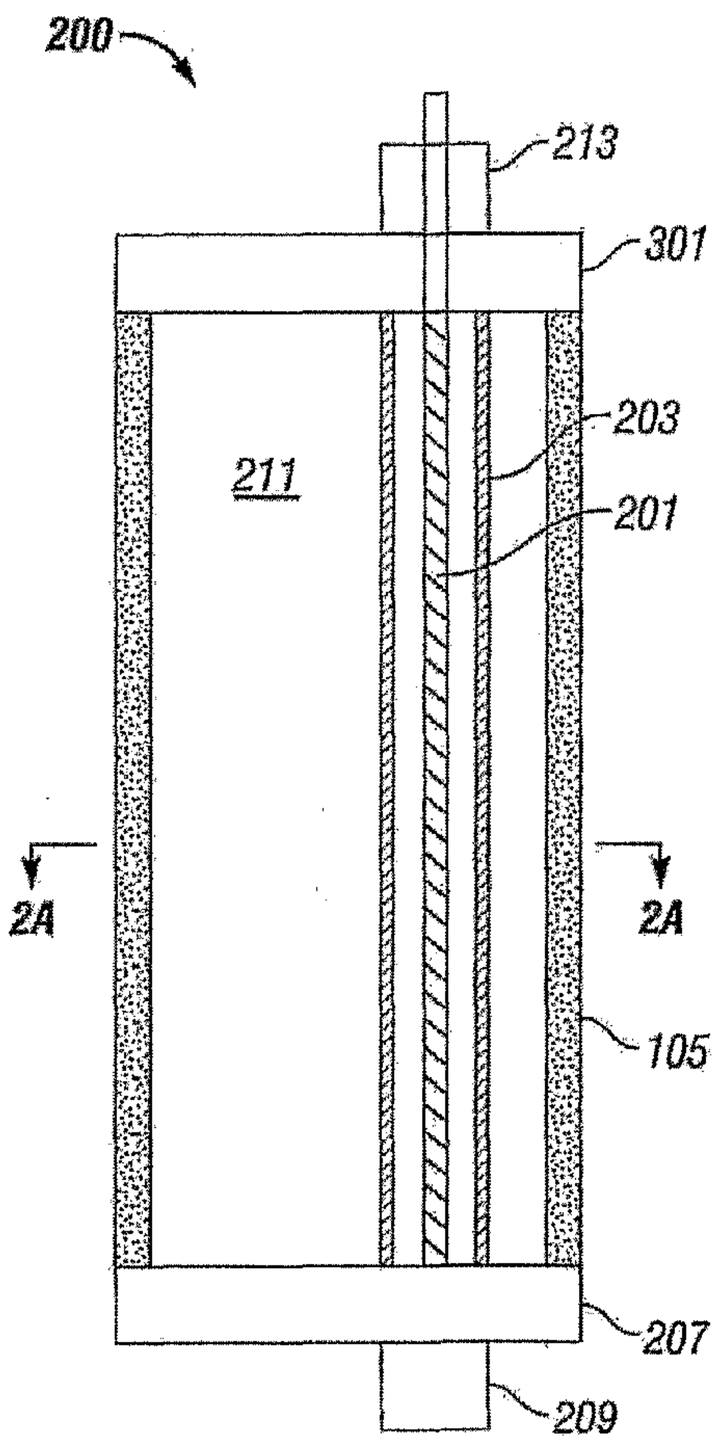
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(57) Abstract: The present invention relates to an optical fiber equipped tubing and methods of making and using the same. The optical fiber equipped tubing comprises a fiber optic tube deployed within a tubular, the fiber optic tube having at least one optical fiber disposed within a duct, the duct typically being a metallic metal compatible with wellbore environments. The present invention also relates to a method of making an optical fiber equipped tubing comprising pumping a fluid into a tubular and deploying a fiber optic tube into the tubular by propelling it in the flow of the pumped fluid. The present invention also provides a method of communicating in wellbore using a fiber optic tube disposed within a wellbore tubular. In certain embodiments, this communication may be combined with a wireless communication system at the surface. In certain embodiments, the tubular may be coiled tubing and the fiber optic tube may be deployed in the coiled tubing while the tubing is spooled on a reel or while the tubing is deployed in a wellbore.

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OPTICAL FIBER EQUIPPED TUBING AND METHODS OF MAKING AND USING

FIELD OF THE INVENTION

[0001] The present invention relates generally to oilfield operations and more particularly methods and apparatus using fiber optics in coiled tubing operations in a wellbore.

BACKGROUND OF THE INVENTION

[0002] Coiled tubing operations are used commonly in the oilfield industry, for example to pump fluids to a desired location in the wellbore or to manipulate oilfield assemblies. One advantage of coiled tubing is that it is provided on reels such that coiled tubing is unreeled as it is inserted into a wellbore for a particular use and then reeled or spooled back on the reel as it is extracted from the wellbore. Coiled tubing reels may be conveniently stored or moved, and spooled coiled tubing may be transported on a trailer, flat, or truck. The use of coiled tubing as a different type of wellbore conveyance in wellbore applications is increasing, resulting in an increasing need for downhole apparatus and methods adapted for use with coiled tubing. Difficulties inherent with using conventional downhole electromechanical apparatus with coiled tubing include lack of power to the downhole apparatus and the lack of telemetry from the downhole apparatus to the surface.

[0003] It is known to use conventional wireline in coiled tubing to provide communications between downhole operations and the surface, including transmitting uphole data measured by a variety of wellbore tools and transmitting commands downhole to effect a variety of operations. Use of wireline cable in coiled tubing presents logistical challenges, however, such as installation of the wireline cable in the coiled tubing and the reduced fluid capacity of the coiled tubing owing to the space taken by the wireline cable.

[0004] The addition of wireline to a coiled tubing string significantly increases the weight of a coiled tubing string. Installation of the wireline into the coiled tubing string is difficult and the wireline is prone to bunch into a "bird nest" within the coiled tubing. This, and the relatively large outer diameter of wireline compared to the internal diameter of coiled tubing, can undesirably obstruct the flow of fluids through the coiled tubing, such flow through the coiled tubing frequently being an integral part of the wellbore operation. Furthermore, some fluids routinely pumped through coiled tubing, such as acid, cement and proppant-bearing fracturing fluids, may have an adverse affect on the integrity or performance of wireline cable. In addition, pumping fluid down the coiled tubing can create a drag force on the wireline cable owing to the frictional force between the fluid and the surface of the cable.

[0005] Installation of wireline or other electrical cable into coiled tubing is difficult and cumbersome as its weight and bending stiffness can contribute to a high friction force between the cable and the interior of the coiled tubing. Methods for installing wireline in coiled tubing are discussed in U.S. Patent 5,573,225 and U.S. Patent 5,699,996, each of which is incorporated herein by reference. The methods described in each of these patents require a significant installation apparatus at the surface to overcome the high frictional force between the cable and the coiled tubing and to convey the cable into the coiled tubing. The size of such an apparatus makes it unfeasible for use in some operations, particularly in offshore operations.

[0006] Use of optical fiber in various applications and operations is increasing. Optical fiber provides many advantages over wireline when used as a transmission medium such as small size, lightweight, large bandwidth capacity, and high speed of transmission. A significant challenge to using optical fibers in subterranean oilfield operations is that the free hydrogen ions will cause darkening of the fiber at the elevated temperatures that are commonly found in subterranean wells. The use of optical fiber in wireline cable is known such as that described in U.S. Patent No 6,690,866 incorporated herein in its entirety by reference. This patent teaches adding a hydrogen absorbing material or scavenging gel to surround the optical fibers inside a first metal

tube. This patent also teaches that wireline cable disclosed therein requires significant tensile strength and teaches that this strength can be obtained by rigidly attaching the first metal tube to the interior of a second metal tube. Both teachings can significantly add to the cost and weight of the cable. In U.S. Patent No 6,557,630, incorporated herein in its entirety by reference, a method of deploying a remote measurement apparatus in a wellbore, the apparatus comprising a conduit in which a fiber optic sensor and a fiber optic cable is disposed, the cable being propelled along the conduit by fluid flow in a conduit. In GB Patent 2362909, incorporated herein in its entirety by reference, a method is proposed for placing sensors that relies upon first installing first a hollow conduit into the coiled tubing and then subsequently pumping a single fiber into that conduit. None of these patents teach or suggest propelling an optically enabled conduit or cable into a tubular using fluid flow.

[0007] Methods of installing optical fibers in tubulars often are directed towards installing the optical fiber by pumping or dragging the fiber into the tubular. In U.S. Patent Application Publication 2003/0172752, incorporated herein by in its entirety by reference, methods for installing an optical fiber through a conduit in a wellbore application using a fluid, wherein a seal is provided between the optical fiber and the conduit are described. To install an optical fiber in coiled tubing using these methods would require 1) unreeling the coiled tubing, 2) extending the coiled tubing (either in a wellbore or on the surface) and 3) deploying the optical fiber. Such a process is directed toward the installation of a single optical fiber in a tubular; it is time consuming and thus costly from an operational perspective. Furthermore, these methods are directed toward installing a single optical fiber in a tubular and are not conducive to installation of multiple fibers in a tubular. In addition, these methods do not contemplate recovery or reuse of the optical fiber.

[0008] Use of multiple optic fibers however may provide advantages in many situations over the use of a single optical fiber. Using multiple fibers provides operational redundancy in the event that any particular fiber becomes damaged or broken. Multiple fibers provide increased transmission capacity over a single fiber and permit flexibility to segregate different types of transmissions to different fibers. These advantages may be particularly important in downhole

applications where access is limited, environmental conditions may be extreme, and dual-direction (uphole and downhole) transmission is required. Using multiple optical fibers also allows an individual optical fiber to be used for a specific apparatus or sensor. This configuration is useful as some sensors, such as Fabry-Perot devices, require a dedicated optical fiber. The configuration also is useful for sensors with digital telemetry for which a separate fiber may be required. Sensors using Fiber-Bragg grating for example require a separate fiber from the fiber used for carrying digital optical telemetry.

[0010] For clarity, the term "duct" is used herein to identify a small tube or hollow carrier that encompasses an optical fiber or fibers. The term "optical fiber" refers to a fiber or a waveguide capable of transmitting optical energy. The term "fiber optic tube" or "fiber optic tether" is used to identify the combination of an optical fiber or multiple optical fibers disposed in a duct. The term "fiber optic cable" refers to a cable, wire, wireline or slickline that comprises one or more optical fibers. "Tubular" and "tubing" refers to a conduit to any kind of a round hollow apparatus in general, and in the area of oilfield applications to casing, drill pipe, metal tube, or coiled tubing or other such apparatus.

[0011] Various methods of manufacturing fiber optic tubes are known. Two examples are laser welding, such as described in U.S. Patent No. 4,852,790, incorporated herein in its entirety, and tungsten inert gas welding (TIG) such as described in U.S. Patent No. 4,366,362, incorporated herein in its entirety. Neither patent teaches or suggests the insertion of such tubes into a spooled tubular by fluid flow.

[0012] Therefore it may be seen that there exists a need for an apparatus, methods of making, and methods of using fiber optic tubing disposed in a tubular, and in particular, a need for such an apparatus and methods of using in wellbore applications.

SUMMARY OF THE INVENTION

[0013] The present invention comprises optical fiber equipped tubing and methods of making and using the same. In a broad sense, the present invention comprises an optical fiber equipped tubing comprising a fiber optic tube deployed within a tubular. In many embodiments, the fiber optic tube comprises a metallic material, and in some embodiments, the fiber optic tube comprises more than one optical fiber. In many embodiments, the fiber optic tube will be constructed in an inert nitrogen environment so that the optical fiber or fibers therein are not exposed to hydrogen or water during manufacturing. The tubular may be, in particular, coiled tubing. In another embodiment, the present invention relates to a method of making an optical fiber equipped tubing comprising pumping a fluid into a tubular, deploying a fiber optic tube into the fluid as pumped in the tubular, such that the flow of the pumped fluid propels the tube along the tubular. When the tubular is coiled tubing, the fiber optic tube may be deployed in the coiled tubing while the tubing is spooled on a reel or while the tubing is deployed in a wellbore. In another embodiment, the present invention provides a method of communicating in a wellbore comprising deploying an optical fiber equipped tubing having at least one optical fiber disposed therein, the fiber optic tubing being disposed in the tubing by fluid flow; determining a property in the wellbore; and transmitting the determined property via at least one of the optical fibers disposed in the fiber optic tubing. In some embodiments, the least one optical fiber senses the information for transmitting. The method may also comprise disposing at least one sensor in the wellbore, with the sensor determining the property, and the sensed information transmitted to the surface via the optical fiber in the fiber optic tube. In other embodiments, more than one sensor may be disposed in the wellbore, each sensor transmitting its sensed property over a different optical fiber in the coiled tubing. In many embodiments the optical fiber or fibers will be attached to a wireless communication device via a pressure bulkhead so that the optical signal can readily transmitted to a surface computer while the coiled tubing is being spooled into and out of the wellbore. In some embodiments, the present invention provides an apparatus that is deployed into the wellbore and in communication with the surface for receiving signals or transmitting sensed information over the fiber optic tubing.

[0014] While a particular embodiment and area of application is presented as an exemplar, namely that of fiber optic equipped coiled tubing useful for wellbore applications, the present invention is not limited to this embodiment and is useful for any application wherein a fiber optic equipped tubing is desirable.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Fig 1 shows an embodiment of the apparatus of the present invention.

[0016] Fig 2A is a cross-sectional view of an embodiment of the present invention.

[0017] Fig 2B is a cross-sectional view of another embodiment of the present invention.

[0018] Fig 3 shows a typical configuration for coiled tubing operations.

DETAILED DESCRIPTION

[0019] The present invention provides an optical fiber equipped tubing and methods of making and using. The optical fiber equipped tubing of the present invention comprises one or more fiber optic tubes disposed in a tubular. An embodiment comprises a method for installing one or more fiber optic tubes in reeled or spooled tubing such as coiled tubing. Another embodiment provides a method for installing one or more fiber optic tubes in coiled tubing deployed in a wellbore.

[0020] Within the present invention is the unexpected recognition that a fiber optic tube may be deployed a tubular by pumping the fiber optic tube in a fluid without additional structure or protection. Methods of pumping cables into a tubular are generally considered infeasible owning to the inherent lack of compressional stiffness of cables. Furthermore, the teachings of fiber optic cables suggest that a fiber optic tube needs additional protection or structure for use in a

wellbore environment. Thus it is counter-intuitive to consider deploying a fiber optic tube directly in a tubular without encapsulating the tube in additional layers, providing a protective coating, or encompassing it in armor. Similarly it is counter-intuitive to consider deploying a fiber optic tube directly through fluid pumping.

[0021] An advantage of the optical fiber equipped tubing of the present invention is that the fiber optic tube possesses a certain level of stiffness in compression, leading it to behave more similar mechanically to coiled tubing than does cable or optical fiber alone. As such, use of a fiber optic tube inside coiled tubing avoids many of the slack management challenges presented by other transmission mechanism. Furthermore, the cross-section of a fiber optic tube is relatively small compared to the inner area within coiled tubing, thus limiting the possible physical influence that the fiber optic tube could have on the mechanical behavior of coiled tubing during deployment and retrieval. The small relative diameter of the fiber optic tube combined with its light weight make it more tolerant of pumping action, which is advantageous to avoid the "bird-nesting" or bundling within the coiled tubing that commonly occurs when installing wireline in coiled tubing. Moreover, as slack management problems are avoided in the present invention, optical fiber equipped coiled tubing may be deploying into and retrieved from a wellbore at a quicker rate than coiled tubing with wireline.

[0022] Referring now to **FIG 1**, optical fiber equipped tubing **200** is shown having tubular **105** within which is disposed fiber optic tube **211**. In **FIG 1,** fiber optic tube **211** is shown comprising duct **203** in which a single optical fiber **201** is disposed. In other embodiments, more than one optical fiber **201** may be provided within fiber optic duct **203**. Surface termination **301** or downhole termination **207** may be provided for both physical and optical connections between optical fiber **201** and one or more borehole apparatus or sensor **209**. The optical fibers may be multi-mode or single-mode. Types of borehole apparatus or sensor **209** may include, for example, gauges, valves, sampling devices, temperature sensors, pressure sensors, distributed temperature sensors, distributed pressure sensors, flow-control devices, flow rate measurement devices, oil/water/gas ratio measurement devices, scale detectors, actuators, locks, release

mechanisms, equipment sensors (e.g., vibration sensors), sand detection sensors, water detection sensors, data recorders, viscosity sensors, density sensors, bubble point sensors, composition sensors, resistivity array devices and sensors, acoustic devices and sensors, other telemetry devices, near infrared sensors, gamma ray detectors, H_2S detectors, CO_2 detectors, downhole memory units, downhole controllers, perforating devices, shape charges, firing heads, locators, and other devices.

[0023] Referring to **FIG** 2**A**, a cross-sectional view of the fiber optic equipped tubing **200** of **FIG 1** is shown. Within tubing **105** is shown a fiber optic tube **211** comprising optical fiber **201** located inside duct **203**. Referring to **FIG** 2B, another embodiment of the present invention is shown in cross-sectional view in which fiber optic equipped tubing **200** has more than one fiber optic tube **211** is disposed in tubular **105** and in which more than one optical fiber **201** is disposed within duct **203** in at least one of the fiber optic tube **211**.

[0024] In fiber optic tube **211**, an inert gas such as nitrogen may be used to fill the space between the optical fiber or fibers **201** and the interior of the duct **203**. The fluid may be pressurized in some embodiments to decrease the susceptibility of the fiber optic tube to localized buckling. In a further embodiment, this laser-welding technique is performed in an enclosed environment filled with an inert gas such as nitrogen to avoid exposure to water or hydrogen during manufacturing, thereby minimizing any hydrogen-induced darkening of the optical fibers during oilfield operations. Using nitrogen to fill the space offers advantages of lower cost and greater convenience over other techniques that may require a buffer material, gel, or sealer in the space. In one embodiment, the duct **203** is constructed by bending a metal strip around the optical fiber or fibers **201** and then welding that strip to form an encompassing duct using laser-welding techniques such as described in US Patent No 4,852,790. This gives a significant reduction in the cost and weight of the resulting fiber optic tube **211** compared to other optical cables previously known in the art. A small amount of gel containing palladium or tantalum can optionally be inserted into either end of the fiber optic tube to keep hydrogen ions

away from the optical fiber or fibers **201** during transportation of the optically enabled tubing **200.**

[0025] Materials suitable for use in duct **203** in fiber optic tube **211** of the present invention provide stiffness to the tube, are resistant to fluids encountered in oilfield applications, and are rated to withstand the high temperature and high pressure conditions found in some wellbore environments. Typically duct **203** in a fiber optic tube **211** is a metallic material, and in some embodiments, duct **203** comprises metal materials such as Inconel™, stainless steel, or Hasetloy™. While fiber optic tubes manufactured by any method may be used in the present invention, laser welded fiber optic tubes are preferred as the heat affected zone generated by laser welding is normally less than that generated by other methods such as TIG, thus reducing the possibility of damage to the optical fiber during welding.

[0026] While the dimensions of such fiber optic tubes are small (for example the diameter of such products commercially available from K-Tube, Inc of California, U.S.A. range from 0.5 mm to 3.5 mm), they have sufficient inner void space to accommodate multiple optical fibers. The small size of such fiber optic tubes is particularly useful in the present invention as they do not significantly deduct from the capacity of a tubular to accommodate fluids or create obstacles to other devices or equipment to be deployed in or through the tubular.

[0027] In some embodiments, fiber optic tube **211** comprises a duct **203** with an outer diameter of 0.071 inches to 0.125 inches (3.175 mm) formed around one or more optical fibers **201**. In a preferred embodiment, standard optical fibers are used, and duct **203** is no more than 0.020 inches (0.508 mm) thick. While the diameter of the optical fibers, the protective tube, and the thickness of the protective tube given here are exemplary, it is noteworthy that the inner diameter of the protective tube can be larger than needed for a close packing of the optical fibers.

[0028] In some embodiments of the present invention, fiber optic tube **211** may comprise multiple optical fibers may be disposed in a duct. In some applications, a particular downhole apparatus may have its own designated optical fiber, or each of a group of apparatuses may have

their own designated optical fiber within the fiber optic tube. In other applications, a series of apparatus may use a single optical fiber.

[0029] Referring now to **FIG 3**, a typical configuration for wellbore operations is shown in which coiled tubing **15** is suitable for use as tubular **105** in the present invention. Surface handling equipment includes an injector system **20** on supports **29** and coiled tubing reel assembly **10** on reel stand **12**, flat, trailer, truck or other such device. The tubing is deployed into or pulled out of the well using an injector head **19**. The equipment further includes a levelwind mechanism **13** for guiding coiled tubing **15** on and off the reel **10**. The coiled tubing **15** passes over tubing guide arch **18** which provides a bending radius for moving the tubing into a vertical orientation for injection through wellhead devices into the wellbore. The tubing passes from tubing guide arch **18** into the injector head **19** that grippingly engages the tubing and pushes it into the well. A stripper assembly **21** under the injector maintains a dynamic and static seal around the tubing to hold well pressure within the well as the tubing passes into the wellhead devices under well pressure. The coiled tubing then moves through a blowout preventor (BOP) stack **23**, a flow tee **25** and wellhead master valve or tree valve **27**. When coiled tubing **15** disposed on coiled tubing reel **10** is deployed into or retrieved from a borehole **8**, the coiled tubing reel **10** rotates.

[0030] Fiber optic tube **211** may be inserted into the coiled tubing **15** through any variety of means. One embodiment comprises attaching a hose to the reel **10** to the other end of which hose is attached a Y-joint. In this configuration, fiber optic tube **211** may be introduced into one leg of the Y and fluid pumped into the other leg. The drag force of the fluid on fiber optic tube **211** then propels the tube down the hose and into the reel **10**. It has been found, that in preferred embodiments wherein the outer diameter of the tether is less than 0.125 inches (3.175 mm), a pump rate as low as 1-5 barrels per minute (2.65 – 13.25 liters per second) is sufficient to propel the tether the full length of the coiled tubing even while it is spooled on the reel.

[0031] In the method and apparatus of the present invention, a fluid, such as gas or water, may be used to propel a fiber optic tube **211** in a tubular **105**. Typically, fiber optic tube **211** is disposed in an unrestrained manner in the pumped fluid. As the fluid is pumped into the tubular, the fiber optic tube is permitted to self-locate in the tubular without the use of external apparatus such as pigs for conveyance or placement or restricting anchors. In particular embodiments, the fluid is pumped and the fiber optic tube or tubes are deployed into coiled tubing while it said coiled tubing is configured in a spooled state on a reel. These embodiments provide logistical advantages as the fiber optic tube or tubes can be deployed into the coiled tubing at a manufacturing plant or other location remote from a wellsite. Thus the optical fiber equipped tubing of the present invention may be transported and field-deployed as a single apparatus, thereby reducing costs and simplifying operations.

[0032] The optical fiber equipped tubing **200** of the present invention may be used in conventional wellbore operations such as providing a stimulation fluid to a subterranean formation through coiled tubing. One advantage of the present invention is that fiber optic tube **211** tolerates exposure to various well treatment fluids that may be pumped into the coiled tubing; in particular, the fiber optic tube or tubes of the present invention can withstand abrasion by proppant or sand and exposure to corrosive fluids such as acids. Preferably the fiber optic tube is configured as a round tube having a smooth outer diameter, this configuration providing less opportunity for degradation and thus a longer useful life for the fiber optic tube.

[0033] The optical fiber equipped tubing of the present invention is useful to perform a variety of wellbore operation including determining a wellbore property and transmitting information from the wellbore. Determining includes, by way of example and not limitation, sensing using the optical fiber, sensing using a separate sensor, locating by a downhole apparatus, and confirming a configuration by a downhole apparatus. The optical fiber equipped tubing of the present invention may further comprise sensors such as fiber optic temperature and pressure sensors or electrical sensors coupled with electro-optical converters, disposed in a wellbore and linked to the surface via a fiber optic tube **211**. Wellbore conditions that are sensed may be

transmitted via fiber optic tube **211**. Data sensed by electrical sensors may be converted to analog or digital optical signals using pure digital or wavelength, intensity or polarization modulation and then provided to the optical fiber or fibers in fiber optic tube **211**. Alternatively, optical fiber **201** may sense some properties directly, for example when optical fiber **201** serves as a distributed temperature sensor or when optical fiber **201** comprises Fiber-Bragg grating and directly senses strain, stress, stretch, or pressure.

[0034] The information from the sensors or the property information sensed by optical fiber **201** may be communicated to the surface via fiber optic tube **211.** Similarly, signals or commands may be transmitted from the surface to a downhole sensor or apparatus via fiber optic tube **201.** In one embodiment of this invention, the surface communication includes a wireless telemetry link such as described in U.S. Patent Application No. 10/926,522, which is incorporated herein in its entirety by reference. In a further embodiment, the wireless telemetry apparatus may be mounted to the reel so that the optical signals can be transmitted while the reel is rotating without the need of a complicated optical collector apparatus. In yet a further embodiment, the wireless apparatus mounted to the reel may include additional optical connectors so that surface optical cables can be attached when the reel is not rotating.

[0035] It is to be appreciated that the embodiments of the invention described herein are given by way of example only, and that modifications and additional components can be provided to enhance the performance of the apparatus without deviating from the overall nature of the invention disclosed herein.

CLAIMS

What is claimed is:

1. An optical fiber equipped tubing comprising a fiber optic tube disposed within a tubular.

2. The tubing of claim 1 wherein the fiber optic tube comprises more than one optical fiber.

3. The tubing of claim 1 wherein the fiber optic tube comprises a duct comprising a metallic material.

4. The tubing of claim 1 wherein the tubular is coiled tubing.

5. The tubing of claim 4 wherein the coiled tubing is spooled on a reel.

6. The tubing of claim 4 wherein the coiled tubing is deployed in a wellbore.

7. The tubing of claim 1 wherein the fiber optic tube is internally pressurized.

8. The tubing of claim 1 wherein the fiber optic tube further contains an inert gas.

9. The tubing of claim 1 wherein the fiber optic tube further contains a gel.

10. A method of making an optical fiber equipped tubing comprising

pumping a fluid into a tubular; and

deploying a fiber optic tube into the fluid as pumped in the tubular, the tube having at least one optical fiber disposed therein,

wherein the flow of the pumped fluid propels the tube along the tubular.

11. The method of claim 10, wherein the tubular is coiled tubing.

12. The method of claim 11 wherein the fluid is pumped into the coiled tubing whilst the tubing is at least partially spooled on a reel.

13. The method of claim 11 wherein the fluid is pumped into the coiled tubing whilst the tubing is deployed in a wellbore.

14. The method of claim 10, wherein the at least one optical fiber is disposed in the fiber optic tube in an inert environment.

15. A method of communicating in a wellbore comprising
deploying an optical fiber equipped tubing into a wellbore, said tubing comprising a fiber optic tube having at least one optical fiber disposed therein, the fiber optic tubing being disposed in the tubing by fluid flow;
determining a property in the wellbore; and
transmitting the determined property via at least one of the optical fibers disposed in the fiber optic tubing.

16. The method of claim 15 wherein the property is determined by the least one optical fiber.

17. The method of claim 15 further comprising disposing at least one sensor in the wellbore, wherein at least one sensor determines the property.

18. The method of claim 15 wherein the determined property is transmitted from the wellbore to the surface.

19. The method of claim 15 further comprising deploying an apparatus into the wellbore and transmitting a signal to the apparatus via at least one of the optical fibers disposed in the fiber optic tubing.

20. The method of claim 15 wherein the tubing is coiled tubing and the step of deploying the tubing comprises unspooling the coiled tubing from a reel into the wellbore.

21. The method of claim 20 further comprising the step of retrieving the coiled tubing from the wellbore by spooling the coiled tubing onto the reel.

22. The method of claim 21 wherein the apparatus is conveyed on the tubing into the wellbore.

23. The method of claim 15, further comprising transmitting a signal from the surface via at least one of the optical fibers.

24. The method of claim 15 wherein the transmission includes wireless communication.

25. The method of claim 24 wherein said fiber optic tubing is disposed on a reel and a wireless apparatus is mounted on the reel.

26. The method of claim 15 wherein more than one optical fiber is disposed within the fiber optic tubing; and further comprising disposing more than one sensor in the wellbore, wherein at least two of the sensors determines a property, each determined property being transmitted on different ones of the optical fibers within the fiber optic tubing.

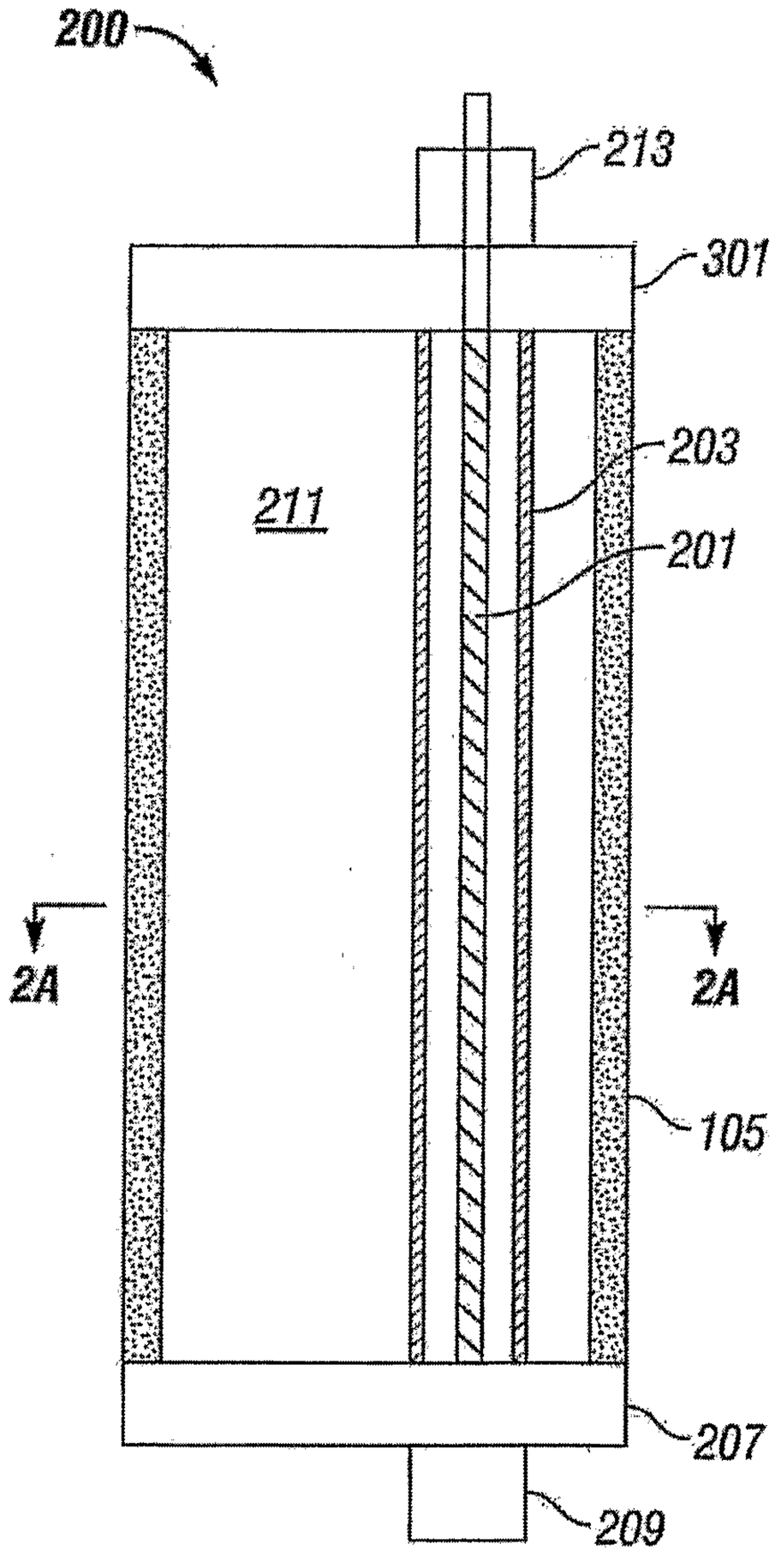


FIG. 1

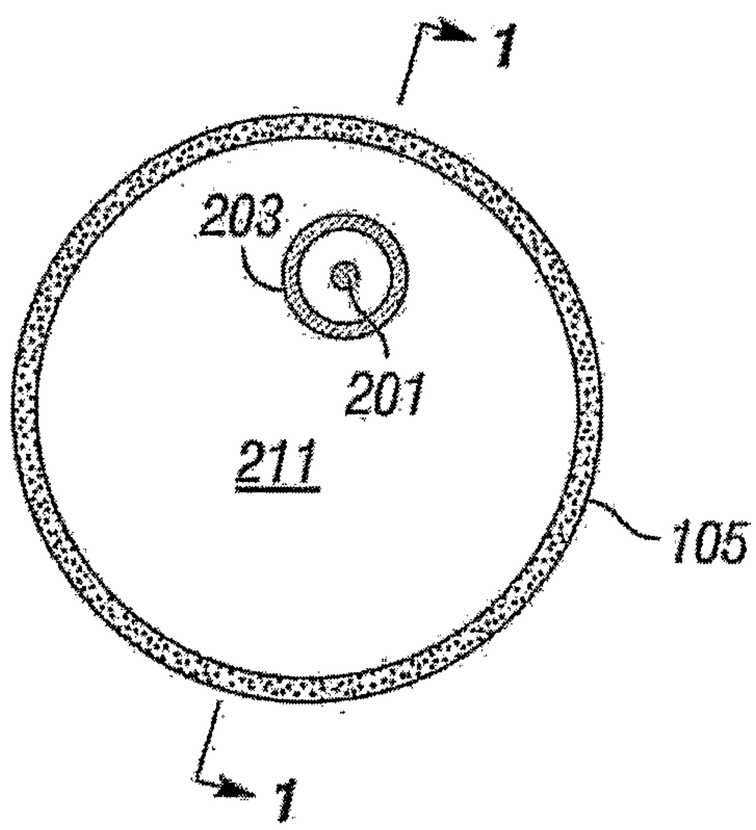


FIG. 2A

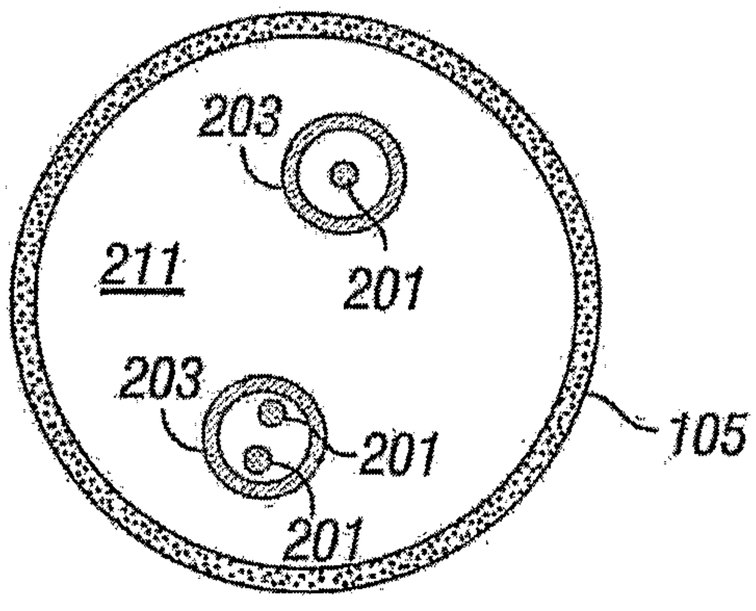


FIG. 2B

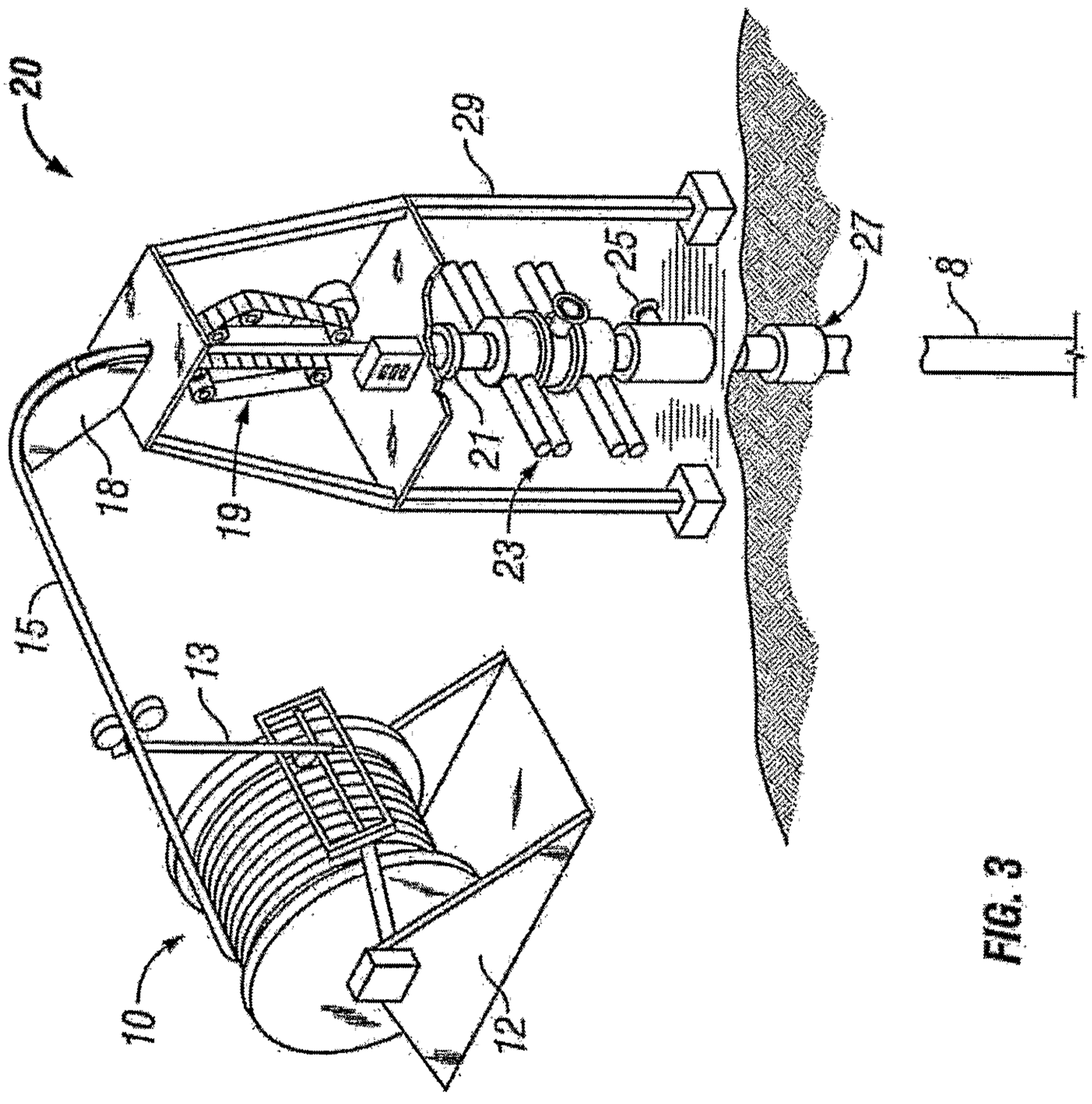
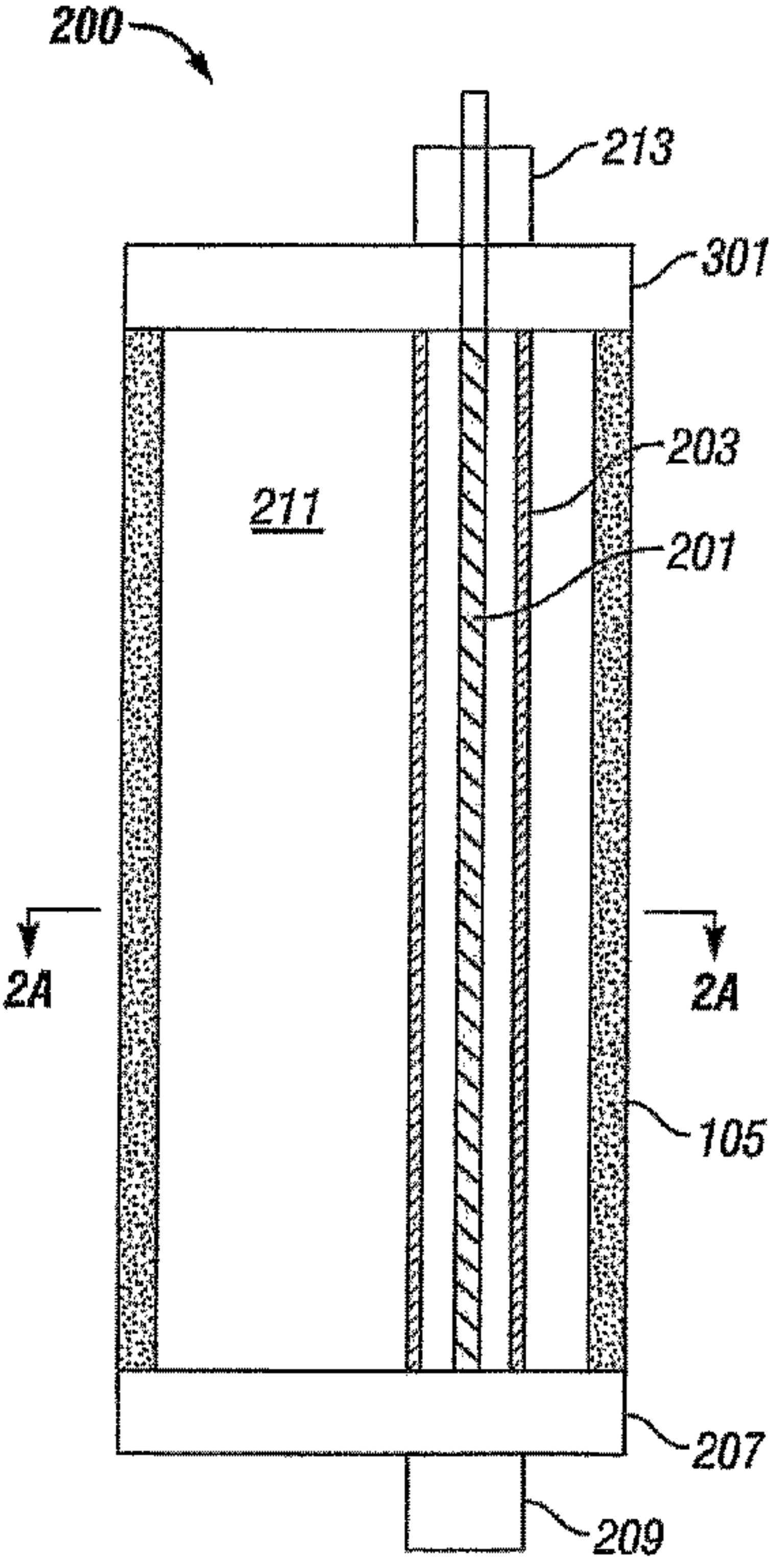


FIG. 3


200
213
301
203
211
201
2A
2A
105
207
209