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Señores

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
DIVISION DE NUEVAS CREACIONES

E. S. D.

SUPERINDUSTRIA Y COMERCIO
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Dependencia: 2000 DIVISION DE NUEVAS CREACIONES

REF: Expediente No.01 058.669- Solicitud de Patente
a favor de INTEVEP, S.A.

Titulada: APARATO Y MÉTODO PARA LLEVAR A CABO MEDICIONES
DE BARRENO

RAMIRO CASTRO DUQUE, vecino de Bogotá, portador de la tarjeta profesional No. 1003, obrando como apoderado de la sociedad INTEVEP, S.A., según lo acredita el documento de poder protocolizado en esa División bajo el No. 14558, me permito anexar al presente escrito los siguientes documentos:

1. Copia certificada por la Oficina de Patentes de Estados Unidos de la primera solicitud presentada para la misma invención, de la cual REIVINDICAMOS PRIORIDAD, junto con su correspondiente traducción del Inglés al castellano.
2. Documento donde consta la cesión del derecho a la Patente otorgado por los inventores al solicitante, debidamente apostillado.
3. Extracto para Publicación y Tarjeta de Archivo Temático.
4. Artes finales (2 de 12 cm X 12 cm y 1 de 6 cm X 6 cm).
5. Dibujos formales.

Del señor Jefe,



RAMIRO CASTRO DUQUE
C.C. No. 170.322 de Bogotá
Código 340
Cra 7 No. 16-56 Piso 9

Bogotá, Octubre 09, 2001
CPB/hsr.

FOLIO 33: TARJETA ARCHIVO TEMATICO

FOLIO 34: EXTRACTO P/PUBLICACION

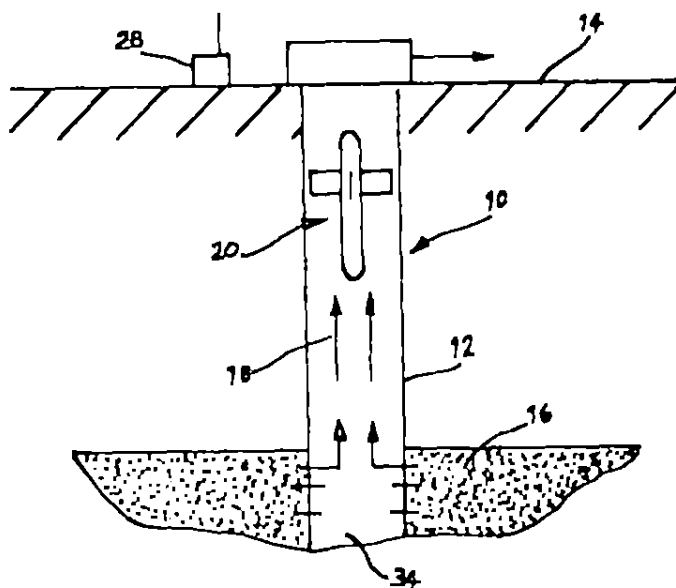


FIG. 1

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July 26, 2001

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APPLICATION NUMBER: 09/619,813
FILING DATE: July 20, 2000



By Authority of the
COMMISSIONER OF PATENTS AND TRADEMARKS

L. Edelen

L. EDELEN
Certifying Officer

07/20/00
10449 U.S. PTO

07-21-00

Case Docket No. 99-561

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THE COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

Sir:

Transmitted herewith for filing is the patent application of:

INVENTOR: AARON RANSON ET AL.

FOR: APPARATUS AND METHOD FOR PERFORMING DOWNHOLE MEASUREMENTS

Enclosed are:

- (XXX) 1 sheet of drawing(s).
- (XXX) An Assignment of the invention to INTEVEP, S.A.
- () A certified copy of _____ Application
No. _____, Filed _____.
- () Verified statement(s) to establish small entity status
under 37 CFR 1.9 and 37 CFR 1.27.
- () INFORMATION DISCLOSURE STATEMENT, LISTING OF PRIOR ART ON
FORM PTO 1449 AND COPIES.

The filing fee has been calculated as shown below:

	No. Filed	No. Extra	SMALL ENTITY		OTHER THAN A SMALL ENTITY	
			Rate	Fee	Rate	Fee
For Basic Fee				\$ 345		\$ 690
Total Claims	19	- 20 = 0	x 9	\$	x 18	\$ 0
Indep Claims	2	- 3 = 0	x 39	\$	x 78	\$
Multiple Dependent Claim 1) Presented			+135	\$	+270	\$
			TOTAL	\$	TOTAL	\$ 690

- () Please charge my Deposit Account No. 02-0184 in the amount of _____. A duplicate copy of this sheet is enclosed.
- (XX) A check in the amount of \$ 730.00 to cover the filing fee and the Assignment Recordal fee.
- (XX) The Commissioner is hereby authorized to charge payment of the following fees associated with this communication or credit any overpayment to Deposit Account No. 02-0184. A duplicate copy of this sheet is enclosed.
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 - (x) Any patent application processing fees under 37 CFR 1.17.
 - (x) Any filing fees under 37 CFR 1.16 for presentation of extra claims.

Date: 7/20/00

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on July 20, 2000

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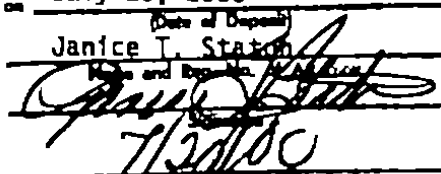
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APPLICATION FOR LETTERS PATENT

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT Aaron Ranson, Jose Zapico, Douglas A. Espin, and Mariela G. Araujo all citizens and residents of VENEZUELA, have invented certain new and useful improvements in APPARATUS AND METHOD FOR PERFORMING DOWNHOLE MEASUREMENTS for which the following is a specification.

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For early entry the correspondence is being
expedited with the United States Postal Service as
Express Mail in an envelope addressed to: Commissioner
of Patents and Trademarks, Washington, D.C. 20429
on July 20, 2000
(Date of Deposit)
Janice T. Statton
Name and Position of Agent

7/20/00
Date of Signature

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BACKGROUND OF THE INVENTION

The invention relates to an apparatus and method for performing a function in a flowing fluid and, more particularly, to a method and apparatus for performing downhole measurements and the like.

Oil and gas wells are drilled into oil and gas bearing formations so as to produce such oil and gas for use as fuel and numerous other products. In the course of such drilling and production, it is critical to obtain information as to the formations drilled through, as well as fluids within the well. Conventional methods for obtaining desirable information include core sampling from the well, measurement while drilling, logging while drilling and the like. These methods all provide critical information which is helpful in optimizing drilling and production activities.

Conventional equipment for obtaining this information includes electrical wiring and/or optical fiber in substantial lengths, for example equivalent to the depth of the well, and various other sensors and analytical equipment. This equipment creates substantial cost and in some cases can require re-completion of a well for installation, particularly to install sensors in appropriate positions.

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Conventional equipment is frequently accompanied by poor robustness or reliability, which leads to poor performance over time. Sensors and other equipment are frequently not reusable and are expensive to install and/or replace.

It is clear that the need remains for improved methods and equipment for obtaining downhole measurements.

It is therefore the primary object of the present invention to provide an apparatus for obtaining downhole measurements which addresses the foregoing disadvantages of the prior art.

It is a further object of the present invention to provide a method for obtaining downhole measurements.

Other objects and advantages of the present invention will appear hereinbelow.

SUMMARY OF THE INVENTION

In accordance with the present invention, the foregoing objects and advantages have been readily attained.

In accordance with the invention, an apparatus is provided for performing a function in a flowing fluid, which apparatus comprises an apparatus body and a drag member associated with said apparatus body and configurable between a drag configuration for moving with said fluid wherein said

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apparatus has a first drag, and a reduced drag configuration for moving against said fluid wherein said apparatus has a second drag which is less than said first drag.

In further accordance with the present invention, a method is provided for positioning an apparatus relative to a flowing fluid, which method comprises the steps of providing a flow of fluid; providing an apparatus comprising an apparatus body and a drag member associated with said apparatus body and configurable between a drag configuration having a first drag for moving with said flow of fluid and a reduced drag configuration having a second drag for moving against said flow of fluid wherein said second drag is less than said first drag; positioning said apparatus in said flow of fluid with said drag member in said reduced drag configuration whereby said apparatus moves against said flow of fluid; and configuring said drag member in said drag configuration whereby said apparatus moves with said flow of fluid.

The apparatus is advantageously provided with sensors for making desired measurements and can be controlled from a surface location.

BRIEF DESCRIPTION OF THE DRAWINGS

A detailed description of preferred embodiments of the present invention follows, with reference to the attached drawings, wherein:

Figure 1 schematically illustrates an oil well drilled to a producing formation and an apparatus positioned therein in accordance with the present invention;

Figure 2 illustrates an embodiment of the present invention in a reduced drag configuration for descending in a well;

Figure 3 illustrates an embodiment of the present invention in a drag configuration for moving upwardly in a well; and

Figure 4 illustrates a cycle path of use of the apparatus of the present invention for obtaining measurements along the depth of a well.

DETAILED DESCRIPTION

The invention relates to an apparatus and method for performing a function in a flowing fluid, and particularly to an apparatus and method for obtaining downhole measurements in a subterranean well environment.

In accordance with the present invention, an apparatus and a method for using the apparatus are provided which

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readily allow for obtaining various desirable measurements in a flowing fluid, for example in a producing oil and gas well, without the conventional disadvantages associated with utilizing equipment attached to wires such as conventional logs, and without the further disadvantages accompanied by installing permanent sensors in downhole locations.

Figure 1 schematically illustrates a typical oil producing well 10 which includes a production tubing 12 positioned from a surface location 14 to a subterranean formation 16 for producing fluid (schematically illustrated by arrows 18) from formation 16 to surface location 14 as desired. Figure 1 also illustrates apparatus 20 in accordance with the invention which can advantageously be positioned within production tubing 12 and configured to travel from surface location 14 to deeper locations within production tubing 12, and back to surface location 14 when desired. Apparatus 20 can be utilized to obtain any and all desired measurements from various downhole locations along production tubing 12 as desired. It should of course be appreciated that apparatus 20 is shown in Figure 1 with exaggerated size so as to better illustrate the present invention.

Turning to Figures 2 and 3, apparatus 20 in accordance with the present invention is further illustrated.

Apparatus 20 in accordance with the present invention preferably includes an apparatus body 22 for housing the various desired components of apparatus 20 as will be further discussed below. Apparatus body 22 is preferably a substantially elongate member having a longitudinal axis. The exterior surface of apparatus body 22 is preferably designed so as to provide a minimum amount of drag to fluids flowing past apparatus 20, or through which apparatus 20 is moving. For example, body 22 may be substantially cylindrical with tapered or rounded ends. Of course, other shapes are also suitable.

Apparatus 20 also includes a drag member 24 which is configurable between a drag configuration (illustrated in Figure 3) and a reduced drag configuration (illustrated in Figure 2). This is further described below.

In a producing well, fluids being produced typically include hydrocarbons, water and any other materials which might be encountered in the particular subterranean formation from which fluids are produced. These fluids flow upwardly through production tubing 12 to surface location 14 as desired. This flow may be driven by pressure within formation 16, and/or various other additional forces such as pumps, gas lift, and the like. In accordance with the present invention, apparatus 20 is adapted and configured

such that, in the reduced drag configuration of Figure 2, the force of gravity is sufficient to pull apparatus 20 downwardly through the upwardly flowing fluid so as to move apparatus 20 against the flow of fluid and in a downward direction within production tubing 12 to deeper locations in the well. This advantageously allows apparatus 20 to be positioned at downhole locations as desired.

When it is desired to return apparatus 20 to the surface, drag member 24 is configured to the drag configuration of Figure 3, which has increased drag as compared to the reduced drag configuration, and which results in the drag force applied by upwardly flowing fluid overcoming the force of gravity and lifting apparatus 20 through production tubing 12 toward surface location 14 as desired. This advantageously allows for apparatus 20 to be positioned at any desired downhole location along production tubing 12, within flowing fluid 18, so as to obtain any desired measurements and the like without the need for conventional logging equipment and/or permanently installed sensors.

Drag member 24 in accordance with the present invention may advantageously be provided as a plurality of substantially planar members 26 which can be positioned substantially parallel to the longitudinal axis of apparatus

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body 22 as shown in Figure 2 so as to provide for a reduced drag configuration. In this configuration, the force of gravity G overcomes the drag of upwardly flowing fluid 18 resulting in downward motion D of apparatus 20 as desired. Planar members 26 can be configured or positioned, in this case through rotation, to a substantially horizontal position with respect to the longitudinal axis of apparatus body 22 as shown in Figure 3 so as to provide an increased drag configuration wherein the force of upwardly flowing fluid 18 overcomes the force of gravity G resulting in upward motion U as shown in Figure 3.

Positioning of drag member 24 between the drag configuration of Figure 3 and the reduced drag configuration of Figure 2 may advantageously be accomplished from a remote location, for example using a preferably wireless control member or transmitter 28 (see Figure 1) positioned at surface location 14 for issuing commands to apparatus 20. Commands can be received, for example through a receiver 30 on apparatus 20, for actuating a motor or motors (not shown) within apparatus body 22 for rotating planar members 26 between the desired positions.

Figure 2 and 3 illustrate planar members 26 positioned in a vertical position (Figure 2) and in a horizontal position (Figure 3) representing the minimum and maximum

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drag positions, respectively. It should be appreciated that planar member 26 could be partially pivoted between the positions of Figures 2 and 3 so as to obtain an intermediate drag position which could be utilized, in combination with a sensor for detecting speed of movement within production tubing 12, to allow for obtaining an equilibrium position wherein apparatus 20 maintains substantially the same position within production tubing 12 for example if a particular measurement must be taken that requires being stationary at a particular level in the well for an extended length of time. By monitoring speed and position of apparatus 20, and adjusting drag member 24 appropriately, apparatus 20 can be positioned to any location within a well, and returned to the surface when desired. Further, the speed of descent and ascent can be controlled by changing the angle of the drag member to increase or decrease drag.

As set forth above, it is a particular advantage of the present invention to be able to obtain various desirable downhole measurements without the need for conventional equipment such as fixed installation sensors and/or wired or otherwise connected devices. Thus, apparatus 20 is typically provided having one or more sensors or other analytical devices positioned on or within body 20 as

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schematically illustrated at 32 for example to obtain measurements of desired conditions. Such conditions may be fluid related conditions including pressure, temperature, density, viscosity, water content, composition, multiphase flow and the like. Additional information which may be desirable to obtain utilizing sensors 32 includes speed of movement of apparatus 20, position of apparatus 20 within production tubing 12, proximity of bottom 34 of well 10, and the like. The actual structure and/or circuitry of such sensors is well known to a person of ordinary skill in the art and is therefore not described herein.

Apparatus 20 in accordance with the present invention includes various electronic devices as described above. Such devices includes sensor 32 and one or more motors (not shown) for driving planar members 36 of drag member 24. A power source for these devices is preferably provided in the form of a rechargeable battery 34, which can ideally be positioned within apparatus body 22. Battery 34 may advantageously be rechargeable such that apparatus 20 can be recharged once it is retrieved at surface location 14. In accordance with a further preferred embodiment of the present invention, apparatus 20 may be provided having a fluid actuated charger or generator 36 operatively associated with rechargeable battery 34 and exposed to

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flowing fluid 18 within production tubing 12 so as to allow for potentially continuous recharging of battery member 34 if desired. The specific components and circuitry of battery 34 and charger 36 are also well known to a person of ordinary skill in the art and are therefore not included herein. For example, drag member 24 could be adapted to convert fluid momentum into rotation of drag member 24 as shown in Fig. 3. This rotation relative to the rest of apparatus 20 could be used to operate charger/generator 36. In this embodiment, stabilizing fins or other structure may be desired to prevent rotation of body 22 along with drag member 24. Of course, other configurations and structures could likewise be used to convert fluid momentum into stored energy for operating apparatus 20 as desired.

Apparatus 20 may advantageously be provided with a control member programmed to provide for particular desirable functions. For example, apparatus 20 may include a control member programmed to sense when battery 34 has reached a low power state at which point drag member 24 could be automatically positioned to the drag position of Figure 3 so as to allow for recovery of apparatus 20 at surface location 14 and recharging of battery 34 and the like.

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The control member may also advantageously be adapted to utilize particular information received by sensors 32 to enhance the downhole measurement ability of apparatus 20. For example, the control member of apparatus 20 may be adapted so as to detect the approach of the bottom 34 of production tubing 12 so that drag member 24 can be properly positioned to increase drag and slow descent of apparatus 20, thereby avoiding a potentially damaging collision with bottom 34 of production tubing 12.

Still further, the control member of apparatus 20 may advantageously be adapted so as to detect abnormalities in one or more fluid conditions and automatically configure drag member 24 to remain at the particular location for an extended period of time obtain additional measurements.

Apparatus 20 may also be provided with capacity for carrying one or more additives such as cement for local repairs, plugging material for selectively closing off one or more zones, or any other material which could advantageously be deployed within production tubing 12 by apparatus 20 if desired. In this embodiment, the control member for apparatus 20 would of course control deployment of such material as well.

In accordance with the present invention, apparatus 20 is provided which is configurable to positions which

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increase and decrease the drag coefficient at the fluid-body interface between apparatus body 22 and flowing fluid 18. The total time-averaged force (F_D) exerted by the flow on an object can be written in a dimensionless manner, utilizing frontal area (A) of the object, as follows:

$$C_D = \frac{F_D / A}{\frac{1}{2} \rho V^2}$$

wherein C_D is the drag coefficient and V is fluid velocity.

In the embodiment of Figures 2 and 3, drag member 24 operates by increasing and decreasing area A as well as changing local geometry which thereby adjusts the drag coefficient C_D .

Through this manipulation, apparatus 20 can be configured to move downwardly within production tubing 12 by the force of gravity, and can be configured to move upwardly with flow 18, utilizing energy provided by flow 18 on drag member 24.

Apparatus 20 in accordance with the present invention will typically be exposed to conditions including temperatures between about 20°C and about 350°C and pressures between about 100 psi and about 25000 psi. It is therefore preferable that apparatus body 22 be selected so as to withstand such conditions, and further that components

within apparatus body 22 be selected so as to withstand such conditions.

It should also readily be appreciated that communication between apparatus 20 and surface location 12 is accomplished utilizing wireless communications, thereby providing a marked improvement over conventional systems utilizing hardwiring and/or optical cables.

Further, apparatus 20 in accordance with the present invention operates utilizing extremely low energy consumption, and can preferably be provided so as to recharge during use utilizing energy from the fluid.

A typical cycle for use of apparatus 20 in accordance with the present invention will now be described.

Use may typically be commenced by introducing apparatus 20 into well 10 utilizing a "lubricator" or any other port which is suitable for introducing apparatus 20 into production tubing 12 from surface location 14. Once apparatus 20 is within production tubing 12, communication is established between apparatus 20 and control member 28. A diagnostic may then advantageously be performed so as to insure all systems of apparatus 20 are functioning.

Assuming that the diagnostic does not indicate any problems, drag member 24 may advantageously be configured to the reduced drag configuration of Figure 2 and apparatus 20

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will begin a smooth falling motion through upwardly flowing fluid 18 as desired. Figure 4 illustrates schematically a cycle path with vertical position of apparatus 20 plotted over time, and various tasks being accomplished along the way. While apparatus 20 is travelling, various measurements are being taken including those which may be automatically programmed and those which may be requested by an operator at surface location 14. Apparatus 20 is preferably adapted to continuously monitor acceleration so as to maintain speed and acceleration below levels which could cause damage upon impact with production tubing 12 and other well equipment.

Information obtained by apparatus 20 may be stored within apparatus 20, for example in local memory, and/or may be transmitted to control member 28 at surface location 14.

During descent, should any abnormal situation be detected, apparatus 20 may be programmed and/or instructed to take an appropriate action. For example, as illustrated at point 38 in Figure 4, it may be desirable to slow or stop descent of apparatus 20 in production tubing 12 so as to perform a further specific measurement task and the like. Upon completion, drag member 24 can again be configured to the reduced drag configuration so as to continue descent as illustrated. Upon reaching a further downhole point, for example point 40 as illustrated in Figure 4, an additional

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task may be performed. Further, if it is now detected that apparatus 20 has reached a close proximity to the bottom of the well, apparatus 20 may advantageously be configured to the drag position of Figure 3 for ascent through production tubing 12 back to surface location 14 as desired.

It should be readily appreciated that apparatus 20 and the use of same provide for substantial advantages as compared to conventional systems and methods for obtaining downhole measurements. Specifically, apparatus 20 avoids the need for permanent installations downhole, and also avoids the need for wired connections or optical connections extended over substantial lengths such as the entire depth of a well and the like.

It is to be understood that the invention is not limited to the illustrations described and shown herein, which are deemed to be merely illustrative of the best modes of carrying out the invention, and which are susceptible of modification of form, size, arrangement of parts and details of operation. The invention rather is intended to encompass all such modifications which are within its spirit and scope as defined by the claims.

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WHAT IS CLAIMED IS:

1. An apparatus for performing a function in a flowing fluid, comprising:

an apparatus body; and

a drag member associated with said apparatus body and configurable between a drag configuration for moving with said fluid wherein said apparatus has a first drag and a reduced drag configuration for moving against said fluid wherein said apparatus has a second drag which is less than said first drag.

2. The apparatus according to claim 1, wherein said apparatus body comprises an elongated member having a longitudinal axis, and wherein said drag member comprises a substantially planar member having a planar surface positionable relative to said apparatus body between said drag configuration wherein said planar surface is substantially perpendicular to said axis and said reduced drag configuration wherein said planar surface is substantially parallel to said axis.

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3. The apparatus according to claim 1, further comprising a control member remotely associated with said drag member for configuring said drag member between said drag configuration and said reduced drag configuration.

4. The apparatus according to claim 1, further comprising a rechargeable power source within said apparatus body and a fluid actuated charger positioned on said apparatus body for charging said power source when said apparatus is exposed to said flowing fluid.

5. The apparatus according to claim 1, further comprising a sensor member mounted relative to said apparatus body for sensing at least one condition of said flowing fluid selected from the group consisting of pressure, temperature, density, viscosity, water content, composition and multiphase flow.

6. The apparatus according to claim 5, further comprising a transmitter member mounted to said apparatus body and a receiver positioned remotely relative to said apparatus body, said transmitter being adapted for transmitting said at least one condition to said receiver.

7. The apparatus according to claim 5, further comprising a storage member mounted to said apparatus body for storing said at least one condition.

8. The apparatus according to claim 1, further comprising a position sensor member mounted to said apparatus body for sensing position of said apparatus.

9. The apparatus according to claim 1, wherein said drag member is configurable to at least one partial drag configuration between said drag configuration and said reduced drag configuration whereby drag relative to said fluid can be adjusted.

10. A method for positioning an apparatus relative to a flowing fluid, comprising the steps of:

providing a flow of fluid;

providing an apparatus comprising an apparatus body and a drag member associated with said apparatus body and configurable between a drag configuration having a first drag for moving with said flow of fluid and a reduced drag configuration having a second drag for moving against said flow of fluid wherein said second drag is less than said first drag;

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positioning said apparatus in said flow of fluid with said drag member in said reduced drag configuration whereby said apparatus moves against said flow of fluid; and

configuring said drag member in said drag configuration whereby said apparatus moves with said flow of fluid.

11. The method according to claim 10, wherein said flow of fluid is a substantially vertical flow of fluid.

12. The method according to claim 10, wherein said flow of fluid is in a directional substantially opposite to gravitational forces on said apparatus.

13. The method according to claim 10, wherein said flow of fluid is in a well producing fluid from a subterranean formation to a surface location.

14. The method according to claim 13, further comprising controlling configuration of said drag member from said surface location when said apparatus is in said well.

15. The method according to claim 13, further comprising the step of measuring, with said apparatus, at least one condition of said flowing fluid selected from the group consisting of pressure, temperature, density, viscosity, water content, composition and multiphase flow.

16. The method according to claim 15, further comprising the step of transmitting said at least one condition from said apparatus in said well to said surface location.

17. The method according to claim 10, further comprising the step of measuring, with said apparatus, at least one condition of said flowing fluid selected from the group consisting of pressure, temperature, density, viscosity, water content, composition and multiphase flow.

18. The method according to claim 17, further comprising the step of storing said at least one condition in said apparatus.

19. The method according to claim 10, further comprising the step of detecting with said apparatus a position of said apparatus relative to said flow of fluid.

ABSTRACT OF THE DISCLOSURE

An apparatus for performing a function in a flowing fluid includes an apparatus body and a drag member associated with the apparatus body and configurable between drag configuration for moving with the fluid wherein the apparatus has a first drag and a reduced drag configuration for moving against the fluid wherein the apparatus has a second drag which is less than the first drag.

Practitioner's Docket No. 99-561 **PATENT**

COMBINED DECLARATION AND POWER OF ATTORNEY
(ORIGINAL, DESIGN, NATIONAL STAGE OF PCT, SUPPLEMENTAL, DIVISIONAL,
CONTINUATION, OR C-I-P)

As a below named inventor, I hereby declare that:

TYPE OF DECLARATION

This declaration is of the following type:

(check one applicable item below)

- ☒ original.
☐ design.
☐ supplemental.

NOTE: If the declaration is for an International Application being filed as a divisional, continuation or continuation-in-part application, do not check next item; check appropriate one of last three items.

- ☐ national stage of PCT.

NOTE: If one of the following 3 items apply, then complete and also attach ADDED PAGES FOR DIVISIONAL, CONTINUATION OR C-I-P.

NOTE: See 37 C.F.R. § 1.53(c) (continued prosecution application) for use of a prior nonprovisional application declaration in the continuation or divisional application being filed on behalf of the same or fewer of the inventors named in the prior application.

- ☐ divisional.
☐ continuation.

NOTE: Where an application discloses and claims subject matter not disclosed in the prior application, or a continuation or divisional application names an inventor not named in the prior application, a continuation-in-part application must be filed under 37 C.F.R. § 1.53(b) (application filing requirements — nonprovisional application).

- ☐ continuation-in-part (C-I-P).

INVENTORSHIP IDENTIFICATION

WARNING: If the inventors are each not the inventors of all the claims, an explanation of the facts, including the ownership of all the claims at the time the last claimed invention was made, should be submitted.

My residence, post office address and citizenship are as stated below, next to my name. I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter that is claimed, and for which a patent is sought on the invention entitled:

TITLE OF INVENTION

APPARATUS AND METHOD FOR PERFORMING DOWNHOLE MEASUREMENTS

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SPECIFICATION IDENTIFICATION

the specification of which:

(complete (a), (b), or (c))

(a) ☒ is attached hereto.

NOTE: The following combinations of information supplied in an oath or declaration filed on the application filing date with a specification are acceptable as minimums for identifying a specification and compliance with any one of the items below will be accepted as complying with the identification requirement of 37 CFR 1.53:

"(1) name of inventor(s), and reference to an attached specification which is both attached to the oath or declaration at the time of execution and submitted with the oath or declaration on filing;

"(2) name of inventor(s), and attorney docket number which was on the specification as filed; or

"(3) name of inventor(s), and title which was on the specification as filed."

Notice of July 13, 1986 (T177 O.G. 63).

(b) ☐ was filed on _____, as ☐ Serial No. 0 / _____
or ☐ _____
and was amended on _____ (if applicable).

NOTE: Amendments filed after the original papers are deposited with the PTO that contain new matter are not accorded a filing date by being referred to in the declaration. Accordingly, the amendments involved are those filed with the application papers or, in the case of a supplemental declaration, are those amendments claiming matter not encompassed in the original statement of invention or claims. See 37 C.F.R. § 1.57.

NOTE: The following combinations of information supplied in an oath or declaration filed after the filing date are acceptable as minimums for identifying a specification and compliance with any one of the items below will be accepted as complying with the identification requirement of 37 CFR 1.53:

"(A) application number (consisting of the series code and the serial number, e.g., 08/123,456);

"(B) serial number and filing date;

"(C) attorney docket number which was on the specification as filed;

"(D) title which was on the specification as filed and reference to an attached specification which is both attached to the oath or declaration at the time of execution and submitted with the oath or declaration; or

"(E) title which was on the specification as filed and accompanied by a cover letter accurately identifying the application for which it was intended by either the application number (consisting of the series code and the serial number, e.g., 08/123,456), or serial number and filing date. Absent any statement(s) to the contrary, it will be presumed that the application filed in the PTO is the application which the inventor(s) executed by signing the oath or declaration."

M.P.E.P. § 601.01(a), 7th Ed.

(c) ☐ was described and claimed in PCT International Application No. _____, filed on _____ and was amended under PCT Article 19 on _____ (if any).

Declaration and Power of Attorney [1-1]—page 2 of 7)

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SUPPLEMENTAL DECLARATION (37 C.F.R. § 1.67(b))

(complete the following where a supplemental declaration is being submitted)

- ☐ I hereby declare that the subject matter of the
- ☐ attached amendment
 - ☐ amendment filed on _____

was part of my/our invention and was invented before the filing date of the original application, above-identified, for such invention.

ACKNOWLEDGEMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information, which is material to patentability as defined in 37, Code of Federal Regulations, § 1.56,

(also check the following items, if desired)

- ☒ and which is material to the examination of this application, namely, information where there is a substantial likelihood that a reasonable Examiner would consider it important in deciding whether to allow the application to issue as a patent, and
- ☐ In compliance with this duty, there is attached an information disclosure statement, in accordance with 37 C.F.R. § 1.98.

PRIORITY CLAIM (35 U.S.C. §§ 119(a)-(d))

NOTE: "The claim to priority need be in no special form and may be made by the attorney or agent if the foreign application is referred to in the oath or declaration as required by § 1.63. The claim for priority and the certified copy of the foreign application specified in 35 U.S.C. 119(b) must be filed in the case of an interference (§ 1.832), when necessary to overcome the date of a reference relied upon by the examiner, when specifically required by the examiner, and in all other situations, before the patent is granted. If the claim for priority or the certified copy of the foreign application is filed after the date the issue fee is paid, it must be accompanied by a petition requesting entry and by the fee set forth in § 1.170. If the certified copy is not in the English language, a translation need not be filed except in the case of interference; or when necessary to overcome the date of a reference relied upon by the examiner, or when specifically required by the examiner, in which event an English language translation must be filed together with a statement that the translation of the certified copy is accurate." 37 C.F.R. § 1.832(d).

I hereby claim foreign priority benefits under Title 35, United States Code, §§ 119(a)-(d) of any foreign application(s) for patent or inventor's certificate or of any PCT International application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT International application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

(complete (a) or (b))

- (d) ☒ no such applications have been filed.
- (a) ☐ such applications have been filed as follows:

NOTE: Where item (a) is entered above and the International Application which designated the U.S. itself claimed priority check here (a), enter the details below and make the priority claim.

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**PRIOR FOREIGN/PCT APPLICATION(S) FILED WITHIN 12 MONTHS
(6 MONTHS FOR DESIGN) PRIOR TO THIS APPLICATION
AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119(a)-(d)**

COUNTRY (OR INDICATE IF PCT)	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 37 USC 119
			☐ YES NO ☐
			☐ YES NO ☐
			☐ YES NO ☐
			☐ YES NO ☐
			☐ YES NO ☐

**CLAIM FOR BENEFIT OF PRIOR U.S. PROVISIONAL APPLICATION(S)
(34 U.S.C. § 119(e))**

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below:

PROVISIONAL APPLICATION NUMBER

FILING DATE

____ / _____
____ / _____
____ / _____

**CLAIM FOR BENEFIT OF EARLIER US/PCT APPLICATION(S)
UNDER 35 U.S.C. § 120**

- ☐ The claim for the benefit of any such applications are set forth in the attached ADDED PAGES TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR DIVISIONAL, CONTINUATION OR CONTINUATION-IN-PART (C+P) APPLICATION.

(Declaration and Power of Attorney [1-1]—page 4 of 7)

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ALL FOREIGN APPLICATION(S), IF ANY, FILED MORE THAN 12 MONTHS
(6 MONTHS FOR DESIGN) PRIOR TO THIS U.S. APPLICATION

NOTE: If the application filed more than 12 months from the filing date of this application is a PCT filing forming the basis for this application entering the United States as (1) the national stage, or (2) a continuation, divisional, or continuation-in-part, then also complete ADDED PAGES TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR DIVISIONAL, CONTINUATION OR C-IP APPLICATION for benefit of the prior U.S. or PCT application(s) under 35 U.S.C. § 122.

POWER OF ATTORNEY

I hereby appoint the following practitioner(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

(list name and registration number)

Robert H. Bachman (19,374); Gregory P. LaPointe (28,385); Barry L. Kelmacher (28,889) and George A. Coury (34,309)

(check the following item, if applicable)

- ☐ I hereby appoint the practitioner(s) associated with the Customer Number provided below to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.
- ☐ Attached, as part of this declaration and power of attorney, is the authorization of the above-named practitioner(s) to accept and follow instructions from my representative(s).

SEND CORRESPONDENCE TO

DIRECT TELEPHONE CALLS TO:
(Name and telephone number)

☒ Address

BACHMAN & LAPOINTE, P.C.
900 Chapel Street
Suite 1201
New Haven, CT 06510-2802

GREGORY P. LAPOINTE
Ext. 111

☐ Customer Number _____

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DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

SIGNATURE(S)

NOTE: Carefully indicate the family (or last) name, as it should appear on the filing receipt and all other documents.

NOTE: Each inventor must be identified by full name, including the family name, and at least one given name without abbreviation together with any other given names or initial, and by his/her residence, post office address and country of citizenship. 37 CFR § 1.634(c).

NOTE: Inventors may execute separate declarations/oaths provided each declaration/oath sets forth all the inventors. Section 1.634(c) requires that a declaration/oath, inter alia, identify each inventor and prohibits the execution of separate declarations/oaths which each sets forth only the name of the executing inventor. 62 Fed. Reg. 63,131, 63,142, October 10, 1997.

Full name of sole or first inventor

Aaron
(GIVEN NAME)

RENSON
(MIDDLE INITIAL OR NAME)

Renson
(FAMILY (OR LAST) NAME)

Inventor's signature

[Signature]

Date 06/28/2000

Country of Citizenship

Venezuela

Residence Calle JAZ-ROS, LA ARBOLEDA, SAN ANTONIO, FORMER MIRA VENEZUELA

Post Office Address Apto. 76343, CARACAS 1070A VENEZUELA.

Full name of second joint inventor, if any

JOSE
(GIVEN NAME)

[Signature]
(MIDDLE INITIAL OR NAME)

2APICO
(FAMILY (OR LAST) NAME)

Inventor's signature

[Signature]

Date 06/28/2000

Country of Citizenship

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Full name of third joint inventor, if any

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A.
(MIDDLE INITIAL OR NAME)

ESPIN
(FAMILY (OR LAST) NAME)

Inventor's signature

[Signature]

Date 06/28/2000

Country of Citizenship

VENEZUELAN

Residence Calle Yance, San Ciriaco, Maracay, Caracas, Venezuela.

Post Office Address Apdo. 76343, Caracas 1070A

VENEZUELA

(Declaration and Power of Attorney [1-3]—page 8 of 7)

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(check proper box(es) for any of the following added page(s)
that form a part of this declaration)

☒ Signature for fourth and subsequent joint inventors. Number of pages added
One

. . .

☐ Signature by administrator(trib), executor(trib) or legal representative for deceased or incapacitated inventor. Number of pages added _____

. . .

☐ Signature for inventor who refuses to sign or cannot be reached by person authorized under 37 CFR 1.47. Number of pages added _____

. . .

☐ Added page for signature by one joint inventor on behalf of deceased inventor(s) where legal representative cannot be appointed in time. (37 CFR 1.47)

. . .

☐ Added pages to combined declaration and power of attorney for divisional, continuation, or continuation-in-part (C-I-P) application.

☐ Number of pages added _____

. . .

☐ Authorization of practitioner(s) to accept and follow instructions from representative.

. . .

(If no further pages form a part of this Declaration,
then end this Declaration with this page and check the following item)

☐ This declaration ends with this page.

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ADDED PAGE TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR SIGNATURE BY FOURTH AND SUBSEQUENT INVENTORS

Full name of fourth joint inventor, if any

Mariela G. Araujo
(GIVEN NAME) (MIDDLE INITIAL OR NAME) (FAMILY FOR LAST NAME)

Inventor's signature Mariela Araujo

Date 06/14/2000 Country of Citizenship Venezuela

Residence Conf. Res. Trebol Hills. Apto B-PBC. San Antonio. Venezuela

Post Office Address Apartado 74343. Caracas 1070A
Venezuela

Full name of fifth joint inventor, if any

(GIVEN NAME) (MIDDLE INITIAL OR NAME) (FAMILY FOR LAST NAME)

Inventor's signature _____

Date _____ Country of Citizenship _____

Residence _____

Post Office Address _____

Full name of sixth joint inventor, if any

(GIVEN NAME) (MIDDLE INITIAL OR NAME) (FAMILY FOR LAST NAME)

Inventor's signature _____

Date _____ Country of Citizenship _____

Residence _____

Post Office Address _____

Full name of seventh inventor, if any

(GIVEN NAME) (MIDDLE INITIAL OR NAME) (FAMILY FOR LAST NAME)

Inventor's signature _____

Date _____ Country of Citizenship _____

Residence _____

Post Office Address _____

Added Page to Combined Declaration and Power of Attorney for Signature by Fourth and Subsequent Inventors (1-2)

000270-ET86T960

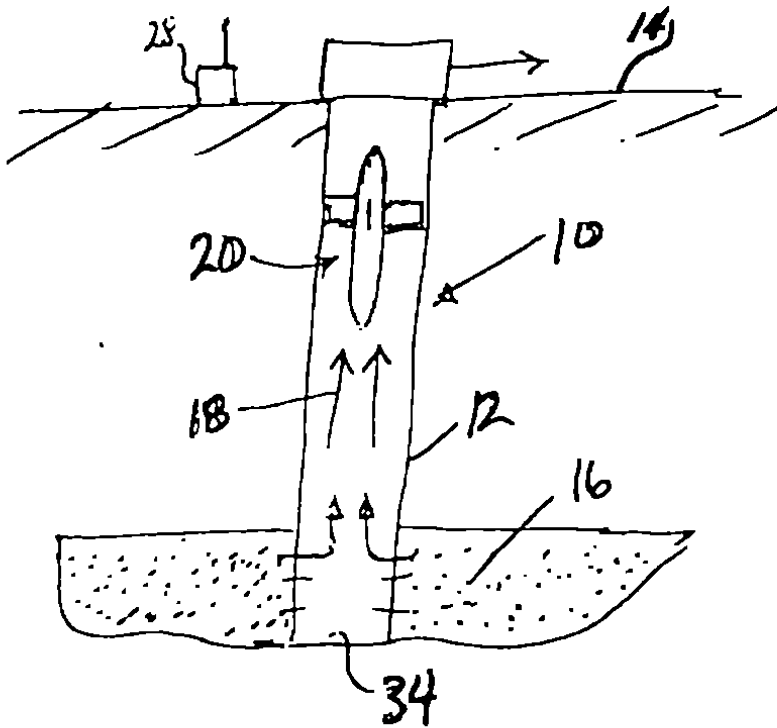


FIG. 1

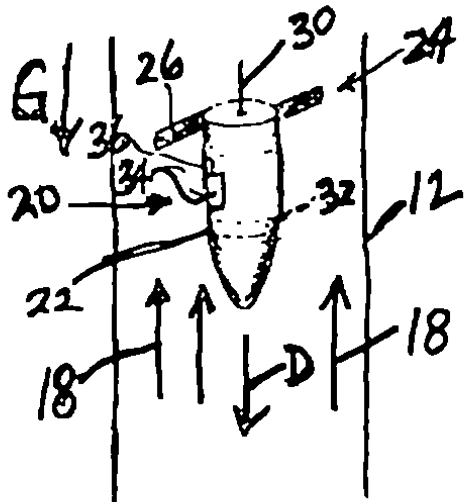


FIG. 2

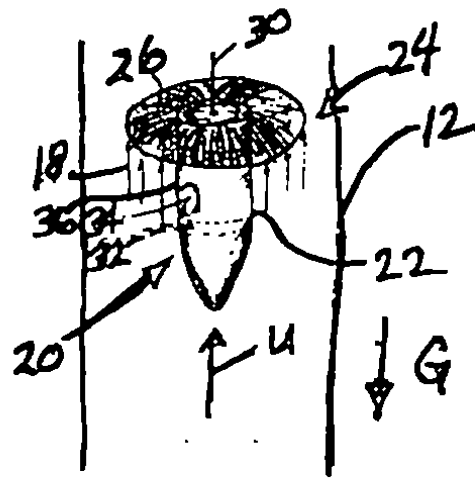


FIG. 3

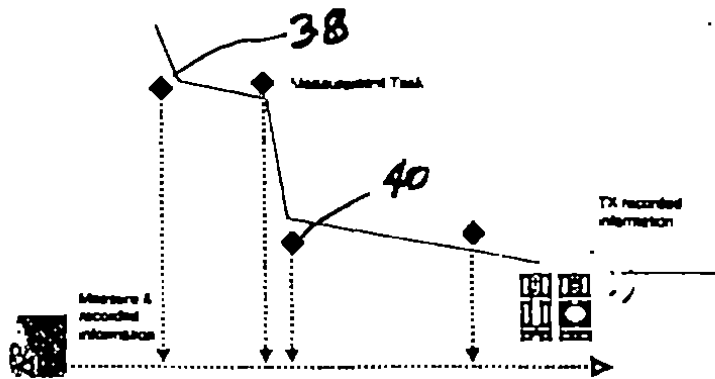


FIG. 4

TRADUCCIÓN DEL INGLÉS AL CASTELLANO de la Solicitud de
Patente de los Estados Unidos No.09/619,813 relacionada con:

APARATO Y MÉTODO PARA REALIZAR MEDICIONES DE
BARRENO

ANEXOS. La Solicitud de Patente de los Estados Unidos Serie No.09/
619,813 arriba mencionada, Declaración y Poder, Solicitud de Patente,
Certificación del Comisionado de Patentes y Marcas de los Estados
Unidos de América.

LOS ESTADOS UNIDOS DE AMÉRICA

DEPARTAMENTO DE COMERCIO DE LOS ESTADOS UNIDOS DE
AMÉRICA

Oficina de Patentes y Marcas de los Estados Unidos

Julio 26, 2001

ESTE PARA CERTIFICAR QUE ANEXO AL PRESENTE SE
ENCUENTRA UNA FIEL COPIA TOMADA DE LOS REGISTROS DE
LA OFICINA DE PATENTES Y MARCAS DE LOS ESTADOS
UNIDOS DE AQUELLOS DOCUMENTOS DE LA SOLICITUD DE
PATENTE IDENTIFICADA ABAJO LA CUAL CUMPLE LOS
REQUISITOS PARA CONCEDERLE UNA FECHA DE
PRESENTACIÓN BAJO LA NORMA 35USC 111.

NUMERO DE SOLICITUD: 09/619,813
FECHA DE PRESENTACION: Julio 20, 2000

Por autorización del
COMISIONADO DE PATENTES Y MARCAS
L. Edelen (Firmado)
L. EDELEN
Funcionario de Certificaciones

SELLO ADHERIDO

99561

SOLICITUD DE TITULO DE PATENTE

A QUIEN PUEDA INTERESAR

CONÓZCASE que Aaron Ranson, Jose Zapico, Douglas A. Espin, y Mariela G. Araujo todos ciudadanos y residentes de VENEZUELA, hemos inventado algunas mejoras nuevas y útiles en APARATO Y MÉTODO PARA REALIZAR MEDICIONES DE BARRENO para lo cual lo siguiente es una especificación.

Certifico por este medio que esta correspondencia está siendo depositada con el Servicio Postal de los Estados Unidos, Correo Expreso en una cubierta dirigida al: Comisionado Asistente para Patentes, Washington, D.C. 20231

en Julio 20, 2000

(Fecha de depósito)

Janice T. Staton

(Nombre y No. Registro)

Janice T. Staton (firmado)

(Firma)

7/20/00

(Fecha de Firma)

ANTECEDENTES DE LA INVENCION

La invención se relaciona con un aparato y un método para llevar a cabo una función en un fluido que fluye y, más particularmente, con un método y un aparato para llevar a cabo mediciones de barreno y similares.

Los pozos de petróleo y gas se perforan en formaciones que llevan petróleo y gas para producir dicho petróleo y gas para uso como combustible y otros numerosos productos. Durante el curso de dicha perforación y producción, es crítico obtener información en cuanto a las formaciones perforadas a través, así como los fluidos dentro del pozo. Los métodos convencionales para obtener información deseable incluyen muestreo de núcleo del pozo, medición mientras se perfora, tala mientras se perfora y similares. Todos estos métodos proporcionan información crítica que ayuda en la optimización de las actividades de perforación y producción.

El equipo convencional para obtener esta información incluye alambrado eléctrico y/o fibra óptica en longitudes sustanciales, por ejemplo equivalente a la profundidad del pozo, y varios otros sensores y equipo analítico. Este equipo crea costo sustancial y en algunos casos puede requerir volver a completar un pozo para instalación, particularmente para instalar sensores en posiciones apropiadas.

El equipo convencional esta acompañado frecuentemente de pobre robustez o confiabilidad, lo cual lleva a pobre desempeño durante el tiempo. Los sensores y otro equipo frecuentemente no son reutilizables y son costosos de instalar y/o reemplazar.

Es claro que permanece la necesidad de métodos y equipos mejorados para obtener mediciones en los barrenos.

Es consecuentemente el objetivo primario de la presente invención proporcionar un aparato para obtener mediciones en barrenos que corrija las anteriores desventajas del arte previo.

Es un objetivo adicional de la presente invención proporcionar un método para obtener mediciones en los barrenos.

Otros objetivos y ventajas de la presente invención se mostrarán enseguida.

RESUMEN DE LA INVENCION

De acuerdo con la presente invención, los anteriores objetivos y ventajas se han obtenido fácilmente.

De acuerdo con la invención, se proporciona un aparato para llevar a cabo una función en un fluido que fluye, cuyo aparato comprende un cuerpo de aparato y un miembro de rastra asociado con dicho cuerpo de aparato y que se configura entre una configuración de rastra para moverse con dicho fluido donde dicho aparato tiene una primera rastra, y una configuración de rastra reducida para moverse contra dicho fluido donde dicho aparato tiene una segunda rastra que es menor que dicha primera rastra.

Adicionalmente de acuerdo con la presente invención, se proporciona un método para colocar un aparato en relación con un fluido que fluye, cuyo método comprende los pasos de proporcionar un flujo de fluido; proporcionar un aparato que comprende un cuerpo de aparato y un miembro de rastra asociado con dicho cuerpo de aparato y que se configura entre una configuración de rastra que tiene una primera rastra para moverse con dicho flujo de fluido y una configuración de rastra reducida que tiene una segunda rastra para moverse contra dicho flujo de fluido donde dicha segunda rastra es menor que dicha primera rastra; colocar dicho aparato en dicho flujo de fluido con dicho miembro de rastra en dicha configuración de rastra reducida por lo cual dicho aparato se mueve contra dicho flujo de fluido; y configurar dicho miembro de rastra

en dicha configuración de rastra por lo cual dicho aparato se mueve con dicho flujo de fluido.

El aparato se proporciona ventajosamente con sensores para hacer las deseadas mediciones y puede controlarse desde una localización superficial.

BREVE DESCRIPCIÓN DE LOS DIBUJOS

Una detallada descripción de las modalidades preferidas de la presente invención sigue, con referencia a los dibujos anexos, donde:

La Figura 1 ilustra esquemáticamente un pozo de petróleo perforado a una formación de producción y un aparato colocado allí de acuerdo con la presente invención;

la Figura 2 ilustra una modalidad de la presente invención en una configuración de rastra reducida para descender en un pozo;

la Figura 3 ilustra una modalidad de la presente invención en una configuración de rastra para moverse hacia arriba en un pozo; y

la Figura 4 ilustra una trayectoria de círculo de uso del aparato de la presente invención para obtener mediciones a lo largo de la profundidad de un pozo.

DESCRIPCIÓN DETALLADA

La invención se relaciona con un aparato y un método para llevar a cabo una función en un fluido que fluye, y particularmente con un aparato y un método para obtener mediciones de barreno en un ambiente de pozo subterráneo.

De acuerdo con la presente invención, se proporciona un aparato y un método para usar el aparato lo cual permite fácilmente obtener varias mediciones deseables en un fluido que fluye, por ejemplo en un pozo de producción de petróleo y gas, sin las desventajas convencionales asociadas con la utilización de equipo unido a alambres tal como equipos convencionales, y sin las adicionales desventajas acompañadas por la instalación de sensores permanentes en las localizaciones de barrenos.

La Figura 1 ilustra esquemáticamente un pozo típico de producción de petróleo 10 que incluye un tubo de producción 12 colocado desde una localización superficial 14 a una formación subterránea 16 para producir fluido (ilustrado esquemáticamente por flechas 18) desde la formación 16 hasta la localización superficial 14 como se desea. La Figura 1 también ilustra el aparato 20 de acuerdo con la invención el cual puede colocarse ventajosamente dentro del tubo de producción 12 y configurado para

viajar desde la localización superficial 14 a localizaciones más profundas dentro del tubo de producción 12, y en retroceso hacia la localización superficial 14 cuando se desee. El aparato 20 puede utilizarse para obtener cualquiera y todas las mediciones deseadas de varias locaciones de barreno a lo largo del tubo de producción 12 como se desee. Se debe por supuesto apreciar que el aparato 20 se muestra en la Figura 1 con tamaño exagerado en forma tal de ilustrar mejor la presente invención.

Volviendo a las Figuras 2 y 3, el aparato 20 de acuerdo con la presente invención se ilustra adicionalmente.

El aparato 20 de acuerdo con la presente invención incluye preferiblemente un cuerpo de aparato 22 para encastrar los varios deseados componentes del aparato 20 tal como se discutirá abajo adicionalmente. El cuerpo de aparato 22 es preferiblemente un miembro sustancialmente alargado que tiene un eje longitudinal. La superficie exterior del cuerpo de aparato 22 se diseña preferiblemente en forma tal de proporcionar una mínima cantidad de rastra a los fluidos que fluyen pasando el aparato 20, o a través de la cual el aparato 20 se mueve. Por ejemplo, el cuerpo 22 puede ser sustancialmente cilíndrico con extremos ahusados o redondeados. Por supuesto, también son adecuadas otras formas.

El aparato 20 también incluye un miembro de rastra 24 el cual es configurable entre una configuración de rastra (ilustrada en la Figura 3) y una configuración de rastra reducida (ilustrada en la Figura 2). Esto se describe adicionalmente abajo.

En un pozo de producción, los fluidos que se producen incluyen típicamente hidrocarburos, agua y cualesquiera otros materiales que pueden encontrarse en la particular formación subterránea a partir de la cual se producen los fluidos. Estos fluidos fluyen hacia arriba a través del tubo de producción 12 hacia la localización superficial 14 como se desee. Este flujo puede dirigirse mediante presión dentro de la formación 16, y/o varias otras fuerza adicionales tales como bombas, elevación de gas, y similar. De acuerdo con la presente invención, el aparato 20 es adaptado y configurado en forma tal que, en la configuración de rastra reducida de la Figura 2, la fuerza de gravedad es suficiente para empujar el aparato 20 hacia abajo a través del fluido que fluye hacia arriba en forma tal de mover el aparato 20 contra el flujo de fluido y en una dirección hacia abajo dentro del tubo de producción 12 hacia localizaciones más profundas en el pozo. Esto permite ventajosamente que el aparato 20 sea colocado en localizaciones del barreno como se desee.

Cuando se desea retornar el aparato 20 a la superficie, el miembro de rastra 24 es configurado a la configuración de rastra de la Figura 3, la cual tiene una rastra incrementada en comparación con la configuración de rastra reducida, y lo cual da como resultado la fuerza de rastra aplicada que fluye hacia arriba fluido que sobrepasa la fuerza de gravedad y levantando el aparato 20 a través del tubo de producción 12 hacia la localización superficial 14 como se desee. Esto permite ventajosamente que el aparato 20 sea colocado en cualquier localización de barreno deseada a lo largo del tubo de producción 12, dentro del fluido que fluye 18, en forma tal de obtener cualesquiera mediciones deseadas y similares sin la necesidad de equipo de tala convencional y/o sensores instalados permanentemente.

El miembro de rastra 24 de acuerdo con la presente invención puede proporcionarse ventajosamente como una pluralidad de miembros sustancialmente planos 26 que pueden colocarse sustancialmente paralelos al eje longitudinal del cuerpo de aparato 22 como se muestra en la Figura 2 en forma tal de proporcionar una configuración de rastra reducida. En esta configuración, la fuerza de gravedad G supera la rastra de fluido que fluye hacia arriba 18 dando como resultado el movimiento hacia abajo D del aparato 20 como se desea. Los miembros planos 26 pueden configurarse o colocarse, en este caso a través de rotación, a una posición sustancialmente horizontal con respecto al eje longitudinal del cuerpo de aparato 22 como se muestra en la Figura 3 en forma tal de proporcionar una configuración de rastra incrementada donde la fuerza de fluido que fluye hacia arriba 18 supera la fuerza de gravedad G dando como resultado un movimiento hacia arriba U como se muestra en la Figura 3.

La colocación del miembro de rastra 24 entre la configuración de rastra de la Figura 3 y la configuración de rastra reducida de la Figura 2 puede llevarse a cabo ventajosamente desde una localización remota, por ejemplo utilizando un miembro de control preferiblemente inalámbrico o transmisor 28 (ver Figura 1) colocado en la localización superficial 14 para sacar comandos al aparato 20. Los comandos pueden recibirse, por ejemplo a través de un receptor 30 en el aparato 20, para accionar un motor o motores (no mostrado) dentro del cuerpo de aparato 22 para rotar los miembros planos 26 entre las deseadas posiciones.

Las Figuras 2 y 3 ilustran miembros planos 26 colocados en una posición vertical (Figura 2) y en una posición horizontal (Figura 3) representando las mínima y máxima posiciones de rastra, respectivamente. Deberá apreciarse que el miembro plano 26 puede pivotar parcialmente entre las posiciones de las Figuras 2 y 3 en forma tal de obtener una posición de rastra intermedia que puede utilizarse, en combinación con un

sensor para detectar la velocidad de movimiento dentro del tubo de producción 12, para permitir obtener una posición de equilibrio donde aparato 20 mantiene sustancialmente la misma posición dentro del tubo de producción 12 por ejemplo si se debe tomar una medición particular que requiere estar estacionario a un nivel particular durante una longitud extendida de tiempo. Vigilando la velocidad y posición del aparato 20, y ajustando el miembro de rastra 24 apropiadamente, el aparato 20 puede colocarse en cualquier localización dentro de un pozo, y retornar a la superficie cuando se desee. Adicionalmente, la velocidad de descenso y ascenso puede controlarse cambiando el ángulo del miembro de rastra para incrementar o decrecer la rastra.

Como se estableció arriba, es una ventaja particular de la presente invención ser capaz de obtener varias deseables mediciones de barreno sin la necesidad de equipo convencional tal como instalación fija de sensores y/o dispositivos con alambre o conectados de alguna otra forma. Consecuentemente, el aparato 20 se proporciona típicamente con uno o más sensores u otros dispositivos analíticos colocados en o dentro del cuerpo 20 como se ilustra esquemáticamente en 32 por ejemplo para obtener mediciones de condiciones deseadas. Dichas condiciones pueden ser condiciones relacionadas con el fluido incluyendo presión, temperatura, densidad, viscosidad, contenido de agua, composición, flujo de múltiples fases y similares. Adicional información que puede ser deseable para obtener utilización de sensores 32 incluye velocidad de movimiento del aparato 20, posición del aparato 20 dentro del tubo de producción 12, proximidad del fondo 34 del pozo 10, y similares. La estructura actual y/o circuitos de dichos sensores es bien conocida para una persona experta en el arte y consecuentemente no se describe aquí.

El aparato 20 de acuerdo con la presente invención incluye varios dispositivos electrónicos como se describe arriba. Dichos dispositivos incluyen el sensor 32 y uno o más motores (no ilustrado) para accionar los miembros planos 36 del miembro de rastra 24. Una fuente de potencia para estos dispositivos se proporciona preferiblemente en forma de una batería recargable 34, la cual puede colocarse idealmente dentro del cuerpo de aparato 22. La batería 34 puede ventajosamente ser recargable tal que el aparato 20 puede recargarse una vez que se encuentra en la localización superficial 14. De acuerdo con una adicional modalidad preferida de la presente invención, el aparato 20 puede proporcionarse con un cargador accionado de fluido o generador 36 asociado operativamente con una batería recargable 34 y expuesto al fluido que fluye 18 dentro del tubo de producción 12 en forma tal de permitir la recarga potencialmente continua del miembro de batería 34 si se desea. Los específicos componentes y circuitos de la batería 34 y el cargador 36 son también bien

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conocidos para una persona experta en el arte y consecuentemente no se incluyen aquí. Por ejemplo, el miembro de rastra 24 puede adaptarse para convertir el momento de fluido en rotación del miembro de rastra 24 como se muestra en la Figura 3. Esta rotación relativa al resto del aparato 20 puede utilizarse para operar el cargador / generador 36. En esta modalidad, finos de estabilización u otra estructura pueden desearse para evitar la rotación del cuerpo 22 conjuntamente con el miembro de rastra 24. Por supuesto, otras configuraciones y estructuras pueden usarse similarmente para convertir el momento de fluido en energía almacenada para operar el aparato 20 como se desee.

El aparato 20 puede proveerse ventajosamente con un miembro de control programado para proporcionar particulares funciones deseables. Por ejemplo, el aparato 20 puede incluir un miembro de control programado para escrutar cuando la batería 34 ha alcanzado un estado de baja potencia en cuyo punto un miembro de rastra 24 puede colocarse automáticamente en la posición de rastra de la Figura 3 en forma tal de permitir la recuperación del aparato 20 en la localización superficial 14 y recargar la batería 34 y similar.

El miembro de control puede también ventajosamente adaptarse para utilizar particular información recibida por los sensores 32 para mejorar la habilidad de medición del barrenado del aparato 20. Por ejemplo, el miembro de control del aparato 20 puede adaptarse en forma tal de detectar la aproximación del botón 34 del tubo de producción 12 en forma tal que el miembro de rastra 24 puede colocarse apropiadamente para incrementar la rastra y el lento descenso del aparato 20, evitando así una colisión potencialmente de daño con el fondo 34 del tubo de producción 12.

Aún adicionalmente, el miembro de control del aparato 20 puede adaptarse ventajosamente en forma tal de detectar anomalías en una o más condiciones del fluido y automáticamente configura el miembro de rastra 24 para permanecer en una particular localización durante un periodo extendido de tiempo para obtener adicionales mediciones.

El aparato 20 puede también proveerse con capacidad para llevar uno o más aditivos tal como cemento para reparaciones locales, material de tapón para cerrar selectivamente una o más zonas, o cualquier otro material que pueda desplegarse ventajosamente dentro del tubo de producción 12 mediante el aparato 20 si se desea. En esta modalidad, el miembro de control para el aparato 20 controlará por supuesto el despliegue de dicho material igualmente.

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De acuerdo con la presente invención, se proporciona un aparato 20 el cual es configurable a posiciones que incrementan y disminuyen el coeficiente de rastra en la interfaz fluido-cuerpo entre el cuerpo de aparato 22 y el fluido que fluye 18. La fuerza promedio en tiempo total (FD) ejercida por el flujo en un objeto puede escribirse en forma no dimensionada, utilizando el área frontal (A) del objeto, como sigue:

$$C_D = \frac{F_D / A}{\frac{1}{2} \rho V^2}$$

donde C_D es el coeficiente de rastra y V es la velocidad del fluido.

En la modalidad de las Figuras 2 y 3, el miembro de rastra 24 opera incrementando y disminuyendo el área A así como cambiando la geometría local la cual ajusta si el coeficiente de rastra C_D .

A través de esta manipulación, el aparato 20 puede configurarse para moverse hacia abajo dentro del tubo de producción 12 mediante la fuerza de gravedad, y puede configurarse para moverse hacia arriba con el flujo 18, utilizando la energía provista por el flujo 18 en miembro de rastra 24.

El aparato 20 de acuerdo con la presente invención estará típicamente expuesto a condiciones que incluyen temperaturas entre alrededor de 20°C y alrededor de 350°C y presiones entre alrededor de 689 kPa y alrededor de 172 250 kPa. Es consecuentemente preferible que el cuerpo de aparato 22 se seleccione en forma tal de soportar dichas condiciones, y adicionalmente que los componentes dentro del cuerpo de aparato 22 se seleccionen en forma tal de soportar dichas condiciones.

También puede apreciarse fácilmente que la comunicación entre el aparato 20 y la localización superficial 12 se cumple utilizando comunicaciones inalámbricas, proporcionando así una marcada mejora sobre sistemas convencionales utilizando alambres y/o cables ópticos.

Adicionalmente, el aparato 20 de acuerdo con la presente invención opera utilizando consumo de energía extremadamente bajo, y puede proporcionarse preferiblemente en forma tal de recargarse durante el uso utilizando energía del fluido.

Un ciclo típico para uso del aparato 20 de acuerdo con la presente invención se describirá ahora.

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El uso comenzará típicamente introduciendo el aparato 20 dentro del pozo 10 utilizando un "lubricante" o cualquier otro puerto que sea adecuado para introducir el aparato 20 dentro del tubo de producción 12 desde la localización superficial 14. Una vez que el aparato 20 está dentro del tubo de producción 12, se establece comunicación entre el aparato 20 y el miembro de control 28. Se puede entonces llevar a cabo un diagnóstico ventajosamente en forma tal de asegurar que todos los sistemas del aparato 20 están funcionando.

Asumiendo que el diagnóstico no indica ningún problema, el miembro de rastra 24 puede configurarse ventajosamente a la configuración de rastra reducida de la Figura 2 y el aparato 20 comenzará a suavizarse fallando en movimiento a través del fluido que fluye 18 ascendente como se desee. La Figura 4 ilustra esquemáticamente una trayectoria de ciclo con la posición vertical del aparato 20 dibujado durante el tiempo, y varias tareas comienzan a cumplirse a lo largo de la vía. Mientras el aparato 20 se desplaza, varias mediciones se toman incluyendo aquellas que pueden programarse automáticamente y aquellas que pueden ser requeridas por un operador a la localización superficial 14. El aparato 20 está preferiblemente adaptado para vigilar continuamente la aceleración en forma tal de mantener la velocidad y la aceleración debajo de niveles que pueden causar daños ante el impacto con el tubo de producción 12 y otros equipos del pozo.

La información obtenida por el aparato 20 puede almacenarse dentro del aparato 20, por ejemplo en la memoria local, y/o puede transmitirse al miembro de control 28 en la localización superficial 14.

Durante el descenso, cualquier situación no normal puede detectarse, el aparato 20 puede programarse y/o instruirse para tomar una acción apropiada. Por ejemplo, como se ilustra en el punto 38 en la Figura 4, puede ser deseable aminorar o detener el descenso del aparato 20 en el tubo de producción 12 en forma tal de realizar una adicional tarea de medición específica y similar. Después de completar, el miembro de rastra 24 puede nuevamente configurarse a la configuración de rastra reducida en forma tal de continuar el descenso tal como se ilustra. Al alcanzar un adicional punto de barreno, por ejemplo el punto 40 como se ilustra en la Figura 4, puede realizarse una tarea adicional. Adicionalmente, si se detecta ahora que el aparato 20 ha alcanzado cercana proximidad con el fondo del pozo, el aparato 20 puede configurarse ventajosamente a la posición de rastra de la Figura 3 para ascenso a través del tubo de producción 12 en retroceso a la localización superficial 14 como se desee.

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Puede apreciarse fácilmente que el aparato 20 y su uso proporciona ventajas sustanciales en comparación con sistemas convencionales y métodos para obtener mediciones de barreno. Específicamente, el aparato 20 evita la necesidad de instalaciones de barreno permanentes, y además evita la necesidad de conexiones con alambres o conexiones ópticas extendidas sobre longitudes sustanciales tal como la profundidad total de un pozo y similar.

Debe entenderse que la invención no está limitada a las ilustraciones descritas y mostradas aquí, las cuales se consideran meramente ilustrativas de los mejores modos de llevar a cabo la invención, y que son susceptibles de modificación de forma, tamaño, arreglo de partes y detalles de operación. La invención pretende más bien abarcar todas las modificaciones que se encuentran dentro de su espíritu y alcance tal como se define mediante las reivindicaciones.

REIVINDICACIONES

Lo que se reivindica es:

1. Un aparato para realizar una función en un fluido que fluye, que comprende:

un cuerpo de aparato; y

un miembro de rastra asociado con dicho cuerpo de aparato y configurable entre una configuración de rastra para moverse con dicho fluido donde dicho aparato tiene una primera rastra y una configuración de rastra reducida para moverse contra dicho fluido donde dicho aparato tiene una segunda rastra que es menor que dicha primera rastra.

2. El aparato de acuerdo con la reivindicación 1, donde dicho cuerpo de aparato comprende un miembro alargado que tiene un eje longitudinal, y donde dicho miembro de rastra comprende un miembro plano sustancialmente que tiene una superficie plana colocable en relación con dicho cuerpo de aparato entre dicha configuración de rastra donde dicha superficie plana es sustancialmente perpendicular a dicho eje y dicha configuración de rastra reducida donde dicha superficie plana es sustancialmente paralela a dicho eje.

3. El aparato de acuerdo con la reivindicación 1, que comprende adicionalmente un miembro de control asociado remotamente con dicho miembro de rastra para configurar dicho miembro de rastra entre dicha configuración de rastra y dicha configuración de rastra reducida.

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4. El aparato de acuerdo con la reivindicación 1, que comprende adicionalmente una fuente de potencia recargable dentro de dicho cuerpo de aparato y un cargador accionado por fluido colocado sobre dicho cuerpo de aparato para cargar dicha fuente de potencia cuando dicho aparato es expuesto a dicho fluido que fluye.

5. El aparato de acuerdo con la reivindicación 1, que comprende adicionalmente un miembro sensor montado en relación con dicho cuerpo de aparato para escrutar por lo menos una condición de dicho fluido que fluye seleccionada a partir del grupo que consiste de presión, temperatura, densidad, viscosidad, contenido de agua, composición y flujo de múltiples fases.

6. El aparato de acuerdo con la reivindicación 5, que comprende adicionalmente un miembro transmisor montado a dicho cuerpo de aparato y un receptor colocado remotamente en relación con dicho cuerpo de aparato, dicho transmisor que está adaptado para transmitir dicha por lo menos una condición hacia dicho receptor.

7. El aparato de acuerdo con la reivindicación 5, que comprende adicionalmente un miembro de almacenamiento montado a dicho cuerpo de aparato para almacenar dicha por lo menos una condición.

8. El aparato de acuerdo con la reivindicación 1, que comprende adicionalmente un miembro sensor de posición montado a dicho cuerpo de aparato para escrutar la posición de dicho aparato.

9. El aparato de acuerdo con la reivindicación 1, donde dicho miembro de rastra es configurable a por lo menos una configuración parcial de rastra entre dicha configuración de rastra y dicha configuración de rastra reducida por lo cual la rastra relativa a dicho fluido puede ajustarse.

10. Un método para colocar un aparato en relación con un fluido que fluye, que comprende los pasos de:

proveer un flujo de fluido;

proveer un aparato que comprende un cuerpo de aparato y un miembro de rastra asociado con dicho cuerpo de aparato y configurable entre una configuración de rastra que tiene una primera rastra para moverse con dicho flujo de fluido y una configuración de rastra reducida que tiene una segunda rastra para moverse contra dicho flujo de fluido donde dicha segunda rastra es menor que dicha primera rastra;

colocar dicho aparato en dicho flujo de fluido con dicho miembro de rastra en dicha configuración de rastra reducida por lo cual dicho aparato se mueve contra dicho flujo de fluido; y

configurar dicho miembro de rastra en dicha configuración de rastra por lo cual dicho aparato se mueve con dicho flujo de fluido.

11. El método de acuerdo con la reivindicación 10, donde dicho flujo de fluido es un flujo de fluido sustancialmente vertical.

12. El método de acuerdo con la reivindicación 10, donde dicho flujo de fluido es direccional sustancialmente opuesto a las fuerzas gravitacionales en dicho aparato.

13. El método de acuerdo con la reivindicación 10, donde dicho flujo de fluido está en un pozo que produce fluido desde una formación subterránea hacia una localización superficial.

14. El método de acuerdo con la reivindicación 13, que comprende adicionalmente controlar la configuración de dicho miembro de rastra desde dicha localización superficial cuando dicho aparato está en dicho pozo.

15. El método de acuerdo con la reivindicación 13, que comprende adicionalmente el paso de medir, con dicho aparato, por lo menos una condición de dicho fluido que fluye seleccionado a partir del grupo que consiste de presión, temperatura, densidad, viscosidad, contenido de agua, composición y flujo de múltiples fases.

16. El método de acuerdo con la reivindicación 15, que comprende adicionalmente el paso de transmitir dicha por lo menos una condición desde dicho aparato en dicho pozo hacia dicha localización superficial.

17. El método de acuerdo con la reivindicación 10, que comprende adicionalmente el paso de medir, con dicho aparato, por lo menos una condición de dicho fluido que fluye seleccionada a partir del grupo que consiste de presión, temperatura, densidad, viscosidad, contenido de agua, composición y flujo de múltiples fases.

18. El método de acuerdo con la reivindicación 17, que comprende adicionalmente el paso de almacenar dicha por lo menos una condición en dicho aparato.

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19. El método de acuerdo con la reivindicación 10, que comprende adicionalmente el paso de detectar con dicho aparato una posición de dicho aparato relativa a dicho flujo de fluido.

EXTRACTO DE LA DIVULGACIÓN

Un aparato para llevar a cabo una función en un fluido que fluye incluye un cuerpo de aparato y un miembro de rastra asociado con el cuerpo de aparato y configurable entre la configuración de rastra para moverse con el fluido donde el aparato tiene una primera rastra y una configuración de rastra reducida para moverse contra el fluido donde el aparato tiene una segunda rastra que es menor que la primera rastra.

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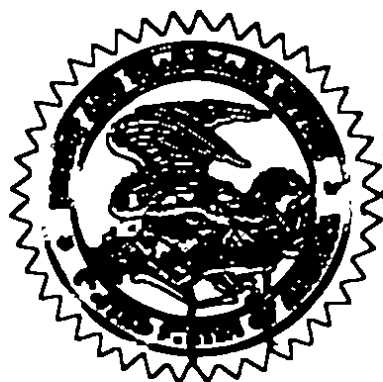
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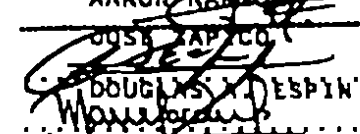
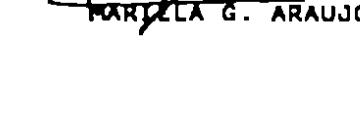
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