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71. **SOLICITANTE** *BP EXPLORATION OPERATING COMPANY LIMITED Y XL TECHNOLOGY LIMITED.*

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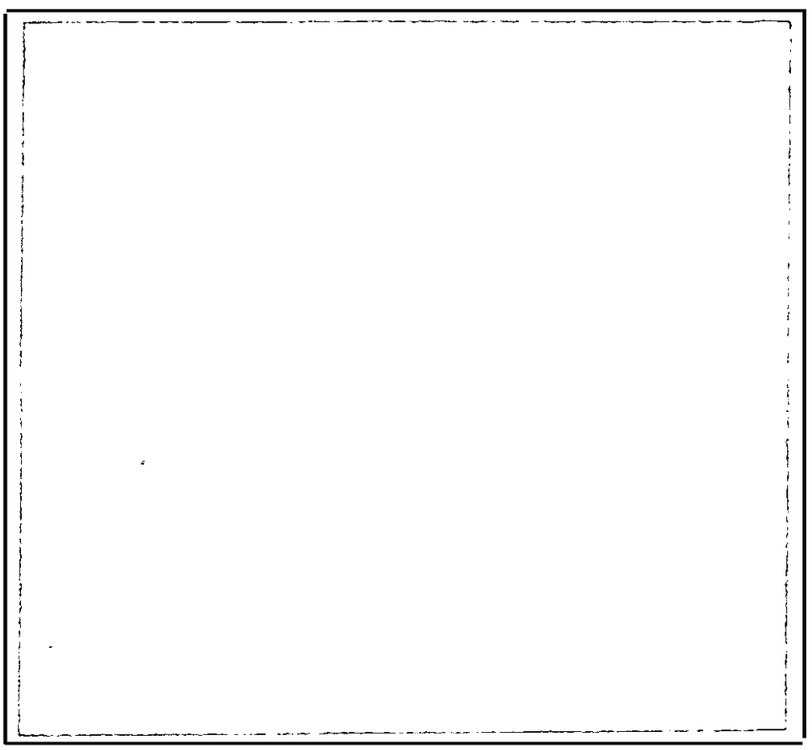
- ☐ Comprobante de pago de la tasa de presentación de la solicitud
- ☐ Documento que acredita la existencia y representación legal cuando el solicitante sea persona jurídica
- ☐ Poderes si fuese el caso
- ☐ Documento de cesión del inventor al solicitante o a su causante
- ☐ Declaraciones
- ☐ Copia de la solicitud internacional (Resumen, descripción, reivindicaciones, dibujos)
- ☐ Traducción de la solicitud internacional al castellano. (Resumen, descripción, reivindicaciones, dibujos)
- ☐ Copia del examen preliminar internacional efectuado por la Autoridad Internacional de examen preliminar (IPER)
- ☐ Traducción del examen preliminar internacional efectuado por la IPEA
- ☐ De ser el caso copia de contrato de acceso.
- ☐ De ser el caso documento que acredite la licencia o autorización de uso de conocimientos tradicionales de las comunidades indígenas.
- ☐ De ser el caso certificado de deposito del material biológico
- ☐ Arte final 12x12.
- ☐ De ser el caso, información sobre otras solicitudes de patente o títulos obtenidos en el extranjero por el mismo titular o su causante, relacionadas parcial o totalmente con la invención de esta solicitud.
- ☐ De ser el caso, modificaciones efectuadas a la solicitud internacional
- ☐ Otros

12 FIGURA CARACTERISTICA



13 Solicito la concesión de la patente,

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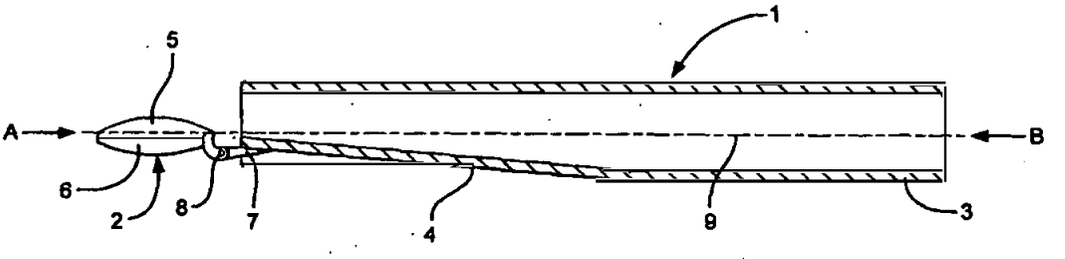


(57) Abstract: A sub surface deployment valve which is particularly suitable for use in underbalanced drilling operations which can be installed through an existing tubular string comprises a radially expandable body (1) having an internal bore and a valve element (2) capable of closing off the internal bore. The deployment valve can be installed by passing the valve through the existing tubular and then radially expanding the radially expandable body of the deployment valve to form a connection resulting from the interference between the external surface of the deployment valve and the tubular string.

WO 2007/034136 A2

Sub-Surface Deployment Valve

The present invention relates to a sub-surface deployment valve suitable for use in underbalanced drilling. In particular, the invention relates to apparatus and methods for installing and using a sub-surface deployment valve which can be installed through an existing tubular string in an oil or gas well.

In conventional rotary drilling methods a wellbore is drilled by rotating a drill bit to which downward force is applied. The drill bit is attached to and rotated by a drill string which has a passageway through which a drilling fluid is circulated. The drilling fluid, usually called drilling mud, is generally circulated down the well through the passageway in the drill string, over the drill bit and returns to the surface through an annular space between the drill string and the wellbore wall. The drilling mud may however be circulated in the reverse direction. The drilling mud has a number of functions, including cooling and lubricating the drill bit and drill string, transporting drill cuttings from the bottom of the borehole to the surface, protecting against blowouts by holding back subsurface pressures and depositing a mud cake on the wall of the borehole to prevent loss of fluids to the formation. When drilling through a formation which does not contain a fluid, such as water, gas or oil, the weight and the pumping rate of the drilling mud are selected so that the pressure at the wellbore wall is maintained between a lower pressure at which the wellbore becomes unstable and an upper pressure at which the wellbore wall is fractured. When the wellbore is drilled through a fluid-containing zone, the drilling mud pressure is generally selected to be above the pressure at which fluid starts flowing into the wellbore (formation pressure), and below the pressure at which undesired invasion of drilling mud into the formation occurs. This is generally referred to as overbalanced drilling.

Drilled wellbores are generally lined with tubular strings, usually steel pipe, referred to as casing. The casing provides support to the wellbore and facilitates the isolation of certain sections of the wellbore adjacent hydrocarbon bearing formations. The casing typically extends down the wellbore from the surface of the well and the annulus between the outside of the casing and the borehole wall is typically, but not necessarily, filled with cement to permanently set the casing in the wellbore.

As the wellbore is drilled to a new depth, additional strings of pipe are run into the well to that depth whereby the upper portion of the string of pipe (often referred to as "liner"), is overlapping the lower portion of the casing. The liner is then fixed or hung in the wellbore, usually by some mechanical slip means well known in the art.

The known overbalanced rotary drilling methods have long been recognized as safe methods for drilling a well. However, a significant disadvantage of such methods is that since the drilling mud pressure is higher than the natural formation pressure, fluid invasion frequently occurs, causing permeability damage to the formation.

Underbalanced drilling differs from the more conventional overbalanced drilling in that the bottomhole circulating pressure is lower than the formation pressure, thereby permitting the well to flow while drilling proceeds. Thus, when drilling through a formation containing oil or gas, production can be obtained from a well prior to completion. Underbalanced drilling can also be used in formations containing other fluids, such as water. In this specification, the term "reservoir formation" is used to denote any rock or earth formation that contains a fluid under pressure.

Advantages that have been claimed for underbalanced drilling include:

- Maintaining wellbore pressure below the reservoir pressure allows reservoir fluids to enter the wellbore, thus avoiding formation damage. Since significant formation damage is avoided, the stimulation requirements during well completion are also reduced, leading to considerable savings.
- During underbalanced drilling there is no physical mechanism to force drilling fluid into the drilled formation. Therefore, lost circulation is kept to a minimum when fractured or high permeability zones are encountered.
- Underbalanced drilling can help in detecting potential hydrocarbon zones, even identifying zones that would have been bypassed with conventional drilling methods.
- Due to the decreased pressure at the drill bit head, underbalanced drilling operations can have superior penetration rates as compared to conventional overbalanced drilling techniques. Along with reduced drilling times, an increase in bit life has sometimes been reported.
- Since there is no filter cake around the wellbore wall, the chances of differential

Underbalanced drilling does however also have some disadvantages. For example, it can be more difficult to control the well in certain circumstances. In particular, problems may arise when it is necessary to remove the drill string from the well or to run it back into the well. Pressure in the wellbore is generally controlled at the surface, such as with a blow-out preventer (BOP). The weight of the drill string holds the drill string within the borehole. However, as sections of the drill string are removed, the drill sting becomes lighter until a depth is reached at which the upward forces acting on the drill string become greater than the downward forces. This depth is called the "string light point". A number of factors affect where exactly in the borehole a drill string will become string light.

The person skilled in the art will be well aware that well bore depths may not be the same as vertical depth so that references to depths in the well bore such as "above" or "below" certain depths generally refer to well bore depths rather than vertical depths

With pressure at the surface of the wellbore, then at some point, as the drill string is removed, the pressure may begin to push or accelerate the remaining drill string out of the wellbore. This is a potentially dangerous situation which could result in a blow-out. If the upward movement of the pipe is not controlled, sufficient momentum may be developed such that the blow out preventer is unable to contain the upward movement. Attempting to close the rams may result in damage to the rams or even their being torn out rather than them arresting the upward movement of the drill pipe. In such a situation, the rams may not be able to shut-in the well after the pipe has been pushed from the well bore.

Methods are known to avoid a blow-out situation. For example, it may be possible to bleed off the surface pressure prior to reaching the string light point. However, reliance on this method can be risky. It is possible for a bridge to form in the formation such that it appears that there is a bleed off of pressure. If the bridge breaks at the wrong moment with the drill pipe almost out of the hole, then significant formation pressure may be applied at the surface resulting in a blow-out.

A very effective and safe practice is to kill the well prior to removal of the drill string, i.e. introduce drilling fluid to provide a pressure in the wellbore which is greater than the formation pressure. However, this practice is undesirable because advantages of underbalanced drilling may be lost. In particular, formation damage may occur as a result of the pressure of the drilling fluids used to kill the well which may be substantially or

Another very effective and safe practice is to use a so-called snubbing unit for removing the drill string. A snubbing unit provides a means for removing and inserting tools and tubulars into wells under pressure and ensures that the wells can be safely serviced without having to use kill weight with fluids. However, it takes a significant amount of time and effort to install a snubbing unit, trip the drill string and uninstall the snubbing unit resulting in increased drilling costs.

US Patent 6,209,663 discloses apparatus and methods for a deployment valve used with an underbalanced drilling system. The deployment valve is positioned in a tubular string, such as casing, at a wellbore depth at or preferably substantially below the string light point of the drill string. The deployment valve has a bore sufficiently large to allow passage of the drill bit therethrough when in the open position. The deployment valve may be closed when the drill string is pulled within the casing. To allow the drill string to be removed from the casing, the pressure produced by the formation can be bled off and the drill sting removed. The drill string can be reinserted, the pressure in the casing above the deployment valve applied to preferably equalize the pressure above and below the deployment valve and the drill string run into the hole. The deployment valve is run in as an integral part of the casing program. Thus, the deployment valve can be secured to the casing and run in with it or may be mounted within the casing by running a smaller tubular string inside the casing.

Sometimes the interior of the initial wellbore has one or more restrictions along its length that reduce the cross-sectional area of the wellbore. For example, the wellbore may have a string of production tubing that is carried concentrically within the main wellbore and that is of a smaller internal diameter than the wellbore or any casing lining the wellbore. Typically, the wellbore has an internal diameter of about 5 inches (12.7 cm) to about 10 inches (25.4 cm), for example 7 inches (17.8 cm) and the production tubing has an internal diameter of about 2.5 inches (6.4 cm) to about 6 inches (15.2 cm), for example 4.5 inches (11.4 cm). This means that any tool that is passed down the interior of that well bore, including a drill string and drill bit, has to be small enough in cross-section to pass through the restriction in order to reach lower levels in the wellbore. This is called through-tubing operations in that any well operations that are to be carried out in the well bore below the end of the production tubing require the equipment to be passed through the interior of the production tubing before it can reach the area where the well operation is to

be carried out. The alternative would be to remove the production tubing in its entirety from the well bore, which is an expensive and time consuming process. Thus, it is very desirable to be able to pass well tools that are to be used in well operations through the interior of the smaller diameter production tubing down below the end of that tubing into the larger diameter wellbore and then carrying out well operations with those tools in that larger area of the wellbore.

It would be useful to be able to install a sub-surface deployment valve at the end of a restriction in the diameter of a wellbore or below such a restriction in a wellbore by running the deployment valve down through the restriction and in particular, it would be useful to be able to install a sub-surface deployment valve at the end of a production tube or below the production tube by running the deployment valve down through the production tubing. Such a deployment valve could provide a means for more safely and/or more quickly removing a drill string from a tubular string, such as a casing string or production tube, when the tubular string is exposed to relatively high formation pressure. However, such a deployment valve should preferably reduce the available bore as little as possible.

Thus according to the present invention, a sub-surface deployment valve comprises a radially expandable body having an internal bore and a valve element capable of closing off the internal bore.

The sub-surface deployment valve, hereinafter deployment valve, is dimensioned such that it can pass through a restriction in a wellbore and is sufficiently radially expandable that it can thereafter be expanded, such that the expanded internal bore is preferably not significantly smaller than the dimensions of the restriction, preferably, the internal bore is not more than 10% smaller than the dimensions of the restriction. Where the restriction is production tubing, the deployment valve may, by careful design and installation, have an internal bore after expansion which is substantially the same as the internal bore of the production tubing.

The valve element is operable to open or close the internal bore of the deployment valve. Any suitable valve element can be used, including an inflatable seal, a flapper valve element, a ball valve or other rotatable closure element or telescoping closure elements.

An embodiment of the deployment valve comprises a radially expandable tubular body having a flapper valve element attached to the expandable tubular body at one end

thereof by pivot connections. The expandable tubular body preferably has a folded or deformed wall at least adjacent the flapper valve element such that the pivot means and flapper valve element can be arranged to minimize the projected size of the deployment valve. For example, the pivot means may be accommodated within the folded wall and may support the flapper valve element in the open position, such that its widest dimension is positioned towards the central axial plane of the tubular body.

In a more preferred embodiment, the flapper valve element is deformable so that it can be passed through a tube of smaller diameter. This deformability can be achieved by the design of the flapper valve element and/or the material of construction. In one embodiment the flapper valve element comprises a sealing surface and a reinforcing portion which is attached to or integrally formed with the sealing surface. The reinforcing portion can comprise substantially parallel ribs the longitudinal axis of which are in the same axis as the longitudinal axis of the tubular body, when the valve element is in the open position. The reinforcing portion can be, for example, a block with substantially parallel slots to form the ribs or can be a series of substantially parallel bars mounted close together forming the ribs. The slots or gaps between the ribs allow the valve element to be deformed. The flapper valve element can be machined from a single piece of material, e.g. by cutting substantially parallel slots in the material. In another embodiment, reinforcing elements can be fixed, e.g. by welding, to one side of a relatively thin plate; the other side of the plate acts as or supports the sealing surface. Another option is to mould the flapper valve element from a suitable moldable material that is inert to the reservoir fluids. The substantially parallel ribs allow the valve element to be deformed, bringing the outer edges of valve element towards each other, thereby reducing the maximum dimension of the valve element transverse to the longitudinal axis of the tubular body of the deployment valve.

It may be possible to deform the flapper valve element as the deployment valve is being introduced into the wellbore at the surface. In another option, the flapper plate element may be deformed and held in the deformed position by a restraining means until after the deployment valve is installed and then the restraining means can be released. For example, the flapper valve element, which in operation may be substantially flat, may be deformed into a curve and restrained by being placed into a tube or by a strap preventing

the curved edges from opening. Once downhole, the restraining tube or strap would be removed to allow the flapper valve element to open out.

Expandable tubulars for use in wellbores are known, as are means for expanding such tubulars. The expansion can be accomplished by a mandrel or a cone-shaped member urged through the tubular that is to be expanded or by any other suitable expander tool.

Although any of the known methods of radially expanding the expandable valve body can be used in the present invention, a preferred method is to use a rotating ball or roller expander. Such devices are known and comprise radially extendible rotatable balls or rollers. The balls or rollers are urged outwardly against the internal wall of the expandable valve body and then the balls or rollers are rotated around the internal surface and are also moved axially along the valve body so that they describe a helical path.

The deployment valve may be hydraulically operated and have at least one hydraulic line for controlling movement of the deployment valve element. A biasing means such as a spring or weight or other control lines may be used to keep the valve element in the open or closed position. In one embodiment, the deployment valve has a spring element to bias closed a flapper valve element and seal it against a sealing surface on the deployment valve body and the flapper valve element can be opened by the weight of the drill string bearing down on the flapper valve element as the drill string is lowered into the well and/or pressure above the flapper valve. Operation of the valve element can also be effected through interaction between the drill string and the deployment valve such as, for example, vertical or rotational movement of the drill string acting on a movable element of the deployment valve.

The present invention includes a method for drilling a wellbore having located within the wellbore a tubular string, which method comprises positioning a deployment valve at least partially within the tubular string such that, once the valve is installed, a drill string can be moved through the valve wherein the deployment valve comprises a radially expandable body with an internal bore and a valve element capable of closing off the internal bore, the method further comprising attaching the deployment valve to or in the tubular string by radially expanding the radially expandable body of the deployment valve to form a connection resulting from the interference between the external surface of the deployment valve and the tubular string.

The tubular string can be any of the tubulars routinely used in wells, including casing, liner and production tubing, but is particularly useful for use in production tubing.

The invention of the present invention can be used with drilling operations that use rotary drills connected to the surface by a tubular drill string. It is also possible to use the invention in wireline drilling operations. A combination of wire line and tubular drill string may also be used. For example, a wireline can be run from the surface to a sub-surface housing for a motor that is capable of driving a tubular drill string having at its distal end a drill bit.

Although the method and apparatus according to the present invention are particularly useful in underbalanced drilling, it will be appreciated that the deployment valve may find other uses, including drilling even when the well is overbalanced for additional well control or even non-drilling operations. For example, the use of the deployment valve can provide a relatively long "lubricator" for deploying long or complex bottom hole assemblies. A lubricator is normally a specially fabricated length of pipe positioned around the surface of a borehole. It may be placed above a valve on top of the assembly of control valves, pressure gauges and chokes assembled at the top of a well to control the flow which is generally called the "Christmas tree" or may be placed above a valve on top of the casing or tubing head, but below the Christmas tree. The lubricator may have union connectors and bleed-off valves and provides a method of sealing off pressure yet still allow the passage of a device, usually on a wireline, or a substance, into the well, without having to kill the well. Once the well has been drilled, the deployment valve can be utilized for the deployment of the completion system, making it possible to run relatively long sections of completion tubulars such as expandable sand screen assemblies, slotted liner systems and production strings.

US 6,305,469 discloses a method of underbalanced drilling which provides a method of creating a wellbore in an earth formation, the wellbore including a first wellbore section and a second wellbore section penetrating a hydrocarbon fluid bearing zone of the earth formation, the method comprising:

(a) drilling the first wellbore section;

(b) arranging a remotely controlled drilling device at a selected location in the first wellbore section, from which selected location the second wellbore section is to be drilled;

(c) arranging a hydrocarbon fluid production tubing in the first wellbore section in sealing relationship with the wellbore wall, the tubing being provided with fluid flow control means and a fluid inlet in fluid communication with said selected location;

(d) operating the drilling device to drill the new wellbore section whereby during drilling of the drilling device through the hydrocarbon fluid bearing zone, flow of hydrocarbon fluid from the second wellbore section into the production tubing is controlled by the fluid flow control means.

US 6,305,469 discloses that the drilling device is releasably connected to the lower end of a hydrocarbon production tubing by a suitable connecting device. The hydrocarbon production tubing is then lowered into the casing until the drilling device is near the bottom of the first wellbore section whereafter the production tubing is fixed to the casing by inflating a packer which seals the annular space formed between the production tubing and the casing.

WO 2004/011766 discloses a method for underbalanced drilling using a remotely controlled drilling device that uses fluid produced from the formation to transport drill cuttings away from the cutting surfaces of the device in which the drilling device is capable of being passed from the surface to a selected location in an existing wellbore without having to pull the hydrocarbon fluid production tubing from the wellbore.

Thus, according to WO 2004/011766, a method of drilling a borehole from a selected location in an existing wellbore penetrating a subterranean earth formation having at least one hydrocarbon fluid bearing zone wherein the existing wellbore is provided with a casing and a hydrocarbon fluid production conduit is arranged in the wellbore in sealing relationship with the wall of the casing, comprises:

(a) passing a remotely controlled electrically operated drilling device from the surface through the hydrocarbon fluid production conduit to the selected location in the existing wellbore;

(b) operating the drilling device such that cutting surfaces on the drilling device drill the borehole from the selected location in the existing wellbore thereby generating drill cuttings wherein during operation of the drilling device, a first stream of produced fluid flows directly to the surface through the hydrocarbon fluid production conduit and a second stream of produced fluid is pumped over

the cutting surfaces of the drilling device via a remotely controlled electrically operated downhole pumping means and the drill cuttings are transported away from the drilling device entrained in the second stream of produced fluid.

The method and apparatus according to the present invention can be utilized in processes such as those described in US 6,305,469 and WO 2004/011766. For example, the deployment valve can be passed through the production tubing to a position at which the deployment valve is at least partially within the production tubing and then radially expanding the body of the deployment valve to attach the deployment valve to the end of the production tubing to form a connection resulting from the interference between the external surface of the deployment valve and the production tubing.

In the method of WO 2004/011766 a tubing can be provided to convey the second stream of produced fluid to the drill bit or to carry the fluid and drill cuttings away from the drill bit. This tubing may extend from the drill bit to the production tubing. The second wellbore can be quite long, e.g. in excess of 1 kilometre. The deployment valve according to the present invention can be used to create a lubricator length in the first wellbore to allow a long length of tubing to be safely introduced into the wellbore.

The invention will now be described with reference to the accompanying drawings in which:

Fig 1 is a schematic sectional drawing of a deployment valve according to the present invention.

Fig 2 is a schematic view in direction A of the deployment valve shown in Fig 1, but not on the same scale.

Fig 3 is a schematic view in direction B of the deployment valve shown in Fig 1, but not on the same scale.

Fig 4 is an isometric representation of a molded flapper valve element suitable for use in the present invention prior to cutting away the wastage.

Fig 5 is a top view of the mould of Fig 4.

Fig 6 is a cross-section along AA of Fig 5.

Fig 7 is a cross-sectional illustration of a flapper valve element similar to that shown in Figs 4 to 6 except that it is produced by welding.

Fig 8 is a schematic representation of the basic elements of the method and apparatus according to the present invention

Figs 9 to 13 are schematic representations of underbalanced drilling using a deployment valve according to the present invention.

Fig 14 is a schematic representation of an existing wellbore which penetrates into a reservoir formation from which existing wellbore a new wellbore is being drilled under underbalanced drilling conditions.

Fig 15 is a schematic representation of an existing wellbore which penetrates into a reservoir formation from which existing wellbore, a new wellbore is being drilled under underbalanced drilling conditions and in which a sandscreen is installed.

Figures 1 to 3 show a deployment valve according to the present invention. The valve comprises a tubular body 1 and a flapper valve element 2. The tubular body 1 is radially expandable and comprises a substantially cylindrical section 3 and a deformed section 4 which comprises a fold in the wall of the tubular body. The flapper valve element 2 has a sealing surface 5 and a reinforcing portion 6 and is mounted on a support bracket 7 via a pin 8 about which the flapper valve element 2 can be rotated. The support bracket 7 is attached to the tubular body 1 within the fold of the deformed section 4. The mounting of the flapper valve element 2 in this manner means that it is positioned towards the central axial plane 9 of the tubular body 1. As seen more clearly in Figs 2 and 3, this positioning and the slightly curved shape of the flapper valve element 2 means that the flapper valve element is substantially the same width as the outer diameter of the substantially cylindrical section 3 of the tubular body 1. The curve of the flapper valve element (2) has brought the edges of the valve element towards each other, thereby reducing the maximum dimension of the valve element transverse to the longitudinal axis of the tubular body of the deployment valve, i.e. the distance across the valve element as shown in Figure 2 is less than the diameter that the valve element will have when operational with the sealing surface (5) substantially flat. An elastomeric seal 10 is positioned on the end of the tubular body against which the flapper valve element will close. When the deployment valve is radially expanded as further described below, the deformed portion 4 is reformed to a substantially circular cross-section and the diameter of the whole of the tubular body 1 can be increased. Reformation of the deformed portion 4 moves the support bracket radially outwardly such that when the flapper valve element 2 is closed against the end of the tubular body 1, it forms a seal against the elastomeric seal 10.

Figs 4 to 6 show a flapper valve molding. The valve can be molded from any suitable material, for example an elastomeric material which is essentially inert to fluids in the wellbore. In the figures, the flapper valve element has not yet been cut out from the molding. Thus the four corners 11, 12, 13 and 14 would be cut away leaving the substantially circular flapper valve element 2 with a connecting arm 15. The flapper valve element 2 has a sealing surface 16 and a reinforcing portion 17. The reinforcing portion 17 provides sufficient strength for the flapper valve to resist the downhole pressure, but provides sufficient flexibility to allow the flapper valve element 2 to be curved as shown in Figs 1 to 3 to facilitate installation. The curvature could be provided during manufacture, by subsequent treatment or may be achieved by physically deforming and restraining the flapper valve element during installation.

Fig 7 illustrates a flapper valve similar to that shown in Figs 4 to 6 except that it is produced by welding rather than moulding. The flapper valve element comprises a sealing plate 18 to which reinforcing elements 19 have been welded as shown by welds 20. Preferably, the flapper valve element is made of stainless steel. It is possible that the welding of the reinforcing elements 19 to the sealing plate may cause some distortion of the sealing plate. Generally, flapper valves require a substantially flat surface on the flapper valve element to achieve a good seal with the valve body. It might have been expected that any distortion would have an unacceptable impact on the sealing quality of the valve. However, it has been found that the flexibility provided by the design of the plate and welded reinforcing elements allows a good seal to be achieved.

A flapper valve element similar to those illustrated in Figs 4 to 7 could also be produced by machining from a block of material.

In any of the moulded, welded or machined designs of flapper valve element, the dimensions of the reinforcing elements, their spacing and the thickness of the sealing surface or plate will depend on the overall dimensions of the valve and the pressures to be contained.

Fig 8 is an elevational schematic view of an underbalanced wellbore operation. A drill bit 21 is shown at the bottom of a wellbore 22 and is drilling in open hole. The wellbore has been drilled through a first formation 23 until a reservoir formation 24 was reached. Casing 25 with a casing shoe 26 at its lower end has been arranged in the wellbore and fixed in position with cement 27. A production tubing 28 has been installed

within the casing 25 which is provided at its lower end with an inflatable packer 29. A well head 30 at the surface provides fluid communication between the production tubing 28 and a hydrocarbons processing facility 31 via pipeline 32. The well head 30 comprises the usual equipment for controlling the flow of fluids from a well, including safety valves and blow out preventers. At the end of the production tubing 28 is a deployment valve 33. The deployment valve is a flapper valve and the valve element is show in the open position. The deployment valve has been installed by passing the deployment valve down through the production tubing and then expanding the tubular body of the deployment valve to fix it to the bottom of the production tubing 28. As drilling continues into the reservoir formation, production fluids flow into the wellbore 22, up the production tubing 28 to the wellhead 30 and thence to the processing facility 31 via pipeline 32.

Figs 9 to 13 illustrate the use of a deployment valve in underbalanced drilling. Elements common with the wellbore shown in Fig 8 have the same numerals. Thus, in Fig 9, the wellbore is lined with casing 25 within which is positioned a production tubing 28 having a deployment valve 33 at the lower end thereof. The deployment valve 33 is located at a well depth which is significantly below the string light position for the drill string. The wellbore 22 has been drilled through formation 23 into reservoir formation 24. The flapper valve element of the deployment valve 33 is closed. The drill string and drill bit 21 have been tripped into the well bore conventionally until the drill bit 21 is positioned above the closed deployment valve 33. At the surface, the pipe rams (not shown) are closed and the production tubing is pressurized up to the pressure in the wellbore at the location of the deployment valve 33. As shown in Fig 10, the flapper valve element of the deployment valve 33 is opened. At the surface, the well will be allowed to flow to reduce the surface pressure to a safe flowing pressure. The pipe rams (not shown) are opened and the drill string and drill bit 21 are tripped further into the well bore. In Fig 11, the drill bit 21 has reached the end of the wellbore and drilling has commenced, with the deployment valve 33 open. In Fig 12, the drill string is being withdrawn from the well. The drill string and drill bit 21 have been withdrawn to a position above the deployment valve 33. Since the deployment valve 33 is positioned significantly below the string light position for the drill string, there is little risk of the formation pressure causing the drill string to move upwardly. In Fig 13, the deployment valve 33 is closed and the pressure within the production tubing 28 is reduced. Isolating and reducing the pressure within the production

tubing 28 from the formation pressure in this manner allows the drill string and bit 21 to be tripped out of the well conventionally and safely.

Fig 14 is an illustration of an existing wellbore which penetrates into a reservoir formation from which existing wellbore a new wellbore is being drilled under underbalanced drilling conditions. Similar elements to the wellbore shown in Fig 8 have the same reference numerals.

An existing wellbore 34 penetrates through an upper formation 23 and into a hydrocarbon-bearing formation 24. A metal casing 25 is arranged in the existing wellbore 34 and is fixed to the wellbore wall by a layer of cement 27. A production tubing 28 is positioned within the existing wellbore 34 and an inflatable packer 29 is provided at the lower end of the production tubing 28 to seal the annular space formed between the production tubing 28 and the casing 25. Positioned at the end of the production tubing 28 is a deployment valve 33 according to the present invention. The deployment valve 33 is installed by passing the deployment valve 33 through the production tubing 28 and then radially expanding the deployment valve so that it locates on the lower portion of the production tubing. A wellhead 30 at the surface provides fluid communication between the production tubing 28 and a hydrocarbon fluid processing facility 31 via a pipe 32. An expandable whipstock 35 is passed through the production tubing 28 and is locked in place in the casing 25 of the existing wellbore 34 via radially expandable locking means 36. Instead of the tubular drill string represented in Fig 8, the apparatus illustrated in Fig 14 utilises a wireline drill string. A remotely controlled electrically operated drilling device 37 is passed into the existing wellbore through the production tubing 28 suspended on a reinforced steel cable 40 comprising at least one electrical conductor wire or segmented conductor (not shown). The lower end of the reinforced steel cable 40 passes through a length of steel tubing 38 which is in fluid communication with a fluid passage (not shown) in the drilling device 37. The drilling device 37 is provided with an electrically operated steering means, for example, a steerable joint (not shown) and an electric motor (not shown) arranged to drive a means (not shown) for rotating drill bit 21 located at the lower end of the drilling device 37. A cylindrical housing 41 is attached to the upper end of the steel tubing 38. The drilling device 37 and/or the housing 41 are provided with an electrically operated pump (not shown) and electrically operated traction wheels or pads 42 which are used to advance the drilling device 37 through a new wellbore section 43. The

cable 40 passes through the housing 41 and the interior of the steel tubing 38 to the drilling device 37.

The new wellbore section 43 is drilled using the drilling device 37, the new wellbore section 43 extending from a window 44 in the casing 25 of the existing wellbore 34 into the hydrocarbon-bearing zone 24 and being a side-track well or lateral well. The window 44 may have been formed using a drilling device comprising a mill which is passed through the production conduit 28 suspended on a cable and is then pulled from the existing wellbore. During drilling of the new wellbore section 43, produced fluid may be pumped down the interior of the steel tubing 38 to the drilling device 37 via a pump located in the cylindrical housing 41. The produced fluid flows from the steel tubing 38 through the fluid passage in the drilling device to the drill bit 21 where the produced fluid serves both to cool the drill bit 21 and to entrain drill cuttings. The drill cuttings entrained in the produced fluid are then passed around the outside of the drilling device 37 into the annulus 39 formed between the steel tubing 38 and the wall of the new wellbore section 43 ("conventional circulation" mode). Alternatively, produced fluid may be pumped through the annulus 39 to the drill bit 21. The drilling cuttings entrained in the produced fluid are then passed through the passage in the drilling device and into the interior of the steel tubing 38 ("reverse circulation" mode).

A plurality of formation evaluation sensors (not shown) may be located: on the drilling device 37 in close proximity to the drill bit 21; on the end of the steel tubing 38 which is connected to the drilling device 37; along the lower end of the cable 40 that lies within the steel tubing 38; and/or along the outside of the steel tubing. The formation evaluation sensors are electrically connected to recording equipment (not shown) at the surface via electrical wire(s) and/or segmented conductor(s) which extend along the length of the cable 40. Where sensors are located on the outside of the steel tubing, the sensors may be in communication with the electrical wire(s) and/or segmented conductor(s) of the cable 40 via electromagnetic means. As drilling with the drilling device 37 proceeds, the formation evaluation sensors are operated to measure selected formation characteristics and to transmit signals representing the characteristics via the electrical conductor wire(s) and/or segmented conductor(s) of the cable 40 to recording equipment at the surface (not shown).

A navigation system (not shown) for the steering means may also be included in the drilling device 37 to assist in navigating the drilling device 37 through the new wellbore section 43.

The steel tubing 38 may be expandable tubing. After drilling of the new wellbore section 43, the expandable steel tubing 38 may be radially expanded to form a liner for the new wellbore section 43 and the drilling device 37 may be retrieved by pulling the cable from the wellbore and/or by actuating the traction wheels or pads 42 such that the drilling device passes through the expanded steel tubing and the hydrocarbon fluid production conduit 28. Methods and apparatus for installing expandable tubulars in oil and gas wells are known and any such methods may be used in the present invention.

Where the steel tubing 38 is not expandable, the steel tubing 38 may be provided with at least one radially expandable packer. The packer(s) may be expanded to seal the annulus formed between the steel tubing 38 and the new wellbore section 43 thereby forming a sealed liner for the new wellbore section 43. Where a pump is located in the housing of the drilling device 37, this pump may be disconnected from the housing and may be retrieved through the interior of the steel tubing 38.

The liner for the new wellbore section may then be perforated to allow hydrocarbons to flow through the interior thereof into the production conduit 28.

The new wellbore section 43 can be relatively long, typically in excess of a kilometre. Installing the steel tubing 38 in a producing well can present difficulties, especially if it is desired not to kill the well.

An effective seal can be made around solid steel pipe or coiled tubing. Thus, the conventional methods for introducing pipe strings into a well can be used if the steel tubing 38 is sufficiently strong. However, it would be preferable to use flexible tubing for the tubing 38. Coiled tubing and solid tubing are both relatively heavy and relatively expensive and costly to deploy. Although, lighter, lower cost and less stiff polymer tubes could be used as the tubing 38, it can be difficult to introduce it into the well. Being lighter, it may become string light at a much shallower depth. Also it is not easy to seal around the pipe at the surface.

As indicated above, when introducing tools or drilling on wireline, the downhole assembly can be made up above the sealing valves which are present in the so-called Christmas tree at the surface of the wellbore. The length of tubing which accommodates

the downhole assembly prior to introducing it into the wellbore via the Christmas tree is generally called a lubricator. The lubricator is generally only about 30 to 40 feet long (9 to 12 m). It is therefore not possible to introduce long lengths of tubing using only the lubricator. In most wells there is a further safety valve positioned about 500 to 1000 ft (150 to 300m) below the surface. The length of wellbore above this sub-surface safety valve could be used to assemble the steel tubing 38 so that it could be lowered into the well. However, this section is still relatively short. Furthermore, since it is not easy to effectively seal around the supporting wire in wireline drilling or around a flexible pipe, it would be preferable not to have the valves in the Christmas tree open whilst relying on the sub-surface safety valve as the sole valve for holding back the well pressure.

The use of the deployment valve according to the present invention allows long lengths of flexible tubing 38 to be introduced into the wellbore for introduction into the new wellbore section 43 in the manner described with reference to Fig 14. By withdrawing the wireline drilling apparatus to above the deployment valve 33 and closing the valve, the pressure in the production tubing can be reduced to a safe operating pressure. The steel tubing can then be introduced into the wellbore without risk of it encountering string light conditions. The deployment valve 33 may be at a depth in excess of 1 km, possibly greater than 3 kilometres. This provides sufficient length for the introduction of a relatively long length of steel tubing 38. Effectively, the production tubing 28 and deployment valve 33 act as a very long lubricator. After introducing the steel tubing 38 into the wellbore, the pressure within the production tubing 28 above the closed deployment valve 33 can be increased and then the deployment valve is opened to allow passage of the wireline drilling apparatus and steel tubing 38 to the new wellbore section 43. Production fluids can then continue to be withdrawn via the production tubing 28.

Fig 15 is similar to Fig 14 and the same elements have the same reference numerals, but instead of steel tubing 38 there is provided plastic tubing 46 and a sandscreen 47. The plastic tubing 46 is in fluid communication with a fluid passage (not shown) in the drilling device 37. The sandscreen 47 is positioned around the plastic tubing 46 and is releasably connected to the drilling apparatus 37. The plastic tubing 46 can, like the steel tubing 38 in Fig 14, be used to transport fluid to or from the drilling apparatus 37. After drilling of the new wellbore section 43, the sandscreen may be expanded, for example, by sealing the plastic tubing 46 and pressurising with fluid to expand the plastic tubing 46 which in turn

Claims

1. A sub-surface deployment valve comprising a radially expandable body (1) having an internal bore and a valve element (2) capable of closing off the internal bore.

2. A deployment valve as claimed in claim 1 comprising a radially expandable tubular body (1) having a flapper valve element (2) attached to the expandable tubular body at one end thereof by pivot connections (7, 8).

3. A deployment valve as claimed in claim 2 in which the expandable tubular body (1) has a folded or deformed wall (4) at least adjacent the flapper valve element (2) such that the pivot means (7, 8) is accommodated within the folded wall and supports the flapper valve element in the open position, such that its widest dimension is positioned towards the central axial plane (9) of the tubular body

4. A deployment valve as claimed in claim 2 or claim 3 in which the flapper valve element (2) is substantially circular and deformable so that it can be passed through a tube (28) of smaller diameter.

5. A deployment valve as claimed in any one of claims 2 to 4 in which the flapper valve element (2) comprises a sealing surface (16) and a reinforcing portion (17) which is attached to or integrally formed with the sealing surface (16), the reinforcing portion (17) comprising substantially parallel ribs the longitudinal axis of which are in the same axis as the longitudinal axis of the tubular body, when the valve element is in the open position (1).

6. A method for drilling a wellbore having located within the wellbore a tubular string comprises positioning a deployment valve at least partially within the tubular string such that, once the deployment valve is installed, a drill string can be moved through the deployment valve wherein the deployment valve comprises a radially expandable body (1) with an internal bore and a valve element (2) capable of closing off the internal bore, the method further comprising attaching the deployment valve to or in the tubular string by radially expanding the radially expandable body of the deployment valve to form a connection resulting from the interference between the external surface of the deployment valve and the tubular string

7. A method as claimed in claim 6 in which the tubular string is production tubing.

8. A method as claimed in either claim 6 or claim 7 in which the deployment valve comprises a radially expandable tubular body having attached thereto a flapper valve element.

9. A method as claimed in any one of claims 6 to 8 in which the drilling is carried out under underbalanced conditions and the deployment valve is located below the string light position of the drill string.

10. A method as claimed in claim 9 in which the drill string can be removed from the wellbore by withdrawing the drill string into the production tubing, to a position where the lower part of the drill string is above the deployment valve, but below the drill light position, closing the deployment valve and reducing the pressure within the production tubing.

11. A method as claimed in claim 6 for drilling a borehole from a selected location in an existing wellbore penetrating a subterranean earth formation having at least one hydrocarbon fluid bearing zone wherein the existing wellbore is provided with at least one surface valve, a casing and a hydrocarbon fluid production conduit arranged in the wellbore in sealing relationship with the wall of the casing, comprising:

(a) passing a remotely controlled electrically operated drilling device from the surface through the hydrocarbon fluid production conduit to the selected location in the existing wellbore;

(b) operating the drilling device such that cutting surfaces on the drilling device drill the borehole from the selected location in the existing wellbore thereby generating drill cuttings wherein during operation of the drilling device, a first stream of produced fluid flows directly to the surface through the hydrocarbon fluid production conduit and a second stream of produced fluid is pumped over the cutting surfaces of the drilling device via a remotely controlled electrically operated downhole pumping means and the drill cuttings are transported away from the drilling device entrained in the second stream of produced fluid.

wherein,

(c) a relatively long tubing is provided to convey the second stream of produced fluid to the drill bit or to carry the fluid and drill cuttings away from the drill bit, and

(d) the deployment valve is located at a depth such that when the tubing is installed or removed from the wellbore, there is a sufficient length within the production tube between the surface valve and the deployment valve to accommodate the relatively long tubing.

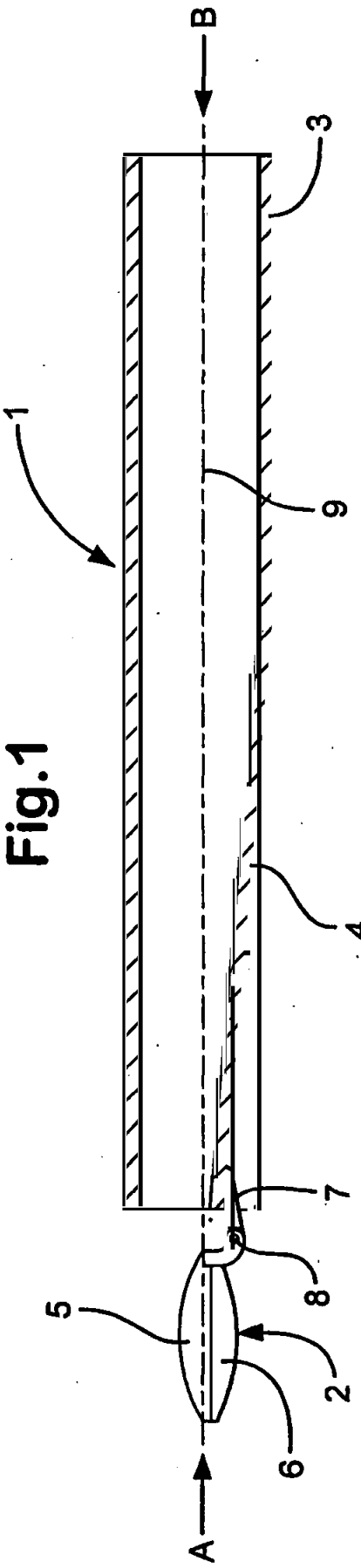


Fig.1

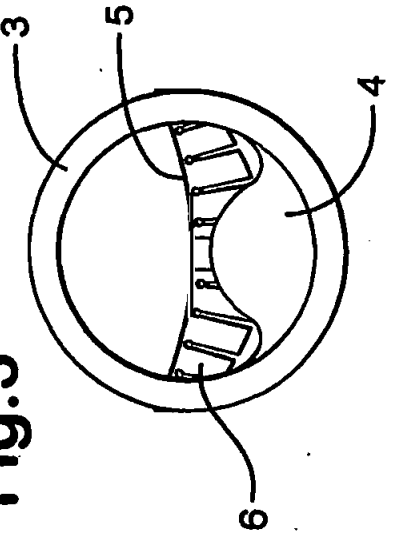


Fig.3

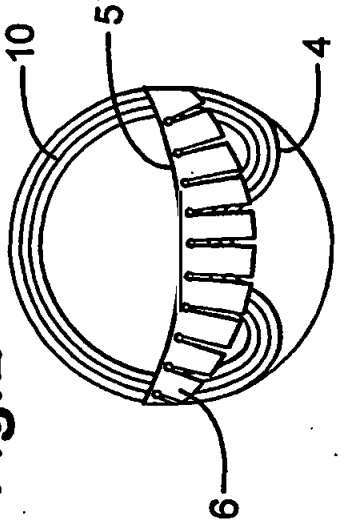
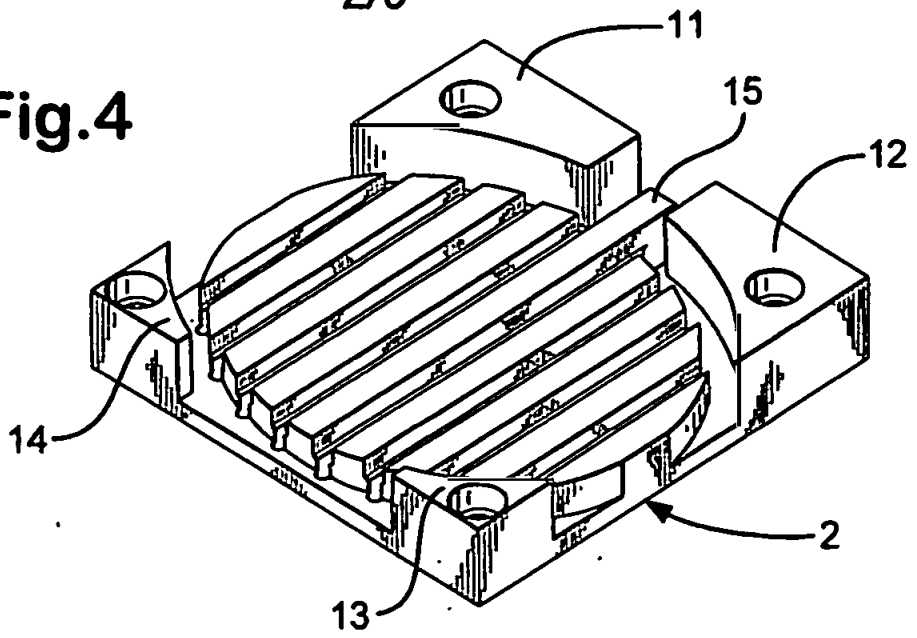


Fig.2

Fig.4



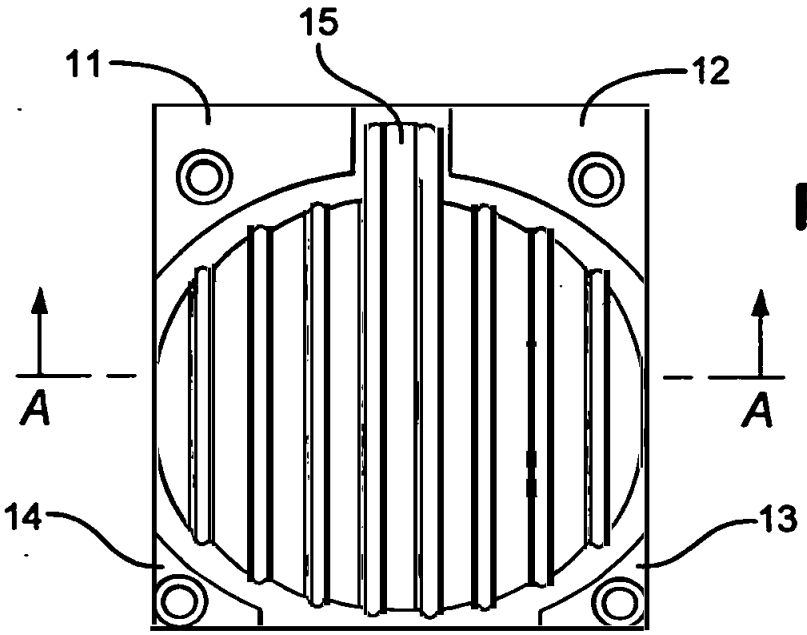
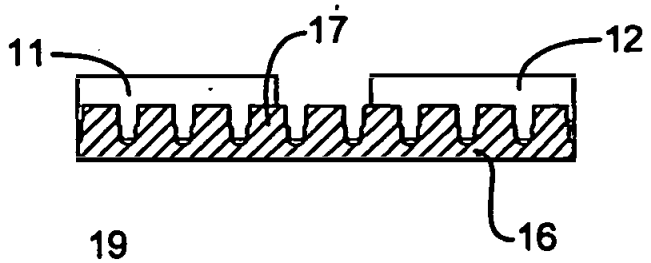


Fig.5

Fig.6



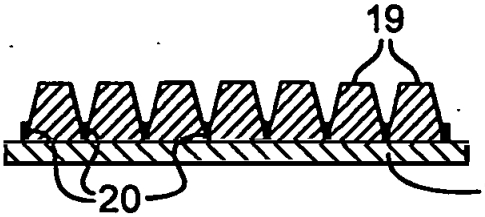


Fig.7

Fig.8

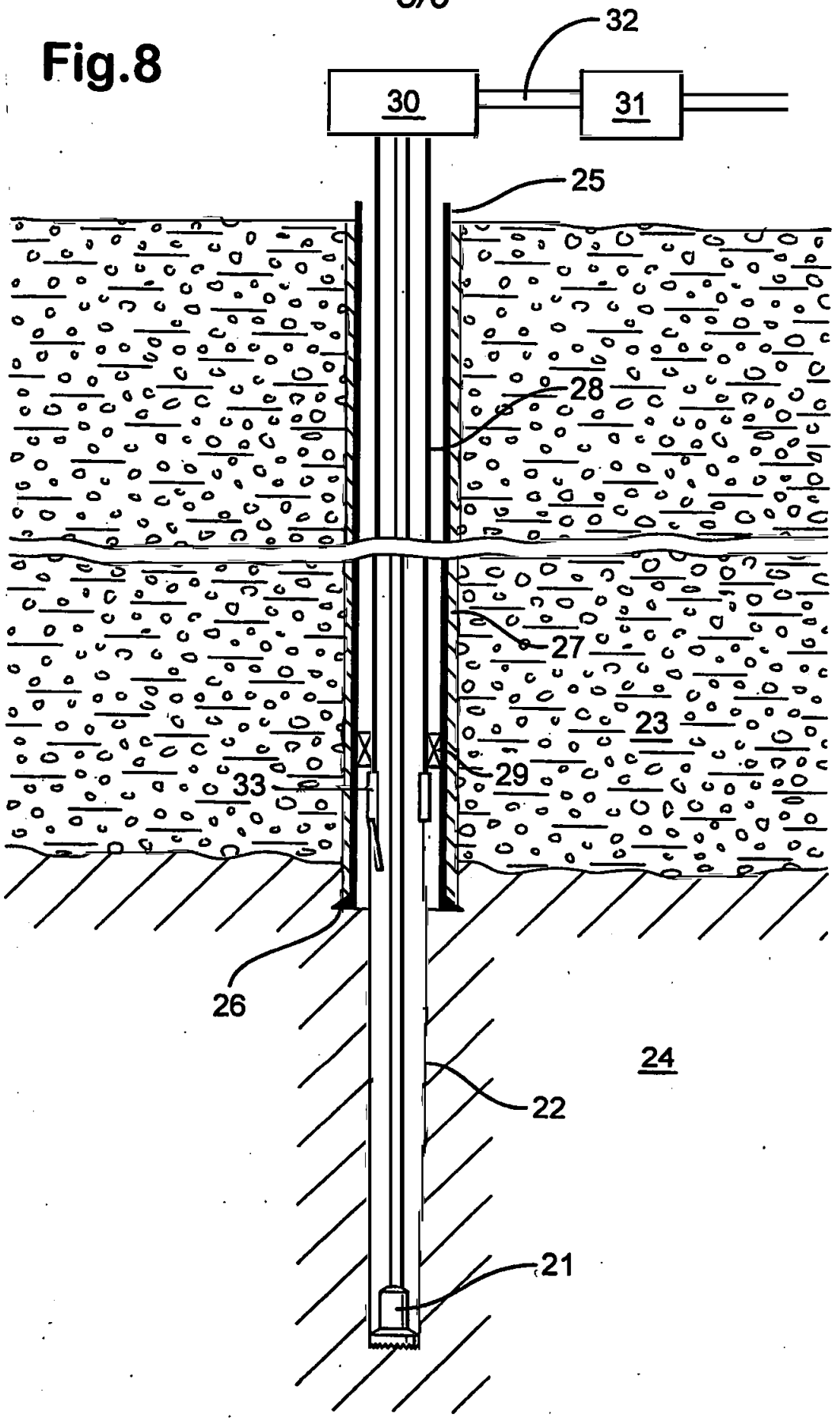


Fig.13

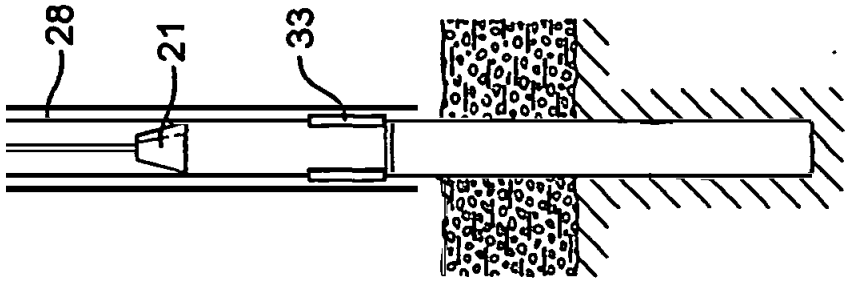


Fig.12

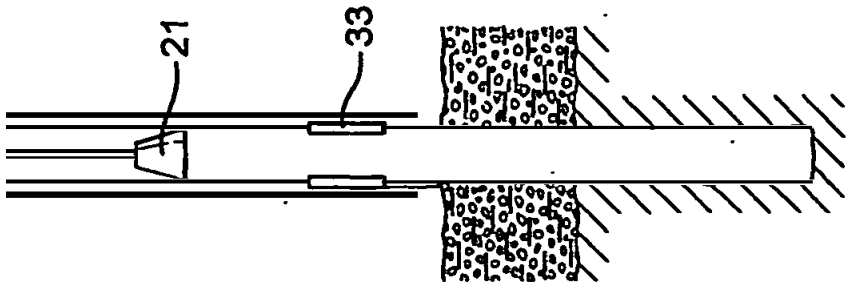


Fig.11

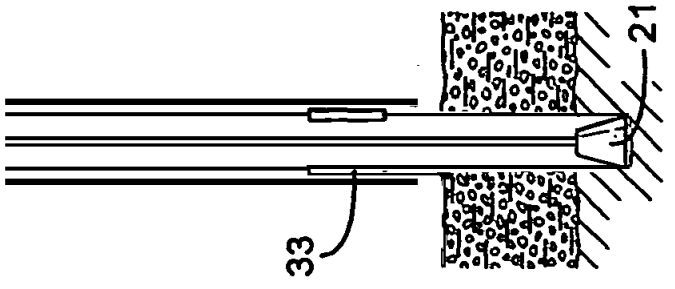


Fig.10

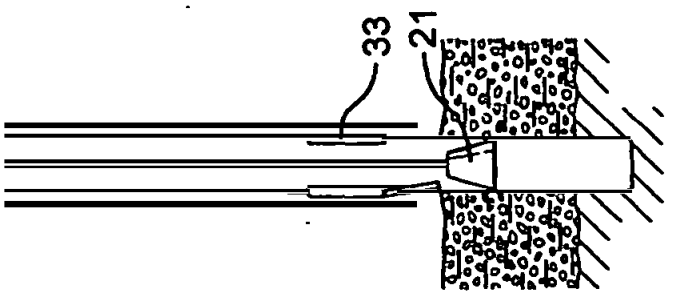


Fig.9

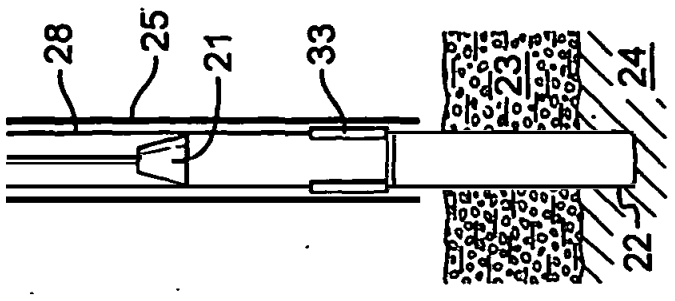


Fig.14

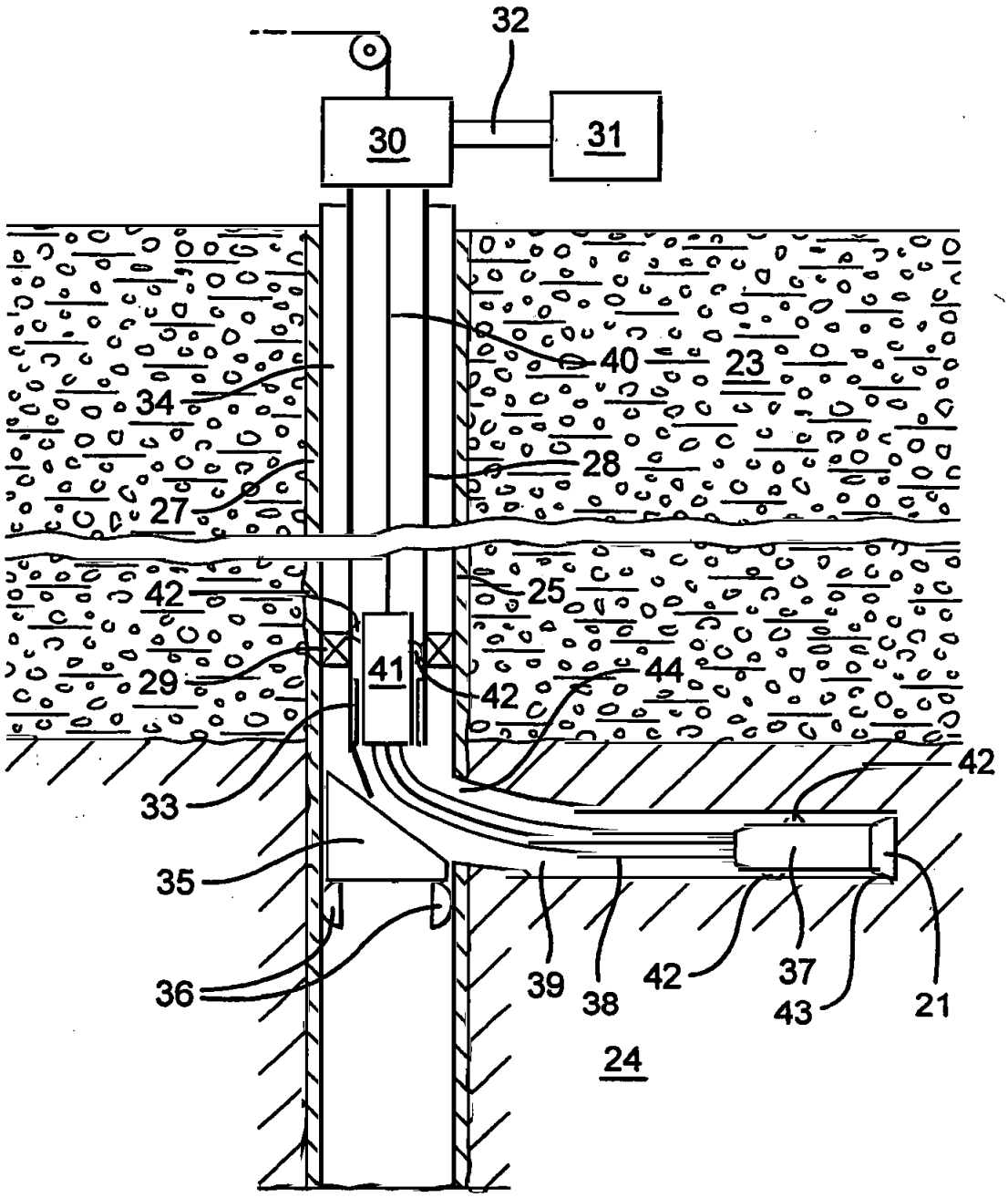

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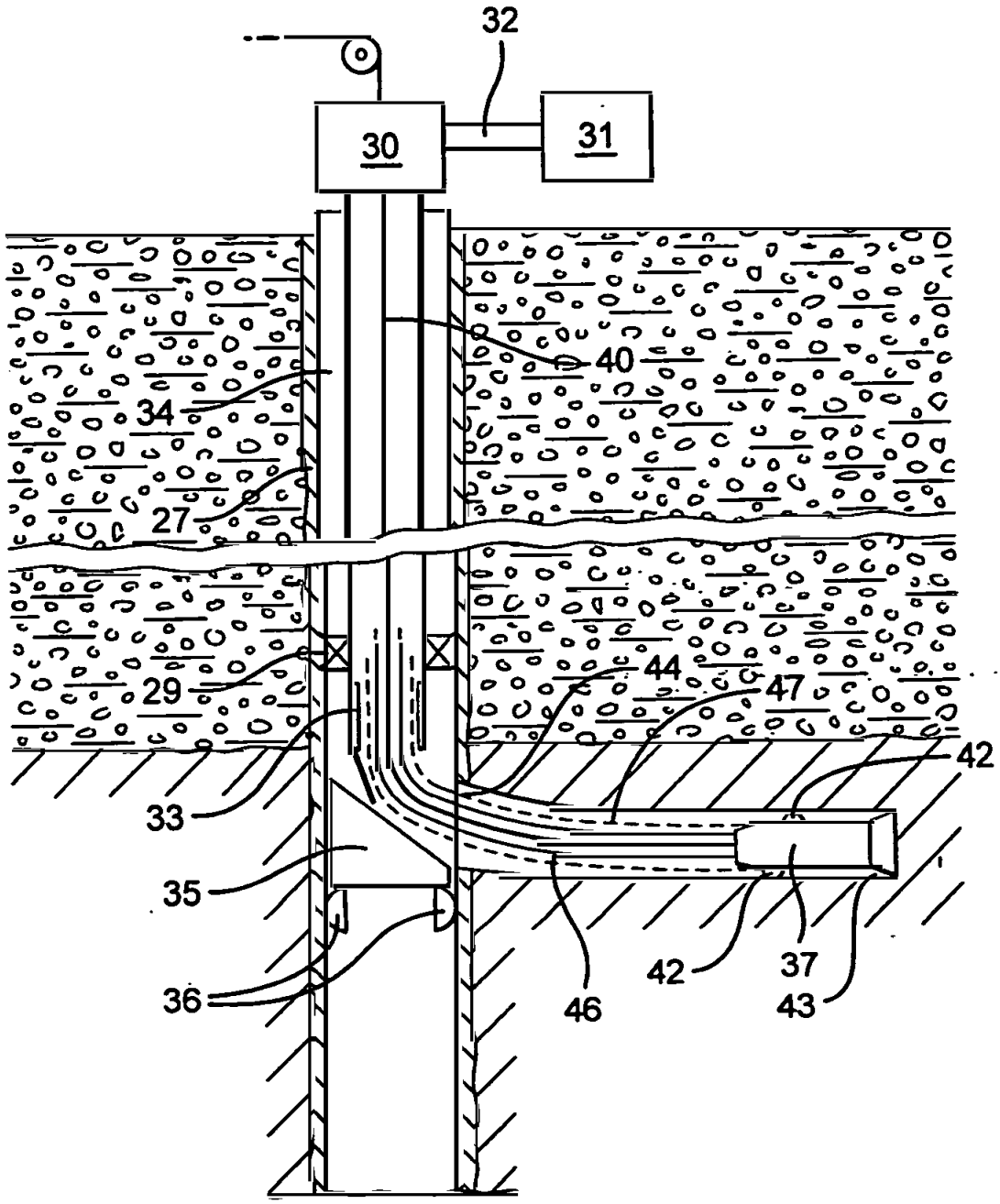
Fig.15



PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
10281		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GB2006/003306	07/09/2006	21/09/2005
Applicant		
BP EXPLORATION OPERATING COMPANY LIMITED		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 6 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      [X] the international application in the language in which it was filed
      [ ] a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. [ ] With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. [ ] **Certain claims were found unsearchable** (See Box No. II)

3. [X] **Unity of invention is lacking** (see Box No III)

4. With regard to the **title**,
   [X] the text is approved as submitted by the applicant
   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,
   [X] the text is approved as submitted by the applicant
   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority

6. With regard to the **drawings**,
   a. the figure of the **drawings** to be published with the abstract is Figure No. 1
      [X] as suggested by the applicant
      [ ] as selected by this Authority, because the applicant failed to suggest a figure
      [ ] as selected by this Authority, because this figure better characterizes the invention
   b. [ ] none of the figures is to be published with the abstract

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2006/003306

A. CLASSIFICATION OF SUBJECT MATTER
INV. E21B43/10 E21B34/10

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E21B

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/226723 A1 (SIMPSON NEIL ANDREW ABERCROMBI [GB]) 18 November 2004 (2004-11-18) paragraph [0079]; figure 19	1
Y		2,5
X	US 3 401 946 A (MALONE BILLY C) 17 September 1968 (1968-09-17) figures 3,5	1
Y	GB 2 197 011 A (AVA INT CORP) 11 May 1988 (1988-05-11) figure 1 when combined with US 2004/226723	2

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

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

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

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 March 2007	13/03/2007

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

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Form PCT/ISA/210 (second sheet) (April 2005)

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4 378 818 A (CORMIER JR ARTHUR J [US]) 5 April 1983 (1983-04-05) column 3, lines 43-45; figures 2,3,5,6 when combined with US 2004/226723	5
A	EP 0 598 139 A1 (KOMATSU MFG CO LTD [JP]) 25 May 1994 (1994-05-25) figure 1	1-5
A	GB 2 373 268 A (KELLER LTD [GB]) 18 September 2002 (2002-09-18) figure 5	1-5
A	US 4 487 525 A (SHIOTSUBO MASAMI [JP] ET AL) 11 December 1984 (1984-12-11) figure 3	1-5
A	US 3 847 214 A (CUSHMAN W) 12 November 1974 (1974-11-12) figure 2	1-5
A	GB 2 337 544 A (GULF TECHNOLOGIES INTERNATIONA [US] GULF TECHNOLOGIES INTERNAT L C [US]) 24 November 1999 (1999-11-24) page 1, lines 3-5; figures 2,3,10,11 page 5, lines 16-24 page 6, lines 20,21 page 7, lines 9-12 page 8, lines 6,7,19,20,24,25 page 14, lines 15,16,19,20,23,24	6-11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2006/003306

Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.

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FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-5

A sub-surface deployment valve comprising a radially expandable body having an internal bore and a valve element capable of closing off the internal bore, wherein (claim 2) the expandable tubular body has a flapper valve element attached to the expandable tubular body at one ened thereof bypilot connections.
The technical problem to be solved can be seen as how to provide a specific valve element to close the through bore of the valve.

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2. claims: 6-11

A method for drilling a wellbore having located within the wellbore a tubular string, comprises positioning a deployment valve in the tubular string such that, a drill string can be moved through the deployment valve which comprises a radially expandable body with an internal bore and a valve element capable of closing off the internal bore, the method comprising attaching the valve to the tubular string by radially expanding the radially expandable body of the valve to form a connection resulting from the interference between the external surface of the valve and the tubular string.
The technical problem to be solved can be seen as how to drill while reducing the number of trips needed.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2006/003306

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004226723 A1	18-11-2004	NONE	
US 3401946 A	17-09-1968	NONE	
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VALVULA DE DESPLIEGUE SUBTERRANEA

La presente invención se refiere a una válvula de despliegue subterránea adecuada para utilizarse en la perforación hipocompensada. En particular, la invención se refiere a un aparato y métodos para instalar y utilizar una válvula de despliegue subterránea que se puede instalar a través de una sarta tubular existente en un pozo de petróleo o gas.

En los métodos de perforación rotativa convencionales se perfora un pozo haciendo girar un trépano al cual se aplica una fuerza descendente. El trépano está unido a, y es girado por, una sarta de perforación que tiene un paso a través del cual circula un fluido de perforación. El fluido de perforación, conocido normalmente como lodo de perforación, se hace circular en general descendentemente por el pozo a través del paso de la sarta de perforación, pasa por el trépano y retorna a la superficie a través de un espacio anular existente entre la sarta de perforación y la pared del pozo. Sin embargo, el lodo de perforación se puede hacer circular en la dirección inversa. El lodo de perforación presenta varias funciones, incluyendo el enfriamiento y lubricación del trépano y de la sarta de perforación, el transporte de los detritos de la perforación desde el fondo del pozo a la superficie, la protección contra erupciones por presiones de contención subterráneas y la deposición de una torta de lodo sobre la pared del pozo para evitar la pérdida de fluidos en la formación. Cuando se perfora a través de una formación que no contiene un fluido, tal como agua, gas o petróleo, el peso y la velocidad de bombeo del lodo de perforación se eligen de manera que la presión en la pared del pozo se mantenga entre una presión más baja a la cual el pozo llega a ser inestable y una presión superior a la cual la pared del pozo se fractura. Cuando el pozo es perforado a través de una zona que contiene fluido, la presión del lodo de perforación se elige generalmente para que se encuentre por encima de la presión a la cual el fluido comienza a fluir al interior del pozo (presión de la formación) y por debajo de la presión a la cual ocurre la invasión indeseada de lodo de perforación en la formación. Esto es referido generalmente como una perforación sobrecompensada.

Los pozos perforados se revisten generalmente con sartas tubulares,

normalmente tubería de acero, lo que se conoce como el entubado. El entubado aporta soporte al pozo y facilita el aislamiento de ciertas secciones del pozo adyacentes a las formaciones portadoras de hidrocarburos. El entubado se extiende habitualmente descendentemente por el pozo desde la superficie del pozo y la corona anular entre el exterior del entubado y la pared del pozo se llena normalmente, pero no necesariamente, con cemento para fijar permanentemente el entubado en el pozo.

A medida que el pozo es perforado a una nueva profundidad, se desplazan por el interior del pozo sartas tubulares adicionales hasta esta profundidad, con lo que la porción superior de la sarta tubular (referida frecuentemente como "tubería de revestimiento"), queda superpuesta a la porción inferior del entubado. La tubería de revestimiento se fija o se cuelga entonces en el pozo, normalmente por ciertos medios de deslizamiento mecánicos bien conocidos en la técnica.

Los métodos conocidos de perforación rotativa sobrecompensada han sido reconocidos desde hace tiempo como métodos seguros para perforar un pozo. Sin embargo, un inconveniente importante de tales métodos es que, puesto que la presión del lodo de perforación es mayor que la presión natural de la formación, se presenta frecuentemente una invasión de fluido, causando daños en la permeabilidad de la formación.

La perforación hipocompensada se diferencia de la perforación sobrecompensada más convencional en que la presión que circula por el fondo del pozo es más baja que la presión de la formación, permitiendo con ello el flujo en el pozo mientras procede la perforación. De este modo, cuando se perfora a través de una formación que contiene petróleo o gas, se puede obtener la producción de un pozo antes de su terminación. La perforación hipocompensada también se puede emplear en formaciones que contienen otros fluidos, tal como agua. En esta descripción, el término "formación del yacimiento" se utiliza para representar cualquier formación de roca o tierra que contenga un fluido a presión.

Las ventajas que han sido reivindicadas para la perforación hipocompensada incluyen:

- El mantenimiento de la presión del pozo por debajo de la presión del yacimiento

permite que los fluidos del yacimiento entren en el pozo, evitando así daños en la formación. Dado que se evita un daño importante en la formación, se reducen también los requisitos de estimulación durante la terminación del pozo, conduciendo ello a ahorros considerables.

- Durante la perforación hipocompensada no existe mecanismo físico para obligar al fluido de perforación al interior de la formación perforada. Por tanto, la pérdida de circulación se mantiene en un mínimo cuando se encuentran zonas fracturadas o de alta permeabilidad.
- La perforación hipocompensada puede ayudar a detectar zonas potenciales de hidrocarburos, incluso identificando zonas que habrían sido obviadas por los métodos de perforación convencionales.
- Debido a la menor presión en la cabeza del trépano, las operaciones de perforación hipocompensada pueden presentar velocidades de penetración superiores en comparación con las técnicas convencionales de perforación sobrecompensada. Junto con menores tiempos de perforación, a veces se ha registrado un incremento en la vida de servicio del trépano.
- Puesto que no existe torta de filtración alrededor de la pared del pozo, las posibilidades de adherencia diferencial también se reducen.

Sin embargo, la perforación hipocompensada también tiene algunos inconvenientes. Por ejemplo, puede ser más difícil controlar el pozo en ciertas circunstancias. En particular, pueden surgir problemas cuando sea necesario retirar la sarta de perforación del pozo o ponerla de nuevo en el pozo. La presión en el pozo es controlada generalmente en la superficie, tal como por medio de una armadura para prevenir erupciones (BOP). El peso de la sarta de perforación mantiene a la misma dentro del pozo. Sin embargo, a medida que se retiran secciones de la sarta de perforación, la misma llega a ser más ligera hasta que se alcanza una profundidad en la cual las fuerzas ascendentes que actúan sobre la sarta de perforación llegan a ser más grandes que las fuerzas descendentes. Esta profundidad es conocida como el "punto ligero de la sarta". Varios factores afectan en qué lugar exactamente del pozo la sarta de perforación llegará a ser ligera.

El experto en la materia sabe muy bien que las profundidades del pozo pueden no ser las mismas que la profundidad vertical, de manera que las referencias a profundidades en el pozo tales como "por encima" o "por debajo" de ciertas profundidades, se refieren generalmente a profundidades del pozo más que a profundidades verticales.

Con presión en la superficie del pozo, entonces en cierto punto, a medida que la sarta de perforación es retirada, la presión puede comenzar a empujar o acelerar el resto de la sarta de perforación al exterior del pozo. Se trata esto de una situación potencialmente peligrosa que podría dar lugar a una erupción. En el caso de que el movimiento ascendente del tubo no se controle, se puede desarrollar una cantidad de movimiento suficiente tal que la armadura preventiva de las erupciones resulta incapaz de contener el movimiento ascendente. El intento de aproximar los arietes puede dar lugar a un daño en los mismos o incluso a que se rompan en lugar de que los mismos detengan el movimiento ascendente del tubo de perforación. En dicha situación, los arietes pueden no ser capaces de cerrar el pozo una vez que el tubo ha sido empujado del pozo.

Se conocen métodos para evitar una situación de erupciones. Por ejemplo, puede ser posible liberar la presión en la superficie antes de alcanzar el punto ligero de la sarta. Sin embargo, confiar en este método puede ser arriesgado. Es posible formar un puente en la formación de manera que se presente allí una liberación de presión. Si el puente se rompe en el momento equivocado con el tubo de perforación casi fuera del pozo, se puede aplicar entonces, en la superficie, una presión importante en la formación que da lugar a una erupción.

Una práctica muy eficaz y segura consiste en ahogar el pozo antes de retirar la sarta de perforación, es decir, introducir fluido de perforación para proporcionar una presión en el pozo que es mayor que la presión en la formación. Sin embargo, esta práctica es indeseable debido a que se pueden perder las ventajas de la perforación hipocompensada. En particular, puede ocurrir un daño en la formación como resultado de la presión de los fluidos de perforación usados para ahogar el pozo, lo cual puede ser sustancial o parcialmente irreversible.

Otra práctica muy eficaz y segura consiste en usar la así llamada unidad de inserción de tubería contra presión para retirar la sarta de perforación. La unidad de inserción de tubería contra presión proporciona un medio para retirar e insertar herramientas y material tubular en los pozos a presión y asegura que los pozos puedan ponerse en servicio de manera segura sin tener que utilizar la medida de ahogar con fluido. Sin embargo, esto supone una cantidad importante de tiempo y esfuerzo para instalar dicha unidad de inserción de tubería contra presión, desplazar la sarta de perforación y desinstalar la unidad de inserción de la tubería contra presión, lo cual se traduce todo ello en mayores costes de la perforación.

La Patente US 6.209.663 describe un aparato y métodos para una válvula de despliegue utilizada con un sistema de perforación hipocompensada. La válvula de despliegue se sitúa en una sarta tubular, tal como un entubado, a una profundidad del pozo o preferentemente por debajo sustancialmente del punto ligero de la sarta de perforación. La válvula de despliegue presenta un ánima suficientemente grande para permitir el paso del trépano a través de la misma cuando se encuentra en la posición abierta. La válvula de despliegue puede ser cerrada cuando la sarta de perforación es impulsada al interior del entubado. Para que la sarta de perforación pueda ser retirada del entubado, la presión producida por la formación puede ser liberada y entonces la sarta de perforación puede ser retirada. La sarta de perforación se puede introducir de nuevo, se puede aplicar la presión en el entubado por encima de la válvula de despliegue para compensar preferentemente la presión por encima y por debajo de la válvula de despliegue y la sarta de perforación se puede desplazar al interior del pozo. La válvula de despliegue es desplazada como una parte íntegra del programa de entubado. De este modo, la válvula de despliegue puede ser asegurada en el entubado y desplazada con el mismo o se puede instalar dentro del entubado mediante el desplazamiento de una sarta tubular más pequeña por el interior del entubado.

A veces el interior del pozo inicial presenta una o más restricciones a lo largo de su longitud que reducen el área en sección transversal del pozo. Por ejemplo, el pozo puede tener una sarta de tubería de producción que se dispone

concéntricamente dentro del pozo principal y que es de un diámetro interno más pequeño que el pozo o de cualquier entubado que reviste el pozo. Habitualmente, el pozo tiene un diámetro interno de alrededor de 5 pulgadas (12,7 cm) a 10 pulgadas (25,4 cm), por ejemplo 7 pulgadas (17,8 cm), y la tubería de producción tiene un diámetro interno de alrededor de 2,5 pulgadas (6,4 cm) a 6 pulgadas (15,2 cm), por ejemplo 4,5 pulgadas (11,4 cm). Esto significa que cualquier herramienta que se pasa descendentemente por el interior de dicho pozo, que incluye una sarta de perforación y un trépano, tiene que tener una sección transversal suficientemente pequeña para pasar a través de la restricción con el fin de alcanzar los niveles más bajos del pozo. Esto es lo que se conoce como operaciones de tubería pasante ya que cualesquiera operaciones en el pozo que hayan de realizarse en el mismo por debajo del extremo de la tubería de producción requieren pasar la instalación a través del interior de la tubería de producción antes de que pueda llegar a la zona en donde ha de realizarse la operación en el pozo. La alternativa consistiría en retirar la tubería de producción en su totalidad del pozo, lo cual es un procedimiento costoso y de larga duración. De este modo, es muy conveniente poder pasar herramientas por el pozo que puedan utilizarse en operaciones en el mismo a través del interior de la tubería de producción de diámetro más pequeño descendentemente por debajo del extremo de dicha tubería al interior del pozo de diámetro más grande y poder realizar entonces operaciones en el pozo con esas herramientas en dicha zona más grande del pozo.

Sería de utilidad poder instalar una válvula de despliegue subterránea al término de una restricción del diámetro de un pozo o por debajo de dicha restricción del pozo mediante el desplazamiento de la válvula de despliegue descendentemente a través de la restricción y, en particular, sería de utilidad poder instalar una válvula de despliegue subterránea en el extremo de una tubería de producción o por debajo de la tubería de producción mediante el desplazamiento de la válvula de despliegue descendentemente a través de la tubería de producción. Dicha válvula de despliegue podría proporcionar un medio para retirar de un modo más seguro y/o más rápido una sarta de perforación de una sarta tubular, tal como una sarta de entubado o tubería de producción, cuando la sarta tubular queda expuesta a la presión

relativamente alta de la formación. Sin embargo, dicha válvula de despliegue deberá reducir preferentemente el ánima disponible en la medida tan pequeña como sea posible.

De este modo, de acuerdo con la presente invención, una válvula de despliegue subterránea comprende un cuerpo que puede expansionarse radialmente y que tiene un ánima interna y un elemento de válvula capaz de cerrar el ánima interna.

La válvula de despliegue subterránea, de aquí en adelante válvula de despliegue, está dimensionada de manera que puede pasar a través de una restricción en un pozo y se puede expansionar radialmente de forma suficiente para que se pueda expansionar posteriormente, de modo que el ánima interna expansionada es con preferencia no más pequeña significativamente que las dimensiones de la restricción, preferentemente, el ánima interna no es mayor del 10% más pequeña que las dimensiones de la restricción. Cuando la restricción se encuentra en la tubería de producción, la válvula de despliegue, a través de un diseño e instalación precisos, puede tener un ánima interna después de la expansión que es sustancialmente la misma que el ánima interna de la tubería de producción.

El elemento de válvula puede ser accionado para abrir o cerrar el ánima interna de la válvula de despliegue. Se puede emplear cualquier elemento de válvula adecuado, incluyendo una junta inflable, un elemento de válvula de charnela, una válvula de bola u otro elemento de cierre rotativo o elementos de cierre por acción telescópica.

Una modalidad de la válvula de despliegue comprende un cuerpo tubular que puede expansionarse radialmente y que tiene un elemento de válvula de charnela unido al cuerpo tubular expansionable en un extremo del mismo mediante conexiones de pivote. El cuerpo tubular expansionable presenta preferentemente una pared doblada o deformada al menos en posición adyacente al elemento de válvula de charnela, de manera que los medios de pivotación y el elemento de válvula de charnela se pueden disponer para reducir al mínimo el tamaño proyectado de la válvula de despliegue. Por ejemplo, los medios de pivotación se pueden acomodar dentro de la pared doblada y pueden soportar al elemento de válvula de charnela en

la posición abierta, de manera que su dimensión más ancha queda situada hacia el plano axial central del cuerpo tubular.

En una modalidad más preferida, el elemento de válvula de charnela es deformable de modo que puede ser pasado a través de una tubería de diámetro más pequeño. Esta capacidad de deformación se puede conseguir mediante el diseño del elemento de válvula de charnela y/o a través del material de construcción. En una modalidad, el elemento de válvula de charnela comprende una superficie de obturación y una porción de refuerzo que está unida a o íntegramente formada con la superficie de obturación. La porción de refuerzo puede comprender nervios sustancialmente paralelos cuyos ejes longitudinales se encuentran en los mismos ejes que los ejes longitudinales del cuerpo tubular, cuando el elemento de válvula está en la posición abierta. La porción de refuerzo puede ser, por ejemplo, un bloque con ranuras sustancialmente paralelas para formar los nervios o puede consistir en una serie de barras sustancialmente paralelas montadas en proximidad entre sí para formar los nervios. Las ranuras o espacios de separación entre los nervios permiten la deformación del elemento de válvula. El elemento de válvula de charnela puede ser mecanizado a partir de una sola pieza de material, por ejemplo mediante el corte de ranuras sustancialmente paralelas en el material. En otra modalidad, los elementos de refuerzo pueden ser fijados, por ejemplo mediante soldadura, en uno de los lados de una placa relativamente delgada; el otro lado de la placa actúa como la superficie de obturación o bien soporta la superficie de obturación. Otra opción consiste en moldear el elemento de válvula de charnela a partir de un material moldeable adecuado que sea inerte a los fluidos del yacimiento. Los nervios sustancialmente paralelos permiten la deformación del elemento de válvula, acercando entre sí los bordes exteriores del elemento de válvula, con lo que se reduce así la dimensión máxima del elemento de válvula transversalmente con respecto al eje longitudinal del cuerpo tubular de la válvula de despliegue.

Puede ser posible deformar el elemento de válvula de charnela a medida que la válvula de despliegue está siendo introducida en el pozo en la superficie. Según otra opción, el elemento de válvula de charnela puede ser deformado y mantenido en

la posición deformada por un medio de restricción hasta una vez instalada la válvula de despliegue, tras lo cual se puede liberar el medio de restricción. Por ejemplo, el elemento de válvula de charnela, que en la práctica puede ser sustancialmente plano, puede ser deformado a una configuración curvada y restringido al colocarse dentro de una tubería o mediante una faja que impide que se abran los bordes curvados. Una vez que se encuentra en el pozo, la faja de restricción se separará para permitir la apertura del elemento de válvula de charnela.

Ya son conocidos los materiales tubulares expansionables para utilizarse en pozos, al igual que lo son los medios para expansionar dichos materiales tubulares. La expansión puede ser realizada mediante un mandril o elemento en forma de cono solicitado a través del material tubular que ha de expansionarse o por cualquier otra herramienta expansionadora adecuada.

Aunque en la presente invención se puede emplear cualquiera de los métodos conocidos para expansionar radialmente el cuerpo de la válvula expansionable, un método preferido consiste en usar un expansor de bolas o rodillos rotativos. Dichos dispositivos son conocidos y comprenden bolas o rodillos rotativos que pueden extenderse radialmente. Las bolas o rodillos son solicitadas hacia el exterior contra la pared interna del cuerpo de la válvula expansionable y luego las bolas o rodillos son girados alrededor de la superficie interna y también se mueven axialmente a lo largo del cuerpo de la válvula de manera que las mismas describen un recorrido helicoidal.

La válvula de despliegue puede ser accionada hidráulicamente y tiene al menos una línea hidráulica para controlar el movimiento del elemento de válvula de despliegue. Se puede emplear un medio de solicitación, tal como un resorte o un peso u otras líneas de control, para mantener el elemento de válvula en la posición abierta o cerrada. En una modalidad, la válvula de despliegue tiene un elemento de resorte para solicitar el cierre del elemento de válvula de charnela y obturarlo contra una superficie obturadora del cuerpo de la válvula de despliegue y el elemento de válvula de charnela puede ser abierto por el peso de la sarta de perforación que se apoya descendentemente sobre el elemento de válvula de charnela a medida que se baja la sarta de perforación al interior del pozo y/o por la presión existente por encima de la

válvula de charnela. El funcionamiento del elemento de válvula también se puede conseguir a través de la intéracción entre la sarta de perforación y la válvula de despliegue tal como, por ejemplo, movimiento vertical o rotacional de la sarta de perforación que actúa sobre un elemento móvil de la válvula de despliegue.

La presente invención incluye un método de perforación de un pozo en donde está situada una sarta tubular dentro del pozo, cuyo método comprende situar una válvula de despliegue al menos parcialmente dentro de la sarta tubular de manera que, una vez instalada la válvula, se puede mover una sarta de perforación a través de la válvula, en donde la válvula de despliegue comprende un cuerpo que puede expansionarse radialmente con un ánima interna y un elemento de válvula capaz de cerrar el ánima interna, comprendiendo además el método unir la válvula de despliegue a o en la sarta tubular mediante la expansión radial del cuerpo que puede expansionarse radialmente de la válvula de despliegue, para formar una conexión resultante de la interferencia entre la superficie externa de la válvula de despliegue y la sarta tubular.

La sarta tubular puede consistir en cualquiera de los materiales tubulares usados normalmente en pozos, incluyendo entubados, tuberías de revestimiento y tuberías de producción, pero resulta particularmente útil para utilizarse en las tuberías de producción.

La presente invención se puede emplear en operaciones de perforación que utilizan trépanos rotativos conectados a la superficie mediante una sarta de perforación tubular. También es posible utilizar la invención en operaciones de perforación por cable. Igualmente, se puede emplear una combinación de perforación por cable y sarta de perforación tubular. Por ejemplo, se puede desplazar un cable desde la superficie a un alojamiento subterráneo para un motor que es capaz de accionar una sarta de perforación tubular que presenta un trépano en su extremo distal.

Aunque el método y aparato de acuerdo con la presente invención resultan particularmente útiles en la perforación hipocompensada, podrá apreciarse que la válvula de despliegue puede encontrar otros usos, incluyendo la perforación incluso

cuando el pozo está sobrecompensado para un control adicional del pozo o incluso operaciones al margen de la perforación. Por ejemplo, el uso de la válvula de despliegue puede proporcionar un "lubricador" relativamente largo para el despliegue de conjuntos en el fondo del pozo largos o complejos. Un lubricador consiste normalmente en una longitud de tubería de fabricación especial situada alrededor de la superficie de un pozo. Se puede colocar por encima de una válvula sobre la parte superior del conjunto de válvulas de control, manómetros y estrangulaciones que están dispuestas en la parte superior de un pozo para controlar el flujo, lo cual en general es conocido como el "árbol de Navidad" o se puede colocar por encima de una válvula sobre la parte superior del cabezal del entubado o tubería, pero por debajo del árbol de navidad. El lubricador puede tener conectores de unión y válvulas de purga y proporciona un método para obturar la presión pero permitir todavía el paso de un dispositivo, normalmente un cable, o una sustancia, al interior del pozo, sin tener que ahogar el pozo. Una vez perforado el pozo, la válvula de despliegue puede ser utilizada para desplegar el sistema de terminación, posibilitando ello el desplazamiento de secciones relativamente largas de materiales tubulares de terminación tales como conjuntos de cribas de arena expansionables, sistemas de revestimiento ranurados y sartas de producción.

La US 6.305.469 describe un método de perforación hipocompensada que proporciona un método para crear un pozo en una formación de tierra, incluyendo el pozo una primera sección de pozo y una segunda sección de pozo que penetra una zona portadora de fluidos de hidrocarburos de la formación de tierra, comprendiendo el método:

(a) perforar la primera sección del pozo;

(b) disponer un dispositivo de perforación controlado a distancia en una posición seleccionada en la primera sección del pozo, desde cuya posición seleccionada ha de perforarse la segunda sección del pozo;

(c) disponer una tubería de producción de fluido hidrocarbonado en la primera sección del pozo en relación estanca con la pared del pozo, estando provista la tubería de medios de control del flujo de fluido y de una entrada de fluido

en comunicación fluídica con dicha posición seleccionada;

(d) accionar el dispositivo de perforación para perforar la nueva sección del pozo, con lo que durante la perforación del dispositivo perforador a través de la zona portadora de fluido hidrocarbonado, el flujo de fluido hidrocarbonado desde la segunda sección del pozo al interior de la tubería de producción es controlado por el medio de control del flujo de fluido.

La US 6.305.469 describe que el dispositivo de perforación está conectado de forma liberable al extremo inferior de una tubería de producción de hidrocarburos mediante un dispositivo de conexión adecuado. La tubería de producción de hidrocarburos se baja entonces por el interior del entubado hasta que el dispositivo de perforación se encuentra cerca del fondo de la primera sección del pozo, tras lo cual se fija la tubería de producción en el entubado mediante el inflado de un obturador que obtura el espacio anular formado entre la tubería de producción y el entubado.

La WO 2004/011766 describe un método de perforación hipocompensada usando un dispositivo de perforación controlado a distancia que emplea el fluido producido por la formación para transportar los detritos de la perforación lejos de las superficies de corte del dispositivo, en donde el dispositivo de perforación es capaz de pasar desde la superficie a una posición seleccionada en un pozo ya existente sin tener que retirar del pozo la tubería de producción de fluido hidrocarbonado.

De este modo, de acuerdo con WO 2004/011766, el método de perforación de un pozo desde una posición seleccionada en un pozo ya existente que penetra una formación de tierra subterránea que tiene al menos una zona portadora de fluido hidrocarbonado, en donde el pozo existente está provisto de un entubado y está dispuesto un conducto de producción de fluido hidrocarbonado en el pozo en una relación estanca con la pared del entubado, comprende:

(a) pasar un dispositivo de perforación de accionamiento eléctrico y controlado a distancia desde la superficie a través del conducto de producción de fluido hidrocarbonado a la posición seleccionada en el pozo existente;

(b) accionar el dispositivo de perforación de manera que las superficies de corte del dispositivo de perforación perforen el pozo desde la posición seleccionada

en el pozo ya existente, generando con ello detritos de perforación, en donde durante el accionamiento del dispositivo de perforación, una primera corriente de fluido producido fluye directamente a la superficie a través del conducto de producción de fluido hidrocarbonado y una segunda corriente de fluido producido es bombeada sobre las superficies de corte del dispositivo de perforación por vía de un medio de bombeo en el fondo del pozo accionado eléctricamente y controlado a distancia, y los detritos de la perforación son transportados lejos del dispositivo de perforación arrastrados en la segunda corriente de fluido producido.

El método y aparato de acuerdo con la presente invención se pueden utilizar en procedimientos tales como aquellos descritos en US 6.305.469 y WO 2004/011766. Por ejemplo, la válvula de despliegue se puede pasar a través de la tubería de producción a una posición en donde la válvula de despliegue se encuentra al menos parcialmente dentro de la tubería de producción, y luego se expansiona radialmente el cuerpo de la válvula de despliegue para unir la válvula de despliegue al extremo de la tubería de producción y formar así una conexión resultante de la interferencia entre la superficie externa de la válvula de despliegue y de la tubería de producción.

En el método de WO 2004/011766 se puede proporcionar una tubería para conducir la segunda corriente de fluido producido hacia el trépano o para transportar el fluido y los detritos de la perforación lejos del trépano. Esta tubería puede extenderse desde el trépano hasta la tubería de producción. El segundo pozo puede ser muy largo, por ejemplo de más de 1 km. La válvula de despliegue de acuerdo con la presente invención se puede emplear para crear una longitud de lubricador en el primer pozo para permitir que una longitud larga de la tubería pueda introducirse de forma segura dentro del pozo.

La invención será descrita ahora con referencia a los dibujos adjuntos en donde:

La figura 1 es una vista esquemática en sección de una válvula de despliegue de acuerdo con la presente invención.

La figura 2 es una vista esquemática en la dirección A de la válvula de despliegue mostrada en la figura 1, pero no a la misma escala.

La figura 3 es una vista esquemática en la dirección B de la válvula de despliegue mostrada en la figura 1, pero no a la misma escala.

La figura 4 es una representación isométrica de un elemento moldeado de válvula de charnela adecuado para utilizarse en la presente invención antes del vaciado de los desperdicios.

La figura 5 es una vista desde arriba del molde de la figura 4.

La figura 6 es una sección transversal a lo largo de A-A de la figura 5.

La figura 7 es una ilustración en sección transversal de un elemento de válvula de charnela similar al mostrado en las figuras 4 a 6 excepto que es producido mediante soldadura.

La figura 8 es una representación esquemática de los elementos básicos del método y aparato de acuerdo con la presente invención.

Las figuras 9 a 13 son representaciones esquemáticas de una perforación hipocompensada que utiliza una válvula de despliegue de acuerdo con la presente invención.

La figura 14 es una representación esquemática de un pozo ya existente que penetra en la formación de un yacimiento a partir de cuyo pozo ya existente está siendo perforado un nuevo pozo bajo condiciones de perforación hipocompensada.

La figura 15 es una representación esquemática de un pozo existente que penetra en la formación de un yacimiento a partir de cuyo pozo existente está siendo perforado un nuevo pozo bajo condiciones de perforación hipocompensada y en donde está instalada una criba o filtro de arena.

Las figuras 1 a 3 muestran una válvula de despliegue de acuerdo con la presente invención. La válvula comprende un cuerpo tubular 1 y un elemento de válvula de charnela 2. El cuerpo tubular 1 se puede expansionar radialmente y comprende una sección sustancialmente cilíndrica 3 y una sección deformada 4 que comprende un doblez en la pared del cuerpo tubular. El elemento de válvula de charnela 2 tiene una superficie de obturación 5 y una porción de refuerzo 6 y está

dispuesto sobre una ménsula de soporte 7 por vía de un pasador 8 alrededor del cual puede girar el elemento de válvula de charnela 2. La ménsula de soporte 7 está unida al cuerpo tubular 1 dentro del doblez de la sección deformada 4. El montaje de esta manera del elemento de válvula de charnela 2 significa que queda situado hacia el plano axial central 9 del cuerpo tubular 1. Como se aprecia más claramente en las figuras 2 y 3, este posicionamiento y la configuración ligeramente curvada del elemento de válvula de charnela 2 significa que el elemento de válvula de charnela es prácticamente del mismo ancho que el diámetro exterior de la sección sustancialmente cilíndrica 3 del cuerpo tubular 1. La curva del elemento de válvula de charnela (2) pone los bordes del elemento de válvula uno hacia el otro, con lo que se reduce la dimensión máxima del elemento de válvula transversalmente con respecto al eje longitudinal del cuerpo tubular de la válvula de despliegue, es decir, la distancia de un lado a otro del elemento de válvula, como se ilustra en la figura 2, es menor que el diámetro que tendrá el elemento de válvula cuando entre en operación con la superficie obturadora (5) sustancialmente plana. Una junta elastómera 10 está situada en el extremo del cuerpo tubular contra la cual se aproximará el elemento de válvula de charnela. Cuando la válvula de despliegue es expansionada radialmente como más adelante se describirá, la posición deformada 4 es reformada a una sección transversal sustancialmente circular y se puede aumentar el diámetro de la totalidad del cuerpo tubular 1. El reformado de la posición deformada 4 hace que la ménsula de soporte se mueva radialmente hacia el exterior, de manera que cuando el elemento de válvula de charnela 12 se aproxima contra el extremo del cuerpo tubular 1, forma una obturación contra la junta elastómera 10.

Las figuras 4 a 6 muestran el moldeo de una válvula de charnela. La válvula puede ser moldeada a partir de cualquier material adecuado, por ejemplo un material elastómero que esencialmente es inerte a los fluidos del pozo. En las figuras, el elemento de válvula de charnela todavía no ha sido cortado del producto moldeado. De este modo, las cuatro esquinas 11, 12, 13 y 14 deberán ser separadas mediante corte dejando el elemento de válvula de charnela sustancialmente circular 2 con un brazo de conexión 15. El elemento de válvula de charnela 2 tiene una superficie

obturadora 16 y una porción de refuerzo 17. La porción de refuerzo 17 aporta una resistencia suficiente a la válvula de charnela para contrarrestar la presión en el fondo del pozo, pero también aporta la flexibilidad suficiente para que el elemento de válvula de charnela 2 pueda ser curvado, como se ilustra en las figuras 1 a 3, para facilitar así la instalación. La curvatura podría ser proporcionada durante la fabricación, mediante posterior tratamiento o bien se puede conseguir mediante deformación y restricción física del elemento de válvula de charnela durante la instalación.

La figura 7 ilustra una válvula de charnela similar a la mostrada en las figuras 4 a 6 excepto que es producida mediante soldadura en lugar de moldeo. El elemento de válvula de charnela comprende una placa obturadora 18 en la cual se han soldado elementos de refuerzo 19 como se muestra por las soldaduras 20. Con preferencia, el elemento de válvula de charnela es de acero inoxidable. Es posible que la soldadura de los elementos de refuerzo 19 en la placa obturadora pueda causar cierta distorsión de la placa obturadora. En general, las válvulas de charnela requieren una superficie sustancialmente plana sobre el elemento de válvula de charnela para conseguir una buena junta con el cuerpo de la válvula. Podría esperarse que cualquier distorsión tuviera un impacto inaceptable sobre la calidad obturadora de la válvula. Sin embargo, se ha comprobado que la flexibilidad aportada por el diseño de la placa y elementos de refuerzo soldados permite lograr una buena junta.

Un elemento de válvula de charnela similar a los ilustrados en las figuras 4 a 7 podría también producirse mediante mecanizado a partir de un bloque de material.

En cualquiera de los diseños moldeados, soldados o mecanizados del elemento de válvula de charnela, las dimensiones de los elementos de refuerzo, su separación y el espesor de la superficie o placa de obturación, dependerán de las dimensiones globales de la válvula y de las presiones que han de contener.

La figura 8 es una vista esquemática en alzado de una operación hipocompensada en un pozo. Se muestra un trépano 21 en el fondo del pozo 22 que está perforando en un agujero abierto. El pozo ha sido perforado a través de una primera formación 23 hasta que se alcanzó una formación de yacimiento 24. El

entubado 25 con una zapata de entubado 26 en su extremo inferior ha sido dispuesto en el pozo y fijado en su posición con cemento 27. Una tubería de producción 28 ha sido instalada dentro del entubado 25 que está provisto, en su extremo inferior, de un obturador inflable 29. Una boca del pozo 30 en la superficie proporciona comunicación fluídica entre la tubería de producción 28 y una instalación de procesado de hidrocarburos 31 por vía de la tubería 32. La boca del pozo 30 comprende el equipo usual para controlar el flujo de fluidos procedentes de un pozo, incluyendo válvulas de seguridad y armaduras para prevenir erupciones. En el extremo de la tubería de producción 28 se encuentra una válvula de despliegue 33. La válvula de despliegue es una válvula de charnela y el elemento de válvula se muestra en la posición abierta. La válvula de despliegue ha sido instalada pasando la válvula de despliegue descendentemente a través de la tubería de producción y luego expansionando el cuerpo tubular de la válvula de despliegue para fijarla en el fondo de la tubería de producción 28. A medida que continúa la perforación al interior de la formación del yacimiento, los fluidos de producción fluyen al interior del pozo 22, ascienden por la tubería de producción 28 hacia la boca del pozo 30 y desde aquí se dirigen a la instalación de procesado 31 por vía de la tubería 32.

Las figuras 9 a 13 ilustran el uso de una válvula de despliegue en una perforación hipocompensada. Los elementos comunes con el pozo mostrados en la figura 8 tienen los mismos números de referencia. De este modo, en la figura 9, el pozo está revestido con el entubado 25 dentro del cual está situado una tubería de producción 28 que tiene una válvula de despliegue 33 en su extremo inferior. La válvula de despliegue 33 está situada a una profundidad en el pozo que se encuentra significativamente por debajo de la posición del punto ligero de la sarta de perforación. El pozo 22 ha sido perforado a través de la formación 23 al interior de la formación del yacimiento 24. El elemento de válvula de charnela de la válvula de despliegue 33 está cerrado. La sarta de perforación y el trépano 21 han sido desplazados al interior del pozo de manera convencional hasta que el trépano 21 queda situado por encima de la válvula de despliegue cerrada 33. En la superficie, los arietes de las tuberías (no ilustrados) están cerrados y la tubería de producción es

presurizada hasta la presión del pozo en la posición de la válvula de despliegue 33. Como se muestra en la figura 10, el elemento de válvula de charnela de la válvula de despliegue 33 está abierto. En la superficie, se permitirá el flujo del pozo para reducir la presión en la superficie a una presión a la cual el flujo sea seguro. Los arietes de las tuberías (no ilustrados) están abiertos y la sarta de perforación y el trépano 21 son desplazados adicionalmente al interior del pozo. En la figura 11, el trépano 21 ha alcanzado el extremo del pozo y se ha iniciado la perforación, con la válvula de despliegue 33 abierta. En la figura 12, la sarta de perforación está siendo retirada del pozo. La sarta de perforación y el trépano 21 se han retirado a una posición por encima de la válvula de despliegue 33. Dado que la válvula de despliegue 33 está situada significativamente por debajo de la posición del punto ligero de la sarta de perforación, existe poco riesgo de que la presión de la formación haga que la sarta de perforación se mueva hacia arriba. En la figura 13, la válvula de despliegue 33 está cerrada y la presión dentro de la tubería de producción 28 se ha reducido. El aislamiento y reducción de la presión dentro de la tubería de producción 28 a partir de la presión de la formación, de la manera indicada, permite que la sarta de perforación y el trépano 21 puedan sacarse del pozo de manera convencional y segura.

La figura 14 es una ilustración de un pozo existente que penetra en la formación de un yacimiento, a partir de cuyo pozo existente está siendo perforado un nuevo pozo bajo condiciones de perforación hipocompensada. Los elementos similares al pozo mostrados en la figura 8 tienen los mismos números de referencia.

Un pozo existente 34 penetra a través de una formación superior 23 y se dirige al interior de la formación portadora de hidrocarburos 24. Un entubado metálico 25 se dispone en el pozo existente 24 y se fija en la pared del pozo mediante una capa de cemento 27. Se sitúa una tubería de producción 28 dentro del pozo existente 34 y se proporciona un obturador inflable 29 en el extremo inferior de la tubería de producción 28 para obturar el espacio anular formado entre la tubería de producción 28 y el entubado 25. Situada en el extremo de la tubería de producción 28 se encuentra una válvula de despliegue 33 de acuerdo con la presente invención. La

válvula de despliegue 33 se instala pasando la válvula de despliegue 33 a través de la tubería de producción 28 y luego expansionando radialmente la válvula de despliegue, de manera que se sitúe sobre la porción inferior de la tubería de producción. Una boca del pozo 30 en la superficie proporciona comunicación fluídica entre la tubería de producción 28 y una instalación 31 para el procesado de fluidos hidrocarbonados por vía de una tubería 32. Se pasa un desviador expansible 35 a través de la tubería de producción 28 y se bloquea en su sitio en el entubado 25 del pozo existente 34 por vía de un medio de bloqueo radialmente expansible 36. En lugar de la sarta de perforación tubular representada en la figura 8, el aparato ilustrado en la figura 14 ilustra una sarta de perforación por cable. Un dispositivo de perforación de accionamiento eléctrico y controlado a distancia 37 se pasa por el interior del pozo existente a través de la tubería de producción 28 suspendido sobre un cable de acero reforzado 40 que comprende al menos un hilo conductor eléctrico o conductor segmentado (no mostrado). El extremo inferior del cable de acero reforzado 40 pasa a través de una longitud de la tubería de acero 38 que está en comunicación fluídica con un paso de fluido (no mostrado) en el dispositivo de perforación 37. El dispositivo de perforación 37 está provisto de un medio de dirección accionado eléctricamente, por ejemplo, una junta dirigible (no ilustrada) y un motor eléctrico (no ilustrado) dispuesto para accionar un medio (no ilustrado) para girar el trépano 21 situado en el extremo inferior del dispositivo de perforación 37. Un alojamiento cilíndrico 41 está unido en el extremo superior de la tubería de acero 38. El dispositivo de perforación 37 y/o el alojamiento 41 están provistos de una bomba accionada eléctricamente (no ilustrada) y ruedas o bloques de tracción de accionamiento eléctrico 42 que se utilizan para avanzar el dispositivo de perforación 37 a través de una nueva sección 43 del pozo. El cable 40 pasa a través del alojamiento 41 e interior de la tubería de acero 38 hacia el dispositivo de perforación 37.

La nueva sección del pozo 43 es perforada utilizando el dispositivo de perforación 37, extendiéndose la nueva sección del pozo 43 desde una ventana 44 del entubado 25 del pozo existente 34 al interior de la zona portadora de hidrocarburos

24 y siendo un pozo de perforación lateral. La ventana 44 puede haber sido formada utilizando un dispositivo de perforación que comprende una fresa que se pasa a través del conducto de producción 28 suspendida en un cable y que es impulsada entonces desde el pozo ya existente. Durante la perforación de la nueva sección del pozo 43, el fluido producido puede ser bombeado descendentemente por el interior de la tubería de acero 38 hacia el dispositivo de perforación 37 por vía de una bomba situada en el alojamiento cilíndrico 41. El fluido producido fluye desde la tubería de acero 38 a través del paso de fluido del dispositivo de perforación hasta el trépano 21 en donde el fluido producido sirve para enfriar el trépano 21 y también para arrastrar los detritos de la perforación. Los detritos de la perforación arrastrados en el fluido producido se pasan entonces alrededor del exterior del dispositivo de perforación 37 al interior de la corona anular 39 formada entre la tubería de acero 38 y la pared de la nueva sección del pozo 43 (modo de "circulación convencional"). Alternativamente, el fluido producido puede ser bombeado a través de la corona anular 39 hasta el trépano 21. Los detritos de la perforación arrastrados en el fluido producido se pasan entonces a través del paso existente en el dispositivo de perforación y al interior de la tubería de acero 38 (modo de "circulación inversa").

Varios sensores de evaluación de la formación (no mostrados) pueden estar situados: en el dispositivo de perforación 37 en estrecha proximidad al trépano 21; en el extremo de la tubería de acero 38 que está conectado al dispositivo de perforación 37; a lo largo del extremo inferior del cable 40 que reside dentro de la tubería de acero 38; y/o a lo largo del exterior de la tubería de acero. Los sensores de evaluación de la formación están conectados eléctricamente a un equipo de registro (no ilustrado) en la superficie por vía de uno o más hilos eléctricos y/o uno o más conductores segmentados que se extienden a lo largo de la longitud del cable 40. Cuando los sensores están situados en el exterior de la tubería de acero, los sensores pueden estar en comunicación con el hilo o hilos eléctricos y/o conductor o conductores segmentados del cable 40 por vía de medios electromagnéticos. A medida que procede la perforación con el dispositivo de perforación 37, los sensores de evaluación de la formación son accionados para medir características

seleccionadas de la formación y para transmitir señales que representan las características por vía del hilo o hilos conductores eléctricos y/o conductor o conductores sementados del cable 40 hacia el equipo de registro en la superficie (no mostrado).

Un sistema de navegación (no ilustrado) para el medio de dirección también se puede incluir en el dispositivo de perforación 37 para asistir en la navegación del dispositivo de perforación 37 a través de la nueva sección del pozo 43.

La tubería de acero 38 puede ser una tubería expansible. Después de la perforación de la nueva sección del pozo 43, la tubería de acero expansible 38 puede ser expandido radialmente para formar un revestimiento para la nueva sección del pozo 43 y el dispositivo de perforación 37 puede ser recuperado tirando del cable del pozo y/o accionando las ruedas de tracción 42, de manera que el dispositivo de perforación pasa a través de la tubería de acero expandido y conducto de producción de fluidos hidrocarbonados 28. Se conocen ya métodos y aparatos para instalar materiales tubulares expansibles en pozos de petróleo y gas y en la presente invención se puede emplear cualquiera de tales métodos.

Cuando la tubería de acero 38 no es expansible, la tubería de acero 38 se puede proporcionar con al menos un obturador radialmente expansible. El obturador u obturadores se pueden expansionar para sellar la corona anular formada entre la tubería de acero 38 y la nueva sección del pozo 43, formando con ello una tubería de revestimiento estanco para la nueva sección del pozo 43. Cuando se sitúa una bomba en el alojamiento del dispositivo de perforación 37, dicha bomba puede ser desconectada del alojamiento y puede ser recuperada a través del interior de la tubería de acero 38.

La tubería de revestimiento para la nueva sección del pozo puede ser entonces perforada para permitir que los hidrocarburos fluyan a través del interior de la misma hacia el conducto de producción 28.

La nueva sección del pozo 43 puede ser relativamente larga, habitualmente de más de un kilómetro. La instalación de la tubería de acero 38 en un pozo en producción puede presentar dificultades, especialmente si se desea no ahogar el pozo.

Se puede realizar una junta eficaz alrededor de la tubería de acero maciza o tubería enrollada. De este modo, en el caso de que la tubería de acero 38 sea suficientemente fuerte se pueden emplear los métodos convencionales para introducir las sartas tubulares dentro de un pozo. Sin embargo, sería preferible utilizar tubería flexible para la tubería 38. La tubería enrollada y la tubería maciza son ambas relativamente pesadas y relativamente caras y costosas de desplegar. Aunque podrían emplearse tuberías poliméricos más ligeras, de menor coste y menos rígidas como la tubería 38, puede resultar difícil introducirlas en el pozo. Al ser más ligeras, pueden llegar a ser el punto ligero de la sarta a una profundidad mucho más superficial. Igualmente, no es sencillo realizar la obturación alrededor de la tubería en la superficie.

Como se ha indicado anteriormente, cuando se introducen herramientas o trépanos por medio de un cable, el montaje en el fondo del pozo se puede efectuar por encima de las válvulas obturadoras que están presentes en el así llamado árbol de Navidad en la superficie del pozo. La longitud de la tubería que aloja el conjunto en el fondo del pozo, antes de introducirlo en el pozo por medio del árbol de Navidad, se conoce generalmente como lubricador. El lubricador tiene generalmente una longitud de solo 30 a 40 pies (9 a 12 m) aproximadamente. Por tanto, no es posible introducir largas longitudes de tubería empleando únicamente el lubricador. En la mayoría de los pozos existe una válvula de seguridad adicional situada a 500-1.000 pies (150-300 m) aproximadamente por debajo de la superficie. La longitud del pozo por encima de esta válvula de seguridad subterránea se podría utilizar para el montaje de la tubería de acero 38 de manera que pudiera ser bajado por el interior del pozo. Sin embargo, esta sección es todavía relativamente corta. Además, puesto que no es sencillo realizar una junta eficaz alrededor del cable de soporte del dispositivo de perforación por cable o alrededor de una tubería flexible, sería preferible que las válvulas del árbol de Navidad no estuvieran abiertas mientras se utiliza la válvula de seguridad subterránea como la única válvula para contener la presión en el pozo.

El uso de la válvula de despliegue de acuerdo con la presente invención permite introducir largas longitudes de tubería flexible 38 en el pozo para su

introducción en la nueva sección del pozo 43 de la manera descrita con referencia a la figura 14. Al extraer el aparato de perforación por cable hasta por encima de la válvula de despliegue 33 y cerrar la válvula, se puede reducir la presión en el conducto de producción a una presión operativa segura. Se puede introducir entonces la tubería de acero en el pozo sin riesgo de que encuentre condiciones de punto ligero en la sarta. La válvula de despliegue 33 puede estar a una profundidad mayor de 1 km, posiblemente mayor de 3 km. Esto aporta una longitud suficiente para la introducción de una longitud relativamente larga de tubería de acero 38. El conducto de producción 28 y la válvula de despliegue 33 actúan de manera eficaz como un lubricador muy largo. Después de introducir la tubería de acero 38 en el pozo, se puede aumentar la presión dentro del conducto de producción 28 por encima de la válvula de despliegue cerrada 33 y luego se abre la válvula de despliegue para permitir el paso del aparato de perforación por cable y tubería de acero 38 a la nueva sección del pozo 43. Se puede continuar entonces la producción de fluido para su extracción por medio del conducto de producción 28.

La figura 15 es similar a la figura 14 y los mismos elementos tienen los mismos números de referencia, pero en lugar de la tubería de acero 38 se proporciona una tubería de material plástico 46 y una criba o filtro de arena 47. La tubería de material plástico 46 se encuentra en comunicación fluídica con un paso de fluido (no mostrado) en el dispositivo de perforación 37. La criba de arena 47 está situada alrededor de la tubería de material plástico 46 y está conectada de forma liberable al aparato de perforación 37. La tubería de material plástico 46, al igual que la tubería de acero 38 en la figura 14, se puede emplear para transportar fluido hacia o desde el aparato de perforación 37. Después de perforar la nueva sección del pozo 43, la criba de arena puede ser expansionada, por ejemplo, por obturación de la tubería de material plástico 46 y presurización con fluido para expandir la tubería de material plástico 46 lo cual causa a su vez la expansión de la criba de arena 47. Al liberar la presión en la tubería de material plástico 46, la misma se desinflará lo suficiente para permitir su retirada de la criba de arena 47.

REIVINDICACIONES

1.- Una válvula de despliegue subterránea, caracterizada porque comprende un cuerpo radialmente expansible (1) que tiene un ánima interna y un elemento de válvula (2) capaz de cerrar el ánima interna.

2.- Una válvula de despliegue según la reivindicación 1, caracterizada porque comprende un cuerpo tubular radialmente expansible (1) que tiene un elemento de válvula de charnela (2) unido al cuerpo tubular expansible en uno de sus extremos mediante conexiones de pivote (7, 8).

3.- Una válvula de despliegue según la reivindicación 2, caracterizada porque el cuerpo radialmente expansible (1) tiene una pared doblada o deformada (4) al menos en posición adyacente al elemento de válvula de charnela (2), de manera que el medio de pivote (7, 8) queda acomodado dentro de la pared doblada y soporta al elemento de válvula de charnela en posición abierta, de modo que su dimensión más ancha queda situada hacia el plano axial central (9) del cuerpo tubular.

4.- Una válvula de despliegue según la reivindicación 2 o 3, caracterizada porque el elemento de válvula de charnela (2) es sustancialmente circular y deformable, de manera que puede ser pasado a través de una tubería (28) de diámetro más pequeño.

5.- Una válvula de despliegue según cualquiera de las reivindicaciones 2 a 4, caracterizada porque el elemento de válvula de charnela (2) comprende una superficie obturadora (16) y una porción de refuerzo (17) que está unida a o formada íntegramente con la superficie obturadora (16), comprendiendo la porción de refuerzo (17) nervios sustancialmente paralelos cuyos ejes longitudinales se encuentran en el mismo eje que el eje longitudinal del cuerpo tubular, cuando el elemento de válvula está en la posición abierta (1).

6.- Un método para perforar un pozo en cuyo interior está situada una sarta tubular, caracterizado porque comprende situar una válvula de despliegue al menos parcialmente dentro de la sarta tubular, de manera que, una vez instalada la válvula de despliegue, se puede mover una sarta de perforación a través de la válvula de despliegue, en donde la válvula de despliegue comprende un cuerpo radialmente

expansible (1) con un ánima interna y un elemento de válvula (2) capaz de cerrar el ánima interna, comprendiendo además el método unir la válvula de despliegue a o en la sarta tubular mediante expansión radial del cuerpo radialmente expansible de la válvula de despliegue, para formar una conexión resultante de la interferencia entre la superficie externa de la válvula de despliegue y la sarta tubular.

7.- Un método según la reivindicación 6, caracterizado porque la sarta tubular es una tubería de producción.

8.- Un método según la reivindicación 6 o 7, caracterizado porque la válvula de despliegue comprende un cuerpo tubular radialmente expansible que tiene, unido al mismo, un elemento de válvula de charnela.

9.- Un método según cualquiera de las reivindicaciones 6 a 8, caracterizado porque la perforación se lleva a cabo bajo condiciones hipocompensadas y porque la válvula de despliegue está situada por debajo de la posición del punto ligero de la sarta de perforación.

10.- Un método según la reivindicación 9, caracterizado porque la sarta de perforación se puede retirar del pozo extrayéndola al interior de la tubería de producción, hasta una posición en donde la parte inferior de la sarta de perforación se encuentra por encima de la válvula de despliegue, pero por debajo de la posición del punto ligero de la sarta de perforación, cerrando la válvula de despliegue y reduciendo la presión dentro de la tubería de producción.

11.- Un método según la reivindicación 6 para perforar un pozo desde una posición seleccionada en un pozo existente que penetra una formación de tierra subterránea que tiene al menos una zona portadora de fluido hidrocarbonado, en donde el pozo existente está provisto de al menos una válvula de superficie, un entubado y un conducto de producción de fluido hidrocarbonato dispuesto en el pozo en una relación estanca con la pared del entubado, que comprende:

(a) pasar un dispositivo de perforación de accionamiento eléctrico y controlado a distancia desde la superficie a través del conducto de producción de fluido hidrocarbonado a la posición seleccionada en el pozo existente;

(b) accionar el dispositivo de perforación de manera que las superficies de corte

del dispositivo de perforación perforen el pozo desde la posición seleccionada en el pozo ya existente, generando con ello detritos de perforación, en donde durante el accionamiento del dispositivo de perforación, una primera corriente de fluido producido fluye directamente a la superficie a través del conducto de producción de fluido hidrocarbonado y una segunda corriente de fluido producido es bombeada sobre las superficies de corte del dispositivo de perforación por vía de un medio de bombeo en el fondo del pozo accionado eléctricamente y controlado a distancia, y los detritos de la perforación son transportados lejos del dispositivo de perforación arrastrados en la segunda corriente de fluido producido;

caracterizado porque:

(c) se proporciona una tubería relativamente larga para conducir la segunda corriente de fluido producido hasta el trépano o para llevar el fluido y los detritos de la perforación lejos del trépano; y

(d) la válvula de despliegue se sitúa a una profundidad tal que cuando la tubería se instala o se retira del pozo, existe una longitud suficiente dentro de la tubería de producción entre la válvula de superficie y la válvula de despliegue para acomodar la tubería relativamente larga.

RESUMEN

Una válvula de despliegue subterránea que resulta particularmente adecuada para utilizarse en operaciones de perforación hipocompensada y que se puede instalar a través de una sarta tubular existente, comprende un cuerpo radialmente expansible (1) que tiene un ánima interna y un elemento de válvula (2) capaz de cerrar el ánima interna. La válvula de despliegue se puede instalar pasando la válvula a través del material tubular existente y luego expansionando radialmente el cuerpo radialmente expansible de la válvula de despliegue para formar una conexión resultante de la interferencia entre la superficie externa de la válvula de despliegue y la sarta tubular.

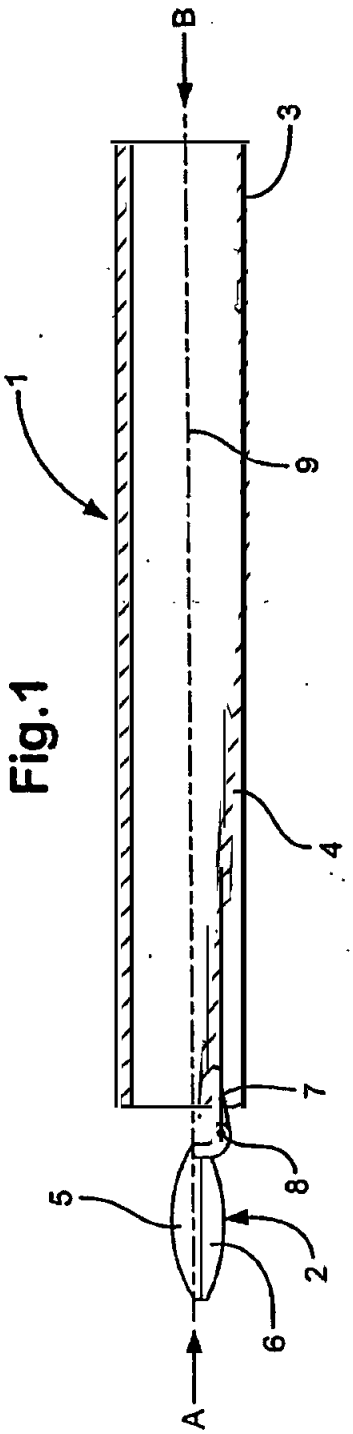


Fig.1

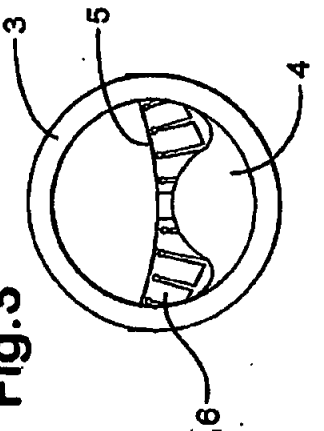


Fig.3

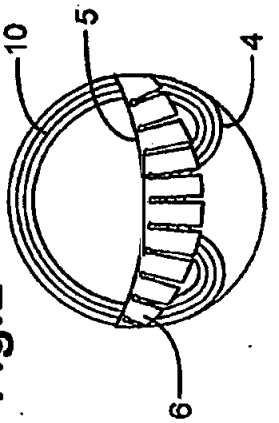
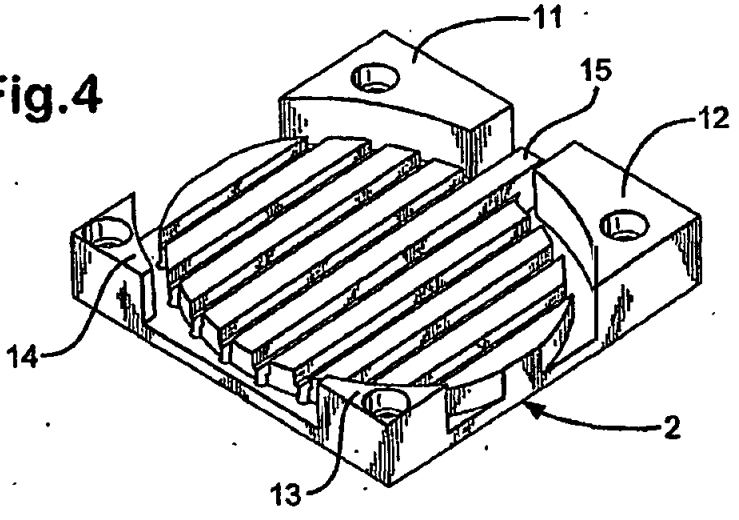


Fig.2

Fig.4



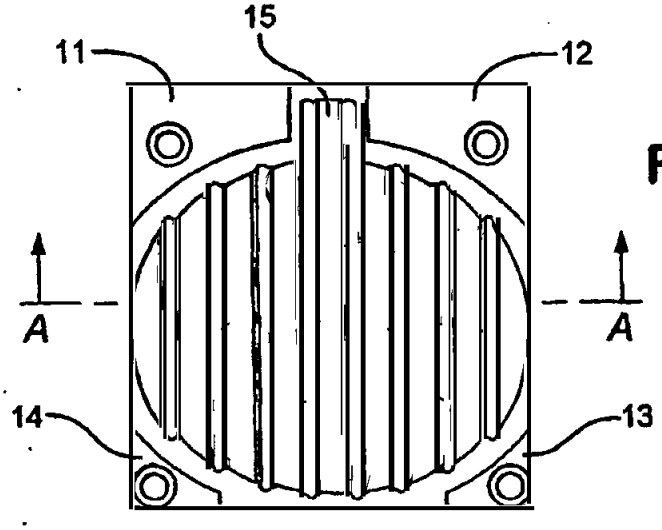
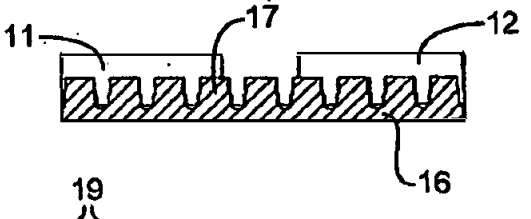


Fig.5

Fig.6



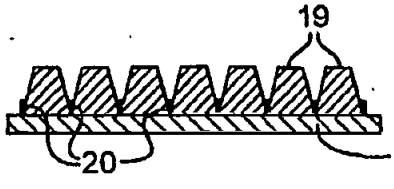


Fig.7

Fig.8

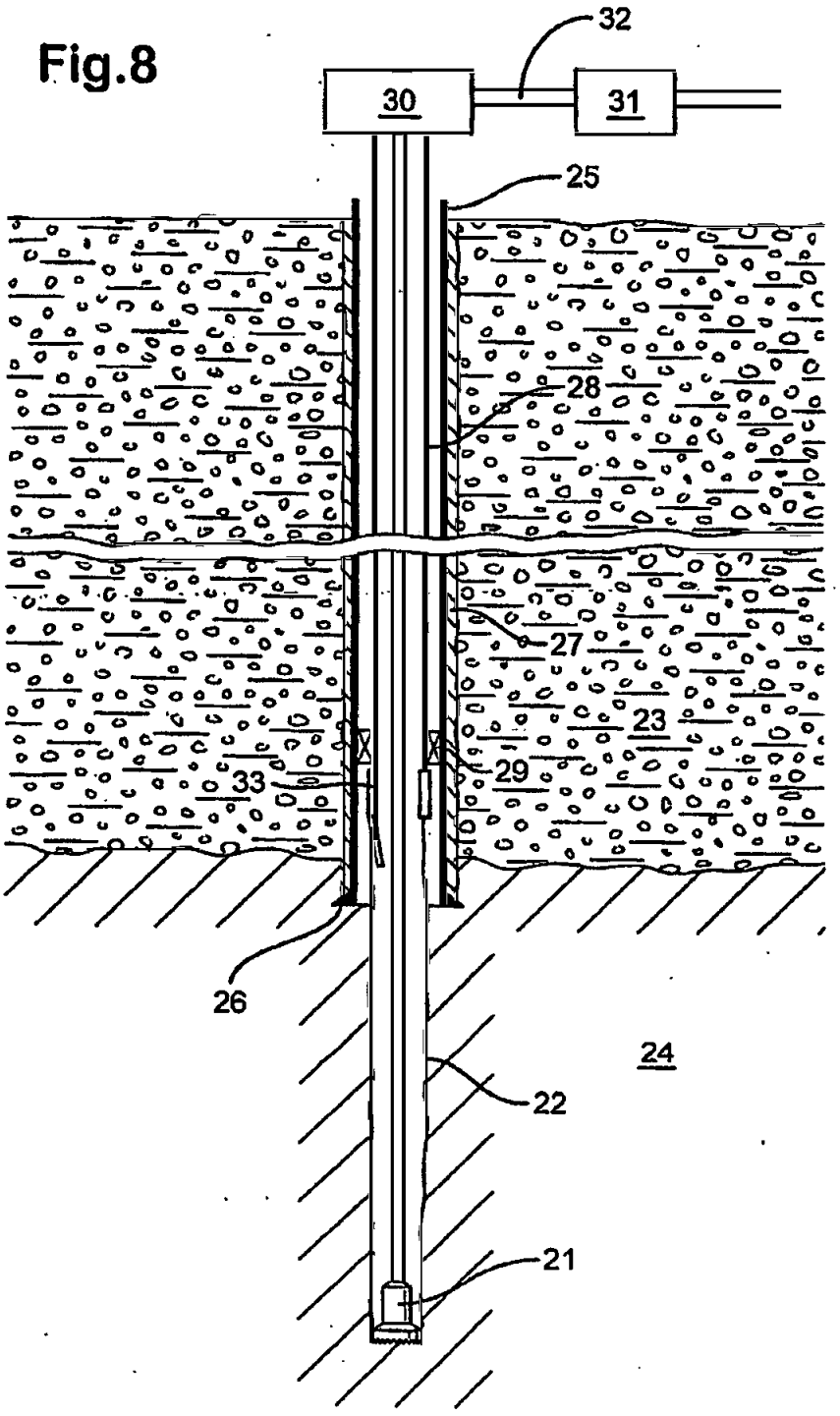


Fig.13

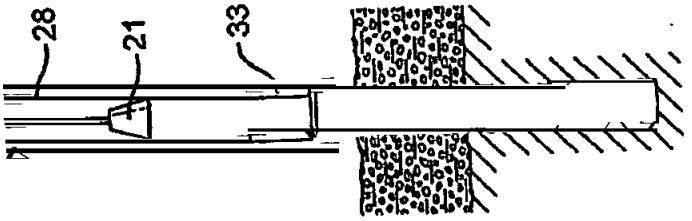


Fig.12

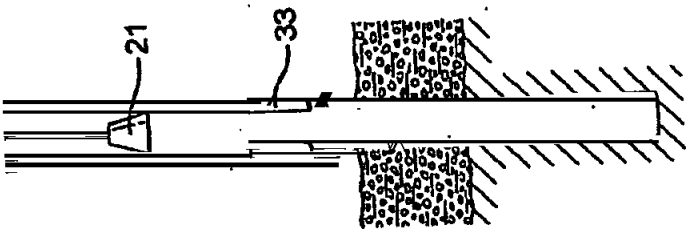


Fig.11

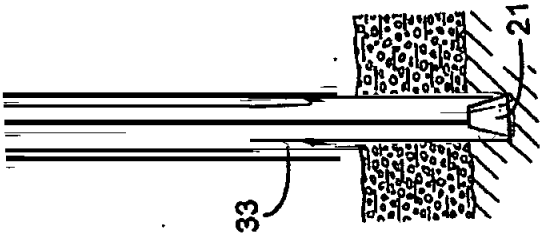


Fig.10

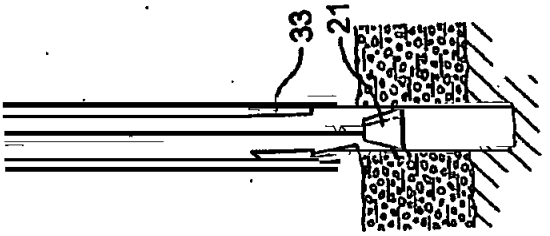


Fig.9

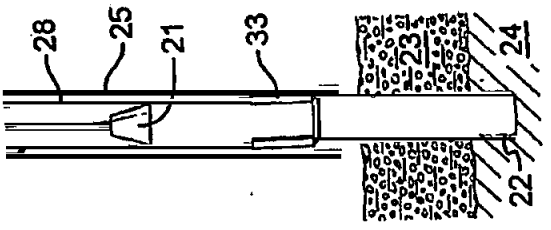


Fig.14

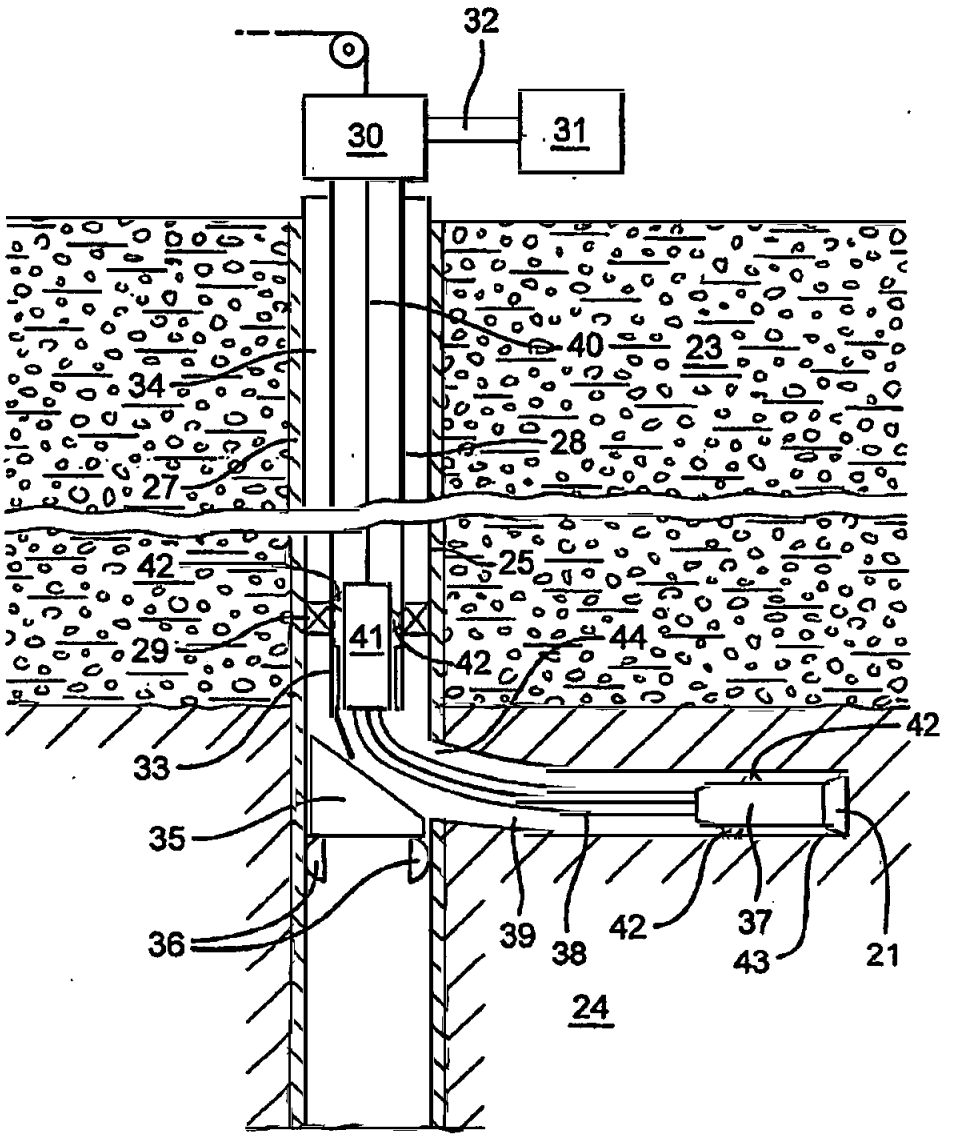

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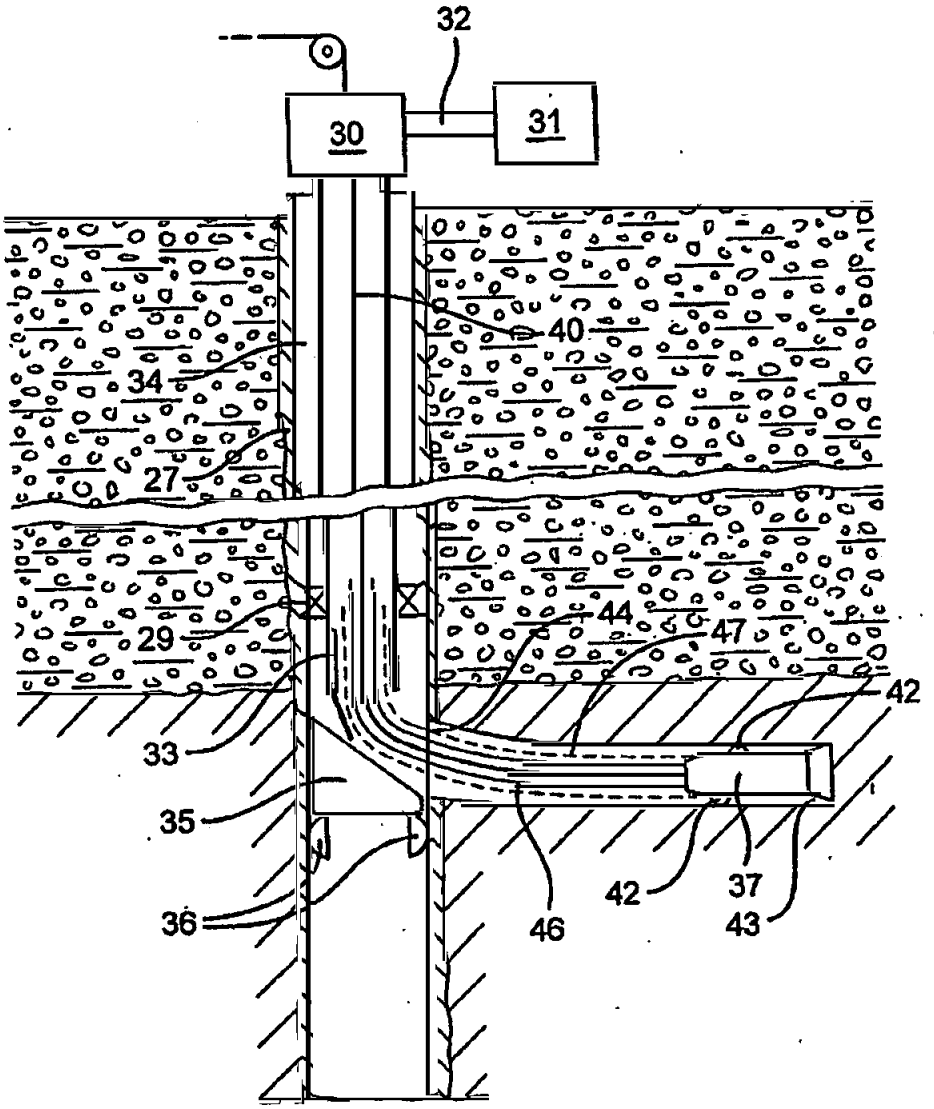
Fig.15



PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* 10281

Box No. I TITLE OF INVENTION

SUB-SURFACE DEPLOYMENT VALVE

Box No. II APPLICANT ☐ This person is also inventor

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

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This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

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☐ inventor only *(If this check-box is marked, do not fill in below.)*

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This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

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☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Continuation of Box No. III **FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)**

If none of the following sub-boxes is used, this sheet should not be included in the request.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

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- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality: GB

State *(that is, country)* of residence: GB

This person is applicant for the purposes of:
☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

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This person is:
- ☐ applicant only
- ☒ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality: GB

State *(that is, country)* of residence: GB

This person is applicant for the purposes of:
☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- ☐ applicant only
- ☐ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of:
☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- ☐ applicant only
- ☐ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of:
☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on another continuation sheet.

Box No. V DESIGNATIONS

The filing of this request **constitutes under Rule 4.9(a), the designation** of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.
However,

- ☐ DE Germany **is not designated** for any kind of national protection
- ☐ JP Japan **is not designated** for any kind of national protection
- ☐ KR Republic of Korea **is not designated** for any kind of national protection
- ☐ RU Russian Federation **is not designated** for any kind of national protection

(The check-boxes above may only be used to exclude (irrevocably) the designations concerned if, at the time of filing, the international application contains in Box No. VI a priority claim to an earlier national application filed in the particular State concerned, in order to avoid the ceasing of the effect, under the national law, of this earlier national application. See the Notes to Box No. V as to the consequences of such national law provisions in these States).

Box No. VI PRIORITY CLAIM

The priority of the following earlier application(s) is hereby claimed:

Filing date of earlier application *(day/month/year)*	Number of earlier application	Where earlier application is:		
		national application: country or Member of WTO	regional application:* regional Office	international application: receiving Office
item (1) 21 September 2005	0519287.7	GB		
item (2)				
item (3)				

☐ Further priority claims are indicated in the Supplemental Box.

The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of this international application is the receiving Office)* identified above as:

☐ all items ☒ item (1) ☐ item (2) ☐ item (3) ☐ other, see Supplemental Box

** Where the earlier application is an ARIPO application, indicate at least one country party to the Paris Convention for the Protection of Industrial Property or one Member of the World Trade Organization for which that earlier application was filed (Rule 4.10(b)(ii)):*

.....

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used)*:

ISA / EP .....

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority)*:

Date *(day/month/year)* Number Country *(or regional Office)*

Box No. VIII DECLARATIONS

The following **declarations** are contained in Boxes Nos. VIII (i) to (v) *(mark the applicable check-boxes below and indicate in the right column the number of each type of declaration)*:

			Number of declarations
☐	Box No. VIII (i)	Declaration as to the identity of the inventor :	
☒	Box No. VIII (ii)	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent :	1
☐	Box No. VIII (iii)	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application :	
☒	Box No. VIII (iv)	Declaration of inventorship (only for the purposes of the designation of the United States of America) :	1
☐	Box No. VIII (v)	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty :	

Box No. VIII (ii) DECLARATION: ENTITLEMENT TO APPLY FOR AND BE GRANTED A PATENT

The declaration must conform to the standardized wording provided for in Section 212; see Notes to Boxes Nos. VIII, VIII (i) to (v) (in general) and the specific Notes to Box No. VIII (ii). If this Box is not used, this sheet should not be included in the request.

Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent (Rules 4.17(ii) and 51*bis*.1(a)(ii)), in a case where the declaration under Rule 4.17(iv) is not appropriate:

In relation to this International Application, BP Exploration Operating Company Limited and XL Technology Limited are entitled to apply for and be granted a patent by virtue of the following:

BP Exploration Operating Company Limited is entitled as employer of the inventor Paul George LURIE and XL Technology Limited is entitled as employer of the inventor Philip HEAD.

☐ This declaration is continued on the following sheet, "Continuation of Box No. VIII (ii)".

Box No. VIII (iv) DECLARATION: INVENTORSHIP (only for the purposes of the designation of the United States of America)

The declaration must conform to the following standardized wording provided for in Section 214; see Notes to Boxes Nos. VIII, VIII (i) to (v) (in general) and the specific Notes to Box No.VIII (iv). If this Box is not used, this sheet should not be included in the request.

Declaration of inventorship (Rules 4.17(iv) and 51*bis*.1(a)(iv)) for the purposes of the designation of the United States of America:

I hereby declare that I believe I am the original, first and sole (if only one inventor is listed below) or joint (if more than one inventor is listed below) inventor of the subject matter which is claimed and for which a patent is sought.

This declaration is directed to the international application of which it forms a part (if filing declaration with application).

This declaration is directed to international application No. PCT/..... (if furnishing declaration pursuant to Rule 26*ter*).

I hereby declare that my residence, mailing address, and citizenship are as stated next to my name.

I hereby state that I have reviewed and understand the contents of the above-identified international application, including the claims of said application. I have identified in the request of said application, in compliance with PCT Rule 4.10, any claim to foreign priority, and I have identified below, under the heading "Prior Applications," by application number, country or Member of the World Trade Organization, day, month and year of filing, any application for a patent or inventor's certificate filed in a country other than the United States of America, including any PCT international application designating at least one country other than the United States of America, having a filing date before that of the application on which foreign priority is claimed.

Prior Applications: .....

.....

I hereby acknowledge the duty to disclose information that is known by me to be material to patentability as defined by 37 C.F.R. § 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the PCT international filing date of the continuation-in-part application.

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.

Name: HEAD, Philip .....

Residence: Virginia Water, Surrey, United Kingdom .....
(city and either US state, if applicable, or country)

Mailing Address: 14 The Orchard, Virginia Water, Surrey, GU25 4DT, United Kingdom .....

.....

Citizenship: British .....

Inventor's Signature: ..... Date: 4/9/06
(The signature must be that of the inventor, not that of the agent)

Name: LURIE, Paul George .....

Residence: East Horsley, Surrey, United Kingdom .....
(city and either US state, if applicable, or country)

Mailing Address: The Jays, Longhurst Road, East Horsley, Surrey, KT24 6AF, United Kingdom .....

.....

Citizenship: British .....

Inventor's Signature: ..... Date: 21/AUG/06
(The signature must be that of the inventor, not that of the agent)

☐ This declaration is continued on the following sheet, "Continuation of Box No. VIII (iv)".

Box No. IX CHECK LIST; LANGUAGE OF FILING

This international application **contains**:

(a) **on paper**, the following number of sheets:

request (including declaration sheets)	:	6
description (excluding sequence listing and/or tables related thereto)	:	18
claims	:	3
abstract	:	1
drawings	:	6
Sub-total number of sheets	:	34
sequence listing	:	
tables related thereto	:	
(for both, actual number of sheets if filed on paper, whether or not also filed in electronic form; see (c) below)		
Total number of sheets	:	34

(b) ☐ **only in electronic form** (Section 801(a)(i))
- (i) ☐ sequence listing
- (ii) ☐ tables related thereto

(c) ☐ **also in electronic form** (Section 801(a)(ii))
- (i) ☐ sequence listing
- (ii) ☐ tables related thereto

Type and number of carriers (diskette, CD-ROM, CD-R or other) on which are contained the
- ☐ sequence listing: .....
- ☐ tables related thereto: .....

(additional copies to be indicated under items 9(ii) and/or 10(ii), in right column)

This international application is **accompanied** by the following item(s) *(mark the applicable check-boxes below and indicate in right column the number of each item)*:

		Number of items
1. ☒ fee calculation sheet	:	1
2. ☒ original separate power of attorney	:	3
3. ☐ original general power of attorney	:	
4. ☒ copy of general power of attorney; reference number, if any:	:	1
5. ☐ statement explaining lack of signature	:	
6. ☐ priority document(s) identified in Box No. VI as item(s):	:	
7. ☐ translation of international application into *(language)*:	:	
8. ☐ separate indications concerning deposited microorganism or other biological material	:	
9. ☐ sequence listing in electronic form *(indicate type and number of carriers)*		
(i) ☐ copy submitted for the purposes of international search under Rule 13*ter* only (and not as part of the international application)	:	
(ii) ☐ *(only where check-box (b)(i) or (c)(i) is marked in left column)* additional copies including, where applicable, the copy for the purposes of international search under Rule 13*ter*	:	
(iii) ☐ together with relevant statement as to the identity of the copy or copies with the sequence listing mentioned in left column	:	
10. ☐ tables in electronic form related to sequence listing *(indicate type and number of carriers)*		
(i) ☐ copy submitted for the purposes of international search under Section 802(b-*quater*) only (and not as part of the international application)	:	
(ii) ☐ *(only where check-box (b)(ii) or (c)(ii) is marked in left column)* additional copies including, where applicable, the copy for the purposes of international search under Section 802(b-*quater*)	:	
(iii) ☐ together with relevant statement as to the identity of the copy or copies with the tables mentioned in left column	:	
11. ☒ other *(specify)*: Form 23/77	:	

Figure of the drawings which should accompany the abstract: 1

Language of filing of the international application: English

Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

R R Hymers

HYMERS, Ronald Robson

For receiving Office use only

1. Date of actual receipt of the purported international application:

2. Drawings:
- ☐ received:
- ☐ not received:

3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:

4. Date of timely receipt of the required corrections under PCT Article 11(2):

5. International Searching Authority (if two or more are competent): ISA /

6. ☐ Transmittal of search copy delayed until search fee is paid

For International Bureau use only

Date of receipt of the record copy by the International Bureau:

The demand must be filed directly with the competent International Preliminary Examining Authority or, if two or more Authorities are competent, with the one chosen by the applicant. The full name or two-letter code of that Authority may be indicated by the applicant on the line below:

IPEA/ EP

PCT

CHAPTER II

DEMAND

under Article 31 of the Patent Cooperation Treaty:
The undersigned requests that the international application specified below be the subject of international preliminary examination according to the Patent Cooperation Treaty.

For International Preliminary Examining Authority use only

Identification of IPEA	Date of receipt of DEMAND

Box No. I IDENTIFICATION OF THE INTERNATIONAL APPLICATION

Applicant's or agent's file reference: 10281

International application No.	International filing date *(day/month/year)*	(Earliest) Priority date *(day/month/year)*
PCT/GB2006/003306	07/09/2006	21/09/2005

Title of invention: Sub-Surface Deployment Valve

Box No. II APPLICANT(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

BP EXPLORATION OPERATING COMPANY LIMITED
Chertsey Road
Sunbury on Thames
Middlesex, TW16 7BP
UNITED KINGDOM

Telephone No.
Facsimile No.
Teleprinter No.
Applicant's registration No. with the Office

State *(that is, country)* of nationality: GB
State *(that is, country)* of residence: GB

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

XL TECHNOLOGY LIMITED
Turbogenset House, Heathrow Summit Centre
Skyport Drive
West Drayton, UB7 0LJ
United Kingdom

State *(that is, country)* of nationality: GB
State *(that is, country)* of residence: GB

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

HEAD, Philip
14 The Orchard
Virginia Water
Surrey, GU25 4DT
United Kingdom

State *(that is, country)* of nationality: GB
State *(that is, country)* of residence: GB

☒ Further applicants are indicated on a continuation sheet.

International application No.
PCT/GB2006/003306

Continuation of Box No. II APPLICANT(S)

If none of the following sub-boxes is used, this sheet should not be included in the demand.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

LURIE, Paul George
The Jays
Longhurst Road
East Horsley,
Surrey, KT24 6AF
United Kingdom

State *(that is, country)* of nationality:	State *(that is, country)* of residence:
GB	GB

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

State *(that is, country)* of nationality:	State *(that is, country)* of residence:

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

State *(that is, country)* of nationality:	State *(that is, country)* of residence:

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

State *(that is, country)* of nationality:	State *(that is, country)* of residence:

☐ Further applicants are indicated on another continuation sheet.

International application No.
PCT/GB2006/003306

Box No. III AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The following person is ☒ agent ☐ common representative

and ☒ *has been appointed earlier and represents the applicant(s) also for international preliminary examination.*

☐ is hereby appointed and any earlier appointment of (an) agent(s)/common representative is hereby revoked.

☐ is hereby appointed, specifically for the procedure before the International Preliminary Examining Authority, in addition to the agent(s)/common representative appointed earlier.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

HYMERS, Ronald Robson
BP International Limited
Global Patents & Technology Law (Central)
Chertsey Road, Sunbury on Thames
Middlesex, TW16 7LN
United Kingdom

Telephone No.
01932 763205

Facsimile No.
01932 762388

Teleprinter No.

Agent's registration No. with the Office

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Box No. IV BASIS FOR INTERNATIONAL PRELIMINARY EXAMINATION

Statement concerning amendments:*

1. The applicant wishes the international preliminary examination to start on the basis of:

☒ the international application as originally filed

the description ☒ as originally filed
☐ as amended under Article 34

the claims ☒ as originally filed
☐ as amended under Article 19 (together with any accompanying statement)
☐ as amended under Article 34

the drawings ☒ as originally filed
☐ as amended under Article 34

2. ☐ The applicant wishes any amendment to the claims under Article 19 to be considered as reversed.

3. ☐ Where the IPEA wishes to start the international preliminary examination at the same time as the international search in accordance with Rule 69.1(b), the applicant requests the IPEA to postpone the start of the international preliminary examination until the expiration of the applicable time limit under Rule 69.1(d).

4. ☐ The applicant expressly wishes the international preliminary examination to start earlier than at the expiration of the applicable time limit under Rule 54*bis*.1(a).

* Where no check-box is marked, international preliminary examination will start on the basis of the international application as originally filed or, where a copy of amendments to the claims under Article 19 and/or amendments of the international application under Article 34 are received by the International Preliminary Examining Authority before it has begun to draw up a written opinion or the international preliminary examination report, as so amended.

Language for the purposes of international preliminary examination: English

☒ which is the language in which the international application was filed.
☐ which is the language of a translation furnished for the purposes of international search.
☐ which is the language of publication of the international application.
☐ which is the language of the translation (to be) furnished for the purposes of international preliminary examination.

Box No. V ELECTION OF STATES

The filing of this demand constitutes the election of all Contracting States which are designated and are bound by Chapter II of the PCT.

International application No.
PCT/GB2006/003306

Box No. VI CHECK LIST

The demand is accompanied by the following elements, in the language referred to in Box No. IV, for the purposes of international preliminary examination:			For International Preliminary Examining Authority use only: received	not received
1. translation of international application	:	sheets	☐	☐
2. amendments under Article 34	:	sheets	☐	☐
3. copy (or, where required, translation) of amendments under Article 19	:	sheets	☐	☐
4. copy (or, where required, translation) of statement under Article 19	:	sheets	☐	☐
5. letter	:	sheets	☐	☐
6. other *(specify)*	:	sheets	☐	☐

The demand is also accompanied by the item(s) marked below:

1. ☒ fee calculation sheet
2. ☐ original separate power of attorney
3. ☐ original general power of attorney
4. ☐ copy of general power of attorney; reference number, if any:
5. ☐ statement explaining lack of signature
6. ☐ sequence listing in electronic form
7. ☐ tables in electronic form related to a sequence listing
8. ☐ other *(specify)*:

Box No. VII SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the demand).

RRH

HYMERS, Ronald Robson
Authorised Agent

For International Preliminary Examining Authority use only

1. Date of actual receipt of DEMAND:

2. Adjusted date of receipt of demand due to CORRECTIONS under Rule 60.1(b):

3. ☐ The date of receipt of the demand is AFTER the expiration of 19 months from the priority date and item 4 or 5, below, does not apply.
   ☐ The applicant has been informed accordingly.
4. ☐ The date of receipt of the demand is WITHIN the time limit of 19 months from the priority date as extended by virtue of Rule 80.5.
5. ☐ Although the date of receipt of the demand is after the expiration of 19 months from the priority date, the delay in arrival is EXCUSED pursuant to Rule 82.
6. ☐ The date of receipt of the demand is AFTER the expiration of the time limit under Rule 54*bis*.1(a) and item 7 or 8, below, does not apply.
7. ☐ The date of receipt of the demand is WITHIN the time limit under Rule 54*bis*.1(a) as extended by virtue of Rule 80.5.
8. ☐ Although the date of receipt of the demand is after the expiration of the time limit under Rule 54*bis*.1(a), the delay in arrival is EXCUSED pursuant to Rule 82.

For International Bureau use only

Demand received from IPEA on:

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

PCT

To:

HYMERS, Ronald, Robson
BP INTERNATIONAL LIMITED
Patents & Agreements
Chertsey Road, Sunbury-on-Thames
Middlesex, TW16 7LN
GRANDE BRETAGNE

Received in PAT
13 APR 2007

NOTIFICATION OF RECEIPT OF DEMAND BY COMPETENT INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

(PCT Rules 59.3(e) and 61.1(b), first sentence and Administrative Instructions, Section 601(a))

Date of mailing *(day/month/year)* 11-04-2007

Applicant's or agent's file reference
10281

IMPORTANT NOTIFICATION

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB2006/003306	7 September 2006 (07-09-2006)	21 September 2005 (21-09-2005)

Applicant
BP EXPLORATION OPERATING COMPANY LIMITED et al.

1. The applicant is hereby **notified** that this International Preliminary Examining Authority considers the following date as the date of receipt of the demand for international preliminary examination of the international application:

23 March 2007 (23-03-2007)

2. This date of receipt is:

- [X] the actual date of receipt of the demand by this Authority (Rule 61.1(b)).
- [ ] the actual date of receipt of the demand on behalf of this Authority (Rule 59.3(e)).
- [ ] the date on which this Authority has, in response to the invitation to correct defects in the demand (Form PCT/IPEA/404), received the required corrections.

3. [ ] **ATTENTION:** That date of receipt is **after** the expiration of 19 months from the priority date. Consequently, in respect of some Offices, the demand does not have the effect of postponing the entry into the national phase until 30 months from the priority date (or later in some Offices) (Article 39(1)) and the acts for entry into the national phase must therefore be performed within 20 months from the priority date (or later in some Offices). **However,** in respect of some other Offices, the time limit of 30 months (or later) may nevertheless apply. See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

[ ] *(If applicable)* This notification confirms the information given by telephone, facsimile transmission or in person on:

4. Only where paragraph 3 applies, a copy of this notification has been sent to the International Bureau.

Name and mailing address of the IPEA/

European Patent Office
D-80298 Munich
Tel. (+49-89) 2399-0
Fax: (+49-89) 2399-4465

Authorized officer

Tsogka, Voula
Tel: 3630

Europäisches Patentamt · European Patent Office · Office européen des brevets

Form PCT/IPEA/402 (April 2002; reprint January 2004)

66

SJD
RMH

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING SUBMISSION OR TRANSMITTAL OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

To:

HYMERS, Ronald, Robson
BP International Limited
Patents & Agreements
Chertsey Road
Sunbury-on-Thames
Middlesex TW16 7LN
ROYAUME-UNI

Date of mailing *(day/month/year)* 18 October 2006 (18.10.2006)	
Applicant's or agent's file reference 10281	**IMPORTANT NOTIFICATION**
International application No. PCT/GB2006/003306	International filing date *(day/month/year)* 07 September 2006 (07.09.2006)
International publication date *(day/month/year)* **Not yet published**	Priority date *(day/month/year)* 21 September 2005 (21.09.2005)
Applicant BP EXPLORATION OPERATING COMPANY LIMITED et al	

1. By means of this Form, which replaces any previously issued notification concerning submission or transmittal of priority documents, the applicant is hereby notified of the date of receipt by the International Bureau of the priority document(s) relating to all earlier application(s) whose priority is claimed. Unless otherwise indicated by the letters "NR", in the right-hand column or by an asterisk appearing next to a date of receipt, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).

2. *(If applicable)* The **letters "NR"** appearing in the right-hand column denote **a priority document which, on the date of mailing of this Form, had not yet been received by the International Bureau** under Rule 17.1(a) or (b). Where, under Rule 17.1(a), the priority document must be submitted by the applicant to the receiving Office or the International Bureau, but the applicant fails to submit the priority document within the applicable time limit under that Rule, **the attention of the applicant is directed** to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

3. *(If applicable)***An asterisk (*)** appearing next to a date of receipt, in the right-hand column, denotes **a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b)** (the priority document was received after the time limit prescribed in Rule 17.1(a) or the request to prepare and transmit the priority document was submitted to the receiving Office after the applicable time limit under Rule 17.1(b)). Even though the priority document was not furnished in compliance with Rule 17.1(a) or (b), the International Bureau will nevertheless transmit a copy of the document to the designated Offices, for their consideration. In case such a copy is not accepted by the designated Office as the priority document, Rule 17.1(c) provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

Priority date	Priority application No.	Country or regional Office or PCT receiving Office	Date of receipt of priority document
21 September 2005 (21.09.2005) ✓	0519287.7 ✓	GB ✓	05 October 2006 (05.10.2006)

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. +41 22 338 82 70

Authorized officer
Dorothée Mülhausen
Facsimile No. +41 22 338 87 40
Telephone No. +41 22 338 96 72

PATENT COOPERATION TREATY

RRH

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

BP INTERNATIONAL LIMITED
Patents & Agreements
Chertsey Road, Sunbury-on-Thames
Middlesex, TW16 7LN
GRANDE BRETAGNE

Received in PAT
13 AUG 2007

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(PCT Rule 71.1)

Date of mailing *(day/month/year)*	10.08.2007
Applicant's or agent's file reference 10281	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB2006/003306	07.09.2006	21.09.2005

Applicant
BP EXPLORATION OPERATING COMPANY LIMITED

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary report on patentability and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary report on patentability. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

The applicant's attention is drawn to Article 33(5), which provides that the criteria of novelty, inventive step and industrial applicability described in Article 33(2) to (4) merely serve the purposes of international preliminary examination and that "any Contracting State may apply additional or different criteria for the purposes of deciding whether, in that State, the claimed inventions is patentable or not" (see also Article 27(5)). Such additional criteria may relate, for example, to exemptions from patentability, requirements for enabling disclosure, clarity and support for the claims.

Name and mailing address of the international preliminary examining authority:	Authorized Officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Kermani, Nathalie Tel. +49 89 2399-7740

Form PCT/IPEA/416 (January 2004)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 10281	**FOR FURTHER ACTION**	See Form PCT/IPEA/416
International application No. PCT/GB2006/003306	International filing date *(day/month/year)* 07.09.2006	Priority date *(day/month/year)* 21.09.2005
International Patent Classification (IPC) or national classification and IPC INV. E21B43/10		
Applicant BP EXPLORATION OPERATING COMPANY LIMITED		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 7 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☐ *sent to the applicant and to the International Bureau)* a total of sheets, as follows:
      ☐ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:
   - ☒ Box No. I Basis of the report
   - ☐ Box No. II Priority
   - ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - ☒ Box No. IV Lack of unity of invention
   - ☒ Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - ☐ Box No. VI Certain documents cited
   - ☒ Box No. VII Certain defects in the international application
   - ☐ Box No. VIII Certain observations on the international application

Date of submission of the demand	Date of completion of this report
2007-03-23	10.08.2007
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Georgescu, Mihnea Telephone No. +49 89 2399-0

Box No. I Basis of the report

1. With regard to the **language**, this report is based on

☒ the international application in the language in which it was filed

☐ a translation of the international application into , which is the language of a translation furnished for the purposes of:

- ☐ international search (under Rules 12.3(a) and 23.1(b))
- ☐ publication of the international application (under Rule 12.4(a))
- ☐ international preliminary examination (under Rules 55.2(a) and/or 55.3(a))

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-18 as originally filed

Claims, Numbers

1-11 as originally filed

Drawings, Sheets

1/6-6/6 as originally filed

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing *(specify)*:
- ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing *(specify)*:
- ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

Box No. IV Lack of unity of invention

1. ☒ In response to the invitation to restrict or pay additional fees, the applicant has, within the applicable time limit:

   ☐ restricted the claims.

   ☒ paid additional fees.

   ☐ paid additional fees under protest and, where applicable, the protest fee.

   ☐ paid additional fees under protest but the applicable protest fee was not paid.

   ☐ neither restricted the claims nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is:

   ☐ complied with.

   ☒ not complied with for the following reasons:

   see separate sheet

4. Consequently, this report has been established in respect of the following parts of the international application:

   ☒ all parts.

   ☐ the parts relating to claims Nos. .

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	2-11
	No:	Claims	1
Inventive step (IS)	Yes:	Claims	3, 4, 6-11
	No:	Claims	1, 2, 5
Industrial applicability (IA)	Yes:	Claims	1-11
	No:	Claims	

2. Citations and explanations (Rule 70.7):

   see separate sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

applicability

V-1 Claim 1

D1, which is considered as the closest prior art, describes the features of claim 1 (fig.19, expandable body 244 and valve element 242 in paragraph 79).

The subject-matter of claim 1 is therefore not new and the claim does not meet the novelty requirement of Art. 33(2)PCT.

Also D2 discloses the features of claim 1 (fig.3 and 5 with expandable body 19 which provides the valve element closing the through bore).

V-2 Claims 2 and 5

The feature of claim 2 is merely a normal design possibility suggested by D3 (fig.1) where the flapper valve is also attached in a tubular string in the context in which claim 2 does not imply that the valve element itself has to be expanded together with the radially expandable body.

The feature of claim 5 is also a normal design possibility in the field of flapper valves taught by D4 (fig. 2 and 5) in the context in which the claim does not require the flapper to be flexible.

Therefore, claims 2 and 5 do not meet the requirement for inventive step of Art. 33(3) PCT.

V-3 Claims 3 and 4

The features of claims 3 and 4 are united through the concept of folding the elements of the deployment valve so that its folded dimension is smaller than a tubular through it has to be conveyed in the wellbore. The valve element and the radially expandable body of D1 have from the very beginning a dimension allowing the passage of the deployment valve through the tubular without having any folded portion. The distinguishing features of claims 3 and 4 do not only allow the passage of the deployment valve through a tubular but also allow its attachment in a tubular which is larger at a lover location that at its upper end, without stretching

dangerously the radially expandable body. Thus, the skilled man would not find obvious to arrive at the subject-matter of claims 3 and 4. Therefore, claims 3 and 4 meet the requirement for inventive step of Art. 33(3) PCT.

V-4 Claim 6

D5 discloses all the features of claim 6 related to the drilling method through a deployment valve (page 5, lines 16-24). Furthermore, D5 discloses also a deployment valve having an expandable body (page 14, line 19, wherein an inflatable body is expanding during inflation). D5 does not hint to which purpose the body of the deployment valve is inflated and does not disclose the direction in which the inflated body expands. Thus, it is neither explicit nor implicit that the expansion of the body of the deployment valve would result in forming an interference connection as defined in claim 6. Although, D1 discloses a deployment valve (fig.19) which is expanded in order to form an interference connection with a casing (240), it does not teach that a drill string can be moved through the valve during drilling. Thus, it appears that the skilled man starting from any of D1 and D5 would not have an apparent incentive to look for the other document and to apply its teaching to the first one. Therefore, claim 6 meets the requirement for inventive step of Art. 33(3) PCT.

V-5 Claims 7 to 11

Claims 7 to 11 as dependent claims from claim 6 also meet the requirements of Art. 33 PCT.

VII - Certain defects

VII-1 The independent claims are not properly cast in the two part form, with those features which in combination are part of the closest prior art (D1 respectively D5) being placed in the preamble, contrary to the requirements of Rule 6.3(b) PCT.

VII-2 Contrary to the requirements of Rule 5.1(a)(ii)PCT, the relevant background art disclosed in documents D1 to D5 is not mentioned in the description, nor are these documents identified therein.

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

To:
BP INTERNATIONAL LIMITED
Attn. Hymers, Ronald Robson
Patents & Agreements
Chertsey Road
Sunbury-on-Thames
Middlesbrough TW16 7LN
GRANDE BRETAGNE

Received in PAT
13 MAR 2007

Applicant's or agent's file reference 10281	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/GB2006/003306	International filing date (day/month/year) 07/09/2006
Applicant BP EXPLORATION OPERATING COMPANY LIMITED	

Date of mailing (day/month/year) 13/03/2007

1. [x] The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the International Search Report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Fascimile No.: (41-22) 338.82.70

   For more detailed instructions, see the notes on the accompanying sheet.

2. [ ] The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. [ ] **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   [ ] the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

   [ ] no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

   The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for International preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

   In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

   See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

Name and mailing address of the International Searching Authority European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Paulina Danissen

Form PCT/ISA/220 (October 2005) *(See notes on accompanying sheet)*

NOTES TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the *PCT Applicant's Guide*, a publication of WIPO.

In these Notes, "Article", "Rule", and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions, respectively.

INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report and the written opinion of the International Searching Authority, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims,description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only (see *PCT Applicant's Guide*, Volume I/A, Annexes B1 and B2).

The attention of the applicant is drawn to the fact that amendments to the claims under Article 19 are not allowed where the International Searching Authority has declared, under Article 17(2), that no international search report would be established (see *PCT Applicant's Guide*, Volume I/A, paragraph 296).

What parts of the international application may be amended?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

When? Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

Where not to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

How? Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Section 205(b)).

The amendments must be made in the language in which the international application is to be published.

What documents must/may accompany the amendments?

Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

see form PCT/ISA/220

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB2006/003306	07.09.2006	21.09.2005

International Patent Classification (IPC) or both national classification and IPC
INV. E21B43/10 E21B34/10

Applicant
BP EXPLORATION OPERATING COMPANY LIMITED

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☒ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☒ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☒ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notifed the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA:	Date of completion of this opinion	Authorized Officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	see form PCT/ISA/210	Georgescu, Mihnea Telephone No. +49 89 2399-7502

Form (PCT/ISA/237) (Cover Sheet) (April 2005)

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WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/GB2006/003306

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).

2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:

   a. type of material:

      ☐ a sequence listing

      ☐ table(s) related to the sequence listing

   b. format of material:

      ☐ on paper

      ☐ in electronic form

   c. time of filing/furnishing:

      ☐ contained in the international application as filed.

      ☐ filed together with the international application in electronic form.

      ☐ furnished subsequently to this Authority for the purposes of search.

3. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

4. Additional comments:

Box No. II Priority

1. ☒ The validity of the priority claim has not been considered because the International Searching Authority does not have in its possession a copy of the earlier application whose priority has been claimed or, where required, a translation of that earlier application. This opinion has nevertheless been established on the assumption that the relevant date (Rules 43*bis*.1 and 64.1) is the claimed priority date.

2. ☐ This opinion has been established as if no priority had been claimed due to the fact that the priority claim has been found invalid (Rules 43*bis*.1 and 64.1). Thus for the purposes of this opinion, the international filing date indicated above is considered to be the relevant date.

3. Additional observations, if necessary:

Box No. IV Lack of unity of invention

1. ☒ In response to the invitation (Form PCT/ISA/206) to pay additional fees, the applicant has, within the applicable time limit:

   ☒ paid additional fees

   ☐ paid additional fees under protest and, where applicable, the protest fee

   ☐ paid additional fees under protest but the applicable protest fee was not paid

   ☐ not paid additional fees

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose not to invite the applicant to pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rule 13.1, 13.2 and 13.3 is

   ☐ complied with

   ☒ not complied with for the following reasons:

   see separate sheet

4. Consequently, this report has been established in respect of the following parts of the international application:

   ☒ all parts.

   ☐ the parts relating to claims Nos.

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	2-11
	No:	Claims	1
Inventive step (IS)	Yes:	Claims	3, 4, 6-11
	No:	Claims	1, 2, 5
Industrial applicability (IA)	Yes:	Claims	1-11
	No:	Claims	

2. Citations and explanations

   see separate sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Reference is made to the following documents:

D1: US 2004/0226723
D2: US 3 401 946
D3: GB 2 197 011
D4: US 4 378 818
D5: GB 2 337 544

IV - Lack of unity of invention

IV-1 D1 discloses the features of claim 1 (see fig.19 and paragraph 79). Subsequently, even before a substantive examination the following groups of potential inventive claims are observed: 1) claims 2 to 5 and 2) 6 to 11. The potential "special technical feature" of claim 2 is that the valve element is a flapper valve element having pivot connections attached to the radially expandable body of the deployment valve. The potential "special technical feature" of claim 6 is that the claim is directed towards a method for drilling in which the drill string can be moved through a deployment valve positioned in a tubular string located in the wellbore. As it can be seen, the "special technical features" are different and potentially contribute to the solutions of different technical problems. Furthermore, claim 2 does not imply that its deployment valve can be used in a drilling process where a drill string can pass through the deployment valve, and in claim 6 is neither explicitly or implicitly described that the drill string passes through the internal bore of the radially expandable body which can be closed off by a valve element of the deployment valve (as the drill string can also drill through the valve or pass through a further bore of the deployment valve) nor implied that the internal bore of the radially expandable body which can be closed off by a valve element of the deployment valve is adapted for allowing the through movement of a drill string. Therefore, the aforementioned groups of potential inventive claims are not linked through a unitary inventive concept.

The following substantive examination upholds the above non-unity objection as the apparently inventive claims 3 and 4 are also not united through the same inventive concept with claim 6. Therefore, the aforementioned groups of claims cannot be part of the same application as independent claims.

V - Reasoned statement with regard to novelty, inventive step or industrial

applicability

V-1 Claim 1

D1, which is considered as the closest prior art, describes the features of claim 1 (fig.19, expandable body 244 and valve element 242 in paragraph 79).

The subject-matter of claim 1 is therefore not new and the claim does not meet the novelty requirement of Art. 33(2)PCT.

Also D2 discloses the features of claim 1 (fig.3 and 5 with expandable body 19 which provides the valve element closing the through bore).

V-2 Claims 2 and 5

The feature of claim 2 is merely a normal design possibility suggested by D3 (fig.1) where the flapper valve is also attached in a tubular string in the context in which claim 2 does not imply that the valve element itself has to be expanded together with the radially expandable body.

The feature of claim 5 is also a normal design possibility in the field of flapper valves taught by D4 (fig. 2 and 5) in the context in which the claim does not require the flapper to be flexible.

Therefore, claims 2 and 5 do not meet the requirement for inventive step of Art. 33(3) PCT.

V-3 Claims 3 and 4

The features of claims 3 and 4 are united through the concept of folding the elements of the deployment valve so that its folded dimension is smaller than a tubular through it has to be conveyed in the wellbore. The valve element and the radially expandable body of D1 have from the very beginning a dimension allowing the passage of the deployment valve through the tubular without having any folded portion. The distinguishing features of claims 3 and 4 do not only allow the passage of the deployment valve through a tubular but also allow its attachment in a tubular which is larger at a lover location that at its upper end, without stretching

dangerously the radially expandable body. Thus, the skilled man would not find obvious to arrive at the subject-matter of claims 3 and 4. Therefore, claims 3 and 4 meet the requirement for inventive step of Art. 33(3) PCT.

V-4 Claim 6

D5 discloses all the features of claim 6 related to the drilling method through a deployment valve (page 5, lines 16-24). Furthermore, D5 discloses also a deployment valve having an expandable body (page 14, line 19, wherein an inflatable body is expanding during inflation). D5 does not hint to which purpose the body of the deployment valve is inflated and does not disclose the direction in which the inflated body expands. Thus, it is neither explicit nor implicit that the expansion of the body of the deployment valve would result in forming an interference connection as defined in claim 6. Although, D1 discloses a deployment valve (fig.19) which is expanded in order to form an interference connection with a casing (240), it does not teach that a drill string can be moved through the valve during drilling. Thus, it appears that the skilled man starting from any of D1 and D5 would not have an apparent incentive to look for the other document and to apply its teaching to the first one. Therefore, claim 6 meets the requirement for inventive step of Art. 33(3) PCT.

V-5 Claims 7 to 11

Claims 7 to 11 as dependent claims from claim 6 also meet the requirements of Art. 33 PCT.

VII - Certain defects

VII-1 The independent claims are not properly cast in the two part form, with those features which in combination are part of the closest prior art (D1 respectively D5) being placed in the preamble, contrary to the requirements of Rule 6.3(b) PCT.

VII-2 Contrary to the requirements of Rule 5.1(a)(ii)PCT, the relevant background art disclosed in documents D1 to D5 is not mentioned in the description, nor are these documents identified therein.

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING
AVAILABILITY OF THE PUBLICATION
OF THE INTERNATIONAL APPLICATION

To:

SJD
MH

HYMERS, Ronald, Robson
BP International Limited
Patents & Agreements
Chertsey Road
Sunbury-on-Thames
Middlesex TW16 7LN
ROYAUME-UNI

Date of mailing *(day/month/year)*
29 March 2007 (29.03.2007)

Applicant's or agent's file reference
10281

IMPORTANT NOTICE

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/GB2006/003306	07 September 2006 (07.09.2006)	21 September 2005 (21.09.2005)

Applicant
BP EXPLORATION OPERATING COMPANY LIMITED et al

The applicant is hereby **notified** that the International Bureau:

☑ has **published** the above-indicated international application on 29 March 2007 (29.03.2007) under No. WO 2007/034136

☐ has **republished** the above-indicated international application on under No. WO
For an explanation as to the reason for this republication of the international application, reference is made to INID codes (15), (48) or (88) (*as the case may be*) on the front page of the published international application.

A copy of the international application is available for viewing and downloading on WIPO's website at the following address: http://www.wipo.int/pctdb (under "Query" enter the PCT or WO number).

The applicant may also request a paper copy of the published international application from the International Bureau by submitting a written request to PatentScope@wipo.int or to the address provided below.

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. +41 22 338 82 70

Authorized officer
Dorothée Mülhausen

e-mail: pt01.pct@wipo.int