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(54) **METHOD OF DRILLING A WELLBORE WITH DISENGAGABLE COUPLERS**

VERFAHREN ZUM BOHREN EINES BOHRLOCHS MIT ENTRIEGELBAREN VERBINDERN

PROCEDE DE FORAGE D'UN PUITS DE FORAGE AVEC DES RACCORDS AMOVIBLES

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Description

[0001] The present invention relates to a method of drilling a wellbore in an earth formation using a drill string connected at the upper end thereof to a rotary drive and being provided with a drill bit. The invention furthermore relates to a drill string for use in the method.

[0002] A frequently encountered problem during drilling of a wellbore is sticking of the drill string in the wellbore. Such sticking can be, for example, due to differential sticking of drill string joints to the wellbore wall as a result of a pressure difference between the drilling fluid pressure in the wellbore and the pressure of earth formation fluid present in the pores of the formation. The problem is more frequently encountered in depleted oil/gas reservoirs where the pore pressure has decreased significantly.

[0003] It is an objective of the invention to provide an improved method of drilling whereby the problem of sticking has been solved.

[0004] It is another objective of the invention to provide a drill string for use in such method.

[0005] In accordance with the invention there is provided a method of drilling a wellbore in an earth formation using a drill string connected at the upper end thereof to a rotary drive and being provided with a drill bit, the drill string comprising a plurality of couplers arranged at selected drill string intervals, each coupler interconnecting two adjacent sections of the drill string and being operable in an engaged mode in which the coupler transmits torque between the adjacent drill string sections and a disengaged mode in which the adjacent drill string sections are free to rotate relative to each other about the longitudinal axis of the drill string, each coupler being controllable by control means for moving the coupler between said engaged mode and said disengaged mode, the method comprising

a) rotating the drill string so as to drill a portion of said wellbore while each coupler is in the engaged mode;
b) when the drill string has become stuck in the wellbore, disengaging a selected one of said couplers which thereby becomes the disengaged coupler;
c) rotating the part of the drill string between the rotary drive and the disengaged coupler;
d) engaging the disengaged coupler, and disengaging the next lower coupler which thereby becomes the disengaged coupler;
e) repeating steps c)-d) until the disengaged coupler is the lowermost coupler.

[0006] In accordance with another aspect of the invention there is provided a drill string for drilling a wellbore in an earth formation, the drill string comprising a drill bit, means for connecting the upper end of the drill string to a rotary drive, and a plurality of couplers arranged at selected drill string intervals, each coupler interconnecting two adjacent sections of the drill string and being operable in an engaged mode in which the coupler transmits torque between the adjacent drill string sections and a disengaged mode in which the adjacent drill string sections are free to rotate relative to each other about the longitudinal axis of the drill string, each coupler being controllable by control means for moving the coupler between said engaged mode and said disengaged mode.

[0007] The invention will be described hereinafter in more detail and by way of example with reference to the accompanying drawing in which

Fig. 1 schematically shows a drill string for use in the method according to the invention.

[0008] In Fig. 1 is shown a drill string 1 extending into a wellbore 3 formed in an earth formation 5. The lower end of the drill string 1 is provided with a drill bit 6 and the upper end of the drill string 1 is connected to a rotary table 7 at surface for rotating the drill string, which rotary table 7 forms part of a conventional drilling rig 9. The drill string 1 is provided with four couplers 10, 12, 14, 16 arranged at selected intervals along the length of the drill string 1, thus dividing the drill string in drill string sections 18, 20, 22, 24, 26. Sections 18, 20 are interconnected by coupler 10, sections 20, 22 are interconnected by coupler 12, sections 22, 24 are interconnected by coupler 14, and sections 24, 26 are interconnected by coupler 16. A fluid passage (not shown) for drilling fluid extends in longitudinal direction through the drill string 1.

[0009] Each coupler is operable in an engaged mode in which the coupler transmits rotation between the two drill string sections interconnected by the coupler, and a disengaged mode in which the couplers allows free rotation of the two drill string sections interconnected by the coupler relative to each other about the longitudinal axis of the drill string. Thus, in the engaged mode coupler 10 transmits rotation from section 18 to section 20, coupler 12 transmits rotation from section 20 to section 22, coupler 14 transmits rotation from section 22 to section 24, and coupler 16 transmits rotation from section 24 to section 26. Conversely, in the disengaged mode coupler 10 allows free rotation of section 18 relative to section 20, coupler 12 allows free rotation of section 20 relative to section 22, coupler 14 allows free rotation of section 22 relative to section 24, and coupler 16 allows free rotation of section 24 relative to section 26.

[0010] Each coupler 10, 12, 14, 16 is provided with an electronic control system (not shown) for selectively switching the coupler from the engaged mode to the disengaged mode and for selectively switching the coupler from the disengaged mode to the engaged mode. Each control system is in communication with the fluid passage of the drill string 1 and is uniquely responsive to a selected fluid pressure variation in the fluid passage. Thus, the control system of coupler 10 is uniquely re-

sponsive to a first pressure variation, i.e. the other couplers are not responsive to the first pressure variation. Similarly, the control system of coupler 12 is uniquely responsive to a second pressure variation, the control system of coupler 14 is uniquely responsive to a third pressure variation, and the control system of coupler 16 is uniquely responsive to a fourth pressure variation.

[0011] The first, second, third and fourth pressure variations are in the form of mutually different series of pressure pulses induced to a column of drilling fluid present in the fluid passage by a fluid pump (not shown) at the drilling rig for pumping drilling fluid through the drill string.

[0012] During normal operation the drill string is rotated by the rotary table 7 in order to drill a portion of the wellbore 3, whereby each coupler 10, 12, 14, 16 is in the engaged mode. When the drill string becomes stuck, for example due to differential sticking of the string 1 to the wellbore wall during a period of time in which an additional drill string part is added to the string 1, the fluid pump is operated to induce the first pressure variation to the column of fluid. As a result the control system of coupler 10 responses so as to switch the coupler 10 to the disengaged mode, while the other couplers remain in the engaged mode. The rotary table 7 is then rotated, and as a result drill string section 18 is rotated due to the fact that only a limited amount of torque is needed to free drill string section 18 when compared to the torque which would be needed to free the entire drill string 1.

[0013] In a next step the pump is operated to produce again the first pressure variation to the fluid column thereby inducing the control system of coupler 10 to switch the coupler 10 back to the engaged mode. Subsequently the pump is operated to produce the second pressure variation in the fluid column. As a result the control system of coupler 12 responses so as to switch the coupler 12 to the disengaged mode, while the other couplers remain in the engaged mode. The rotary table 7 is then rotated, and as a result drill string sections 18 and 20 are simultaneously rotated. It is thereby relevant to note that no differential sticking of drill string section 18 has occurred in the short period of time between engaging coupler 10 and disengaging coupler 12.

[0014] Next the pump is operated to produce again the second pressure variation to the fluid column thereby inducing the control system of coupler 12 to switch the coupler 12 back to the engaged mode. Subsequently the pump is operated to produce the third pressure variation in the fluid column. As a result the control system of coupler 14 responses so as to switch the coupler 14 to the disengaged mode, while the other couplers remain in the engaged mode. The rotary table 7 is then rotated, and as a result drill string sections 18, 20 and 22 are simultaneously rotated. No differential sticking of drill string sections 18 and 20 has occurred in the short period of time between engaging coupler 12 and disengaging coupler 14.

[0015] Next the pump is operated to produce again the third pressure variation to the fluid column thereby inducing the control system of coupler 14 to switch the coupler 14 back to the engaged mode. Subsequently the pump is operated to produce the fourth pressure variation in the fluid column. As a result the control system of coupler 16 responses so as to switch the coupler 16 to the disengaged mode, while the other couplers remain in the engaged mode. The rotary table 7 is then rotated, and as a result drill string sections 18, 20, 22 and 24 are simultaneously rotated. No differential sticking of drill string sections 18, 20 and 22 has occurred in the short period of time between engaging coupler 14 and disengaging coupler 16.

[0016] Finally the pump is operated to produce again the fourth pressure variation to the fluid column thereby inducing the control system of coupler 16 to switch the coupler 16 back to the engaged mode. The rotary table 7 is then rotated, and as a result the entire drill string 1 is rotated. In this manner the drill string 1 has been freed from differential sticking in a stepwise manner.

Claims

1. A method of drilling a wellbore in an earth formation using a drill string (1) connected at the upper end thereof to a rotary drive (7) and being provided with a drill bit (6), the drill string comprising a plurality of couplers (10, 12, 14, 16) arranged at selected drill string intervals, each coupler interconnecting two adjacent sections of the drill string and being operable in an engaged mode in which the coupler transmits torque between the adjacent drill string sections and a disengaged mode in which the adjacent drill string sections are free to rotate relative to each other about the longitudinal axis of the drill string, each coupler being controllable by control means for moving the coupler between said engaged mode and said disengaged mode, the method comprising

   a) rotating the drill string so as to drill a portion of said wellbore while each coupler is in the engaged mode;
   b) when the drill string has become stuck in the wellbore, disengaging a selected one of said couplers which thereby becomes the disengaged coupler;
   c) rotating the part of the drill string between the rotary drive and the disengaged coupler;
   d) engaging the disengaged coupler, and disengaging the next lower coupler which thereby becomes the disengaged coupler; and
   e) repeating steps c)-d) until the disengaged coupler is the lowermost coupler.

2. The method of claim 1, wherein in step b) the drill string has become stuck in the wellbore due to dif-

ferential sticking.

3. A drill string (1) or drilling a wellbore in an earth formation, the drill string comprising a drill bit (6), means for connecting the upper end of the drill string to a rotary drive (7), and **characterised by** a plurality of couplers (10, 12, 14, 16) arranged at selected drill string intervals, each coupler interconnecting two adjacent sections of the drill string and being operable in an engaged mode in which the coupler transmits torque between the adjacent drill string sections and a disengaged mode in which the adjacent drill string sections are free to rotate relative to each other about the longitudinal axis of the drill string, each coupler being controllable by control means for moving the coupler between said engaged mode and said disengaged mode.

4. The drill string of claim 3, wherein the drill string includes a fluid passage for drilling fluid, and each coupler is controllable by the action of a selected fluid pressure variation in the fluid passage.

5. The drill string of claim 4, wherein each coupler is controllable by the action of a selected fluid pressure pulse in the fluid passage.

6. The drill string of claim 4 or 5, wherein each coupler is provided with an electronic, electric or electromechanical control circuit responsive to said selected fluid pressure variation.

Patentansprüche

1. Verfahren zum Bohren eines Bohrloches in einer Erdformation unter Verwendung eines Bohrgestänges (1), das an seinem oberen Ende mit einem Drehantrieb (7) verbunden und mit einem Bohrmeißel (6) ausgestattet ist, wobei das Bohrgestänge eine Vielzahl von Kupplungen (10, 12, 14, 16) aufweist, die in vorbestimmten Bohrgestängeintervallen angeordnet sind, wobei jede Kupplung zwei benachbarte Abschnitte des Bohrgestänges miteinander verbindet und in einen Eingriffsmodus versetzbar ist, in welchem die Kupplung zwischen benachbarten Bohrgestängeabschnitten ein Drehmoment überträgt, und einen Nichteingriffsmodus, in welchem die benachbarten Bohrgestängeabschnitte relativ zueinander um die Längsachse des Bohrgestänges frei drehen können, wobei jede Kupplung durch Steuermittel steuerbar ist, um die Kupplung zwischen dem Eingriffsmodus und dem Nichteingriffsmodus zu bewegen, wobei das Verfahren umfaßt:

   a) Drehen des Bohrgestänges, um einen Teil des Bohrloches zu bohren, während sich jede Kupplung im Eingriffsmodus befindet;

   b) bei einem Steckenbleiben des Bohrgestänges im Bohrloch Lösen einer vorbestimmten Kupplung, die damit die Nichteingriffskupplung wird;

   c) Drehen des Teiles des Bohrgestänges zwischen dem Drehantrieb und der Nichteingriffskupplung;

   d) Ineingriffbringen der Nichteingriffskupplung und Außereingriffbringen der nächstniedrigeren Kupplung, die damit die Nichteingriffskupplung wird; und

   e) Wiederholen der Schritte c) - d), bis die Nichteingriffskupplung die unterste Kupplung ist.

2. Verfahren nach Anspruch 1, bei welchem im Schritt b) das Bohrgestänge im Bohrloch infolge eines differentiellen Anhaftens steckengeblieben ist.

3. Bohrgestänge (1) zum Bohren eines Bohrloches in einer Erdformation, wobei das Bohrgestänge einen Bohrmeißel (6) und Mittel zum Verbinden des oberen Endes des Bohrgestänges mit einem Drehantrieb (7) aufweist, **dadurch gekennzeichnet, daß** eine Vielzahl von Kupplungen (10, 12, 14, 16) vorgesehen ist, die in vorbestimmten Bohrgestängeintervallen angeordnet sind, wobei jede Kupplung zwei benachbarte Abschnitte des Bohrgestänges miteinander verbindet und zwischen einem Eingriffsmodus, in welchem die Kupplung zwischen den benachbarten. Bohrgestängeabschnitten ein Drehmoment überträgt, und einem Nichteingriffsmodus betätigbar ist, in welchem die benachbarten Bohrgestängeabschnitte relativ zueinander um die Längsachse des Bohrgestänges frei drehen können, wobei jede Kupplung durch Steuermittel steuerbar ist, um die Kupplung zwischen dem Eingriffsmodus und dem Nichteingriffsmodus zu bewegen.

4. Bohrgestänge nach Anspruch 3, bei welchem das Bohrgestänge einen Fluiddurchgang für Bohrfluid aufweist, und jede Kupplung durch die Wirkung einer vorbestimmten Fluiddruckveränderung in dem Fluiddurchgang steuerbar ist.

5. Bohrgestänge nach Anspruch 4, bei welchem jede Kupplung durch die Wirkung eines vorbestimmten Fluiddruckimpulses in dem Fluiddurchgang steuerbar ist.

6. Bohrgestänge nach Anspruch 4 oder 5, bei welchem jede Kupplung mit einem elektronischen, elektrischen oder e-lektro-mechanischen Steuer-

kreis ausgestattet ist, der auf die vorbestimmte Fluiddruckänderung anspricht.

Revendications

1. Procédé de forage d'un puits de forage dans une formation terrestre utilisant un train de tiges (1) connecté à son extrémité supérieure à un entraînement rotatif (7) et étant pourvu d'un trépan (6), le train de tiges comprenant une pluralité de raccords (10, 12, 14, 16) disposés à intervalles sélectionnés sur le train de tiges, chaque raccord interconnectant deux sections adjacentes du train de tiges et pouvant être mis en service en mode accouplé dans lequel le raccord transmet le couple entre les sections adjacentes du train de tiges et en mode désaccouplé dans lequel les sections adjacentes du train de tiges sont libres de tourner les unes par rapport aux autres autour de l'axe longitudinal du train de tiges, chaque raccord pouvant être contrôlé par des moyens de contrôle pour transférer le raccord entre ledit mode accouplé et ledit mode désaccouplé, le procédé consistant :

a) à faire tourner le train de tiges de manière à forer une partie dudit puits de forage pendant que chaque raccord est dans le mode accouplé,
b) quand le train de tiges est bloqué dans le puits de forage, à désaccoupler un raccord choisi parmi lesdits raccords, lequel devient de ce fait le raccord désaccouplé,
c) à faire tourner la partie du train de tiges entre l'entraînement rotatif et le raccord désaccouplé,
d) à accoupler le raccord désaccouplé, et à désaccoupler le raccord inférieur suivant qui devient de ce fait le raccord désaccouplé, et
e) à répéter les étapes c) - d) jusqu'à ce que le raccord désaccouplé soit le raccord le plus bas.

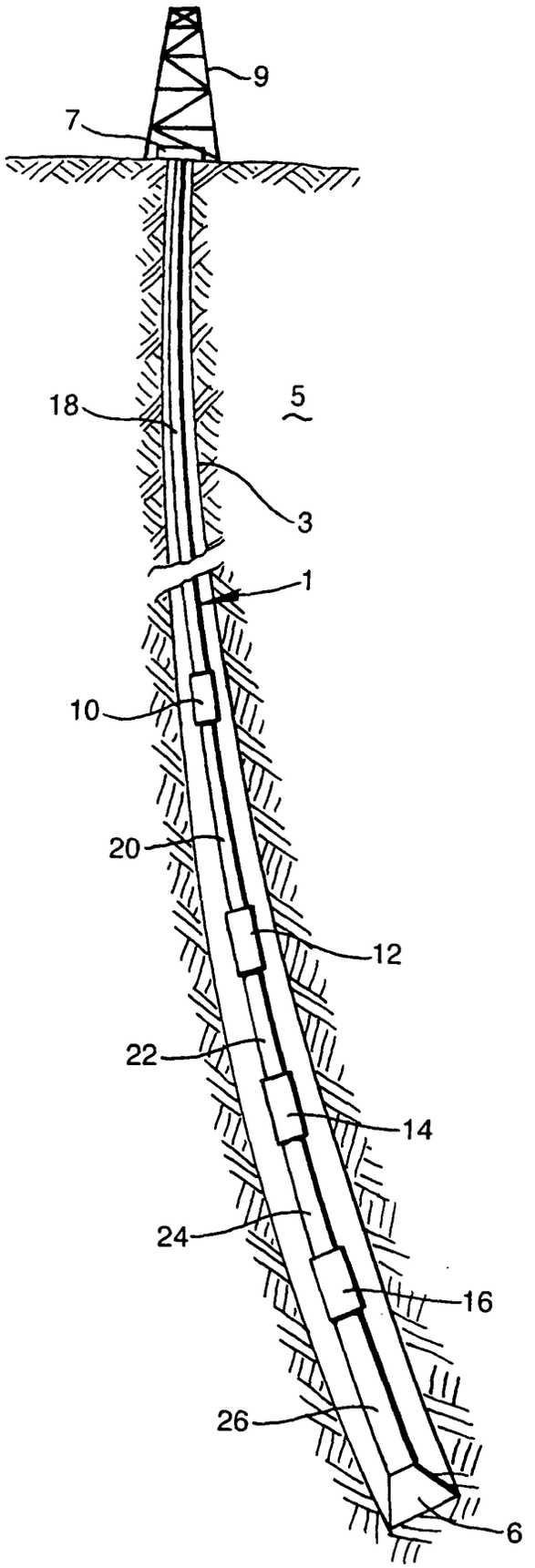
2. Procédé de la revendication 1, dans lequel à l'étape b), le train de tiges est bloqué dans le puits de forage en raison d'une adhérence différentielle.

3. Train de tiges (1) pour forer un puits de forage dans une formation terrestre, le train de tiges comprenant un trépan (6), des moyens pour connecter l'extrémité supérieure du train de tiges à un entraînement rotatif (7), et **caractérisé par** une pluralité de raccords (10, 12, 14, 16) disposés à intervalles sélectionnés sur le train de tiges, chaque raccord interconnectant deux sections adjacentes du train de tiges et pouvant être mis en service en mode accouplé dans lequel le raccord transmet le couple entre les sections adjacentes du train de tiges et en mode désaccouplé dans lequel les sections adjacentes du train de tiges sont libres de tourner les unes par rapport aux autres autour de l'axe longitudinal du train de tiges, chaque raccord pouvant être contrôlé par des moyens de contrôle pour transférer le raccord entre ledit mode accouplé et ledit mode désaccouplé.

4. Train de tiges selon la revendication 3, dans lequel le train de tiges comprend un passage fluidique pour le fluide de forage, et chaque raccord peut être contrôlé par l'action d'un changement de pression de fluide sélectionné dans le passage fluidique.

5. Train de tiges selon la revendication 4, dans lequel chaque raccord peut être contrôlé par l'action d'une impulsion de pression de fluide sélectionnée dans le passage fluidique.

6. Train de tiges selon la revendication 4 ou 5, dans lequel chaque raccord est pourvu d'un circuit de contrôle électronique, électrique ou électromécanique réagissant audit changement de pression de fluide sélectionné.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