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(54) Apparatus and methods for through-casing remedial zonal isolation

(57) This invention relates to a method of achieving hydraulic zonal isolation by use of a deployable isolation assembly (22) and zonal isolation drilling tool. The deployable isolation assembly is lowered downhole to the region where hydraulic seal loss has occurred. The zonal isolation drilling tool is capable of drilling into the formation layer, pumping zonal isolation fluid and plugging the hole in a single trip. Evaluation of isolation and job progress can also be performed.

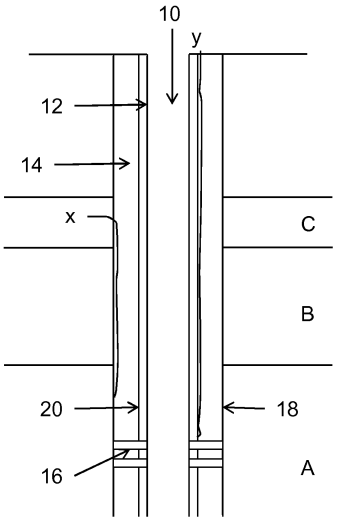

Figure 1

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Description

Technical field

[0001] This invention relates in wellbore operations for remedial zonal isolation. In particular, the invention relates to apparatus and methods for remedial zonal isolation in wells that have a casing, such as those found in the oil and gas industry.

Background art

[0002] Figure 1 shows a schematic view of a wells of the type used in the oil and gas industry. When constructing such wells" it is common to line the well 10 with a steel casing 12 that is secured in place with a sheath of cement 14. The cement serves not only to support the casing 12, but to provide hydraulic isolation between the various underground zones A, B, C through which the well has been drilled. Oil or gas from zone A is allowed to enter the casing through perforations 16 formed in the casing 12 and cement 14 and flow back to the surface. However, the presence of the cement 14 prevents flow of fluids x, y outside the casing 12, either back to the surface or into other zones A, B, which can include aquifers or the like.

[0003] Loss of hydraulic isolation may be caused by primary cement failure (for example at the cement-formation interface 18, or cement-casing interface 20) or another such event. This may lead to the leaking of wellbore or formation fluids into surrounding zones.

[0004] One common approach to remediation of such cement failure is known as 'squeeze cementing'. In such an operation, the location of the cement failure is determined, the zone of the well isolated, a hole drilled through the casing, an a low viscosity cement slurry is pumped under pressure into the interval to fill any cracks in the damaged cement. Such procedures are notoriously complex and unreliable. They are also expensive, requiring the presence of a specialist cementing rig and other equipment.

[0005] In another operation used in the oil and gas industry, formation fluids are sampled using a tool that can be lowered into the well to drill a hole through casing and cement so that fluid can flow from the formation to the tool. Once the sample has been retrieved, the hole in the casing is plugged to maintain hydraulic isolation. An example of such a tool is the CHDT of Schlumberger (see also US5687806).

[0006] Evaluation of zonal isolation, cement properties and job progress is also desirable.

[0007] This invention seeks to overcome problems associated with current squeeze cementing operations by providing a through casing technique for placing remediation fluids that does not require the complex setup of current techniques.

Disclosure of the invention

[0008] A first aspect of the invention provides an apparatus for performing remedial zonal isolation in a well having a casing surrounded by a cement layer, the apparatus comprising a tool body that can be positioned in the well adjacent a region to be treated, the tool body including;

- a measurement system for evaluating the cement around the casing in the region to be treated;
- a drilling system for drilling a hole in the casing;
- a system for pumping remediation fluid through the hole in the casing into the cement layer; and
- a system for plugging the hole in the casing after remediation fluid has been pumped into the cement layer.

[0009] The apparatus preferably further comprises an orientation system for orienting the tool body to a predetermined azimuthal position.

[0010] The drilling system, pumping system and plugging system can be operable more than once for any given trip in the well.

[0011] The apparatus can also comprise a telemetry system for providing data communication between the tool body and a control system at the well surface.

[0012] The measurement system preferably comprises one or more acoustic and/or nuclear measurement systems.

[0013] A conveyance system comprising drill pipe, coiled tubing or a wireline cable can also be provided, and the tool body can further comprise an anchoring system for securing the tool body in place while remedial operations are performed.

[0014] A second aspect of the invention provides a method of performing remedial zonal isolation in a well having a casing surrounded by a cement layer, the method comprising:

- positioning an apparatus as claimed in any preceding claim in the well so as to position the tool body in a region to be treated;
- evaluating the cement layer in the region to be treated to identify a location loss of zonal isolation in the cement layer;
- drilling a hole in the casing adjacent to the location of the loss of zonal isolation;
- pumping remediation fluids through the hole into the cement layer at the location of the loss of zonal isolation; and
- plugging the hole in the casing.

[0015] A preferred embodiment of method further comprises re-evaluating the cement layer after the remediation fluids have been pumped and the hole plugged to determine if zonal isolation has been restored to the location.

[0016] Following the step of re-evaluating the cement layer, the tool body can be repositioned and the steps of drilling, pumping and plugging are repeated at a new location. The step of repositioning typically involves reorienting the tool body to a new azimuthal position.

[0017] The steps of positioning, evaluating, drilling, pumping and plugging can be repeated at a number of locations in the same well.

[0018] Further aspects of the invention will be apparent from the following description.

Brief description of the drawings

[0019] Figure 1 is a schematic view of a well having a cemented casing;

Figure 2 is a schematic layout of an embodiment of a tool for use in the present invention; and

Figure 3 shows an detailed view or part of the tool of Figure 2.

Mode(s) for carrying out the invention

[0020] Figure 2 shows an apparatus according to an embodiment of the invention, comprising a tool body 22 which can be suspended in a borehole on a suitable conveyance system 24. In this embodiment, the conveyance system is a wireline cable, although coiled tubing or drill pipe could equally be used.

[0021] The tool body 22 comprises a sensor section 26; a main body section 28 including a drilling and plugging mechanism 30 and anchoring pistons 32; an upper body section 34 incoporating a supply of remediation fluids (e.g. a cementing composition) that is connected through to the main body 36; and an orientation head and electronics section 38 that connects to the wireline cable 24 and is operable to rotate the tool to a predetermined azimuthal orientation.

[0022] The sensor section includes one or more sensor systems for evaluating the cement behind casing to identify loss of hydralulic isolation due to cement failure. Such sensors include acoustic (particularly ultrasonic) sensors or nuclear sensors. Such sensors and measurement techinques are well-known.

[0023] Figure 3 shows more detail of the main body section 28 with the tool deployed in a casing 12. The main tool body 28 includes the drilling and plugging mechanisms. These are essentially similar to those of the CHDT discussed above. The drilling mechanism includes a drill bit 40 mounted on a flexible drill shaft 42. Two drilling motors are provided, one 44 for rotating the drill shaft 42 and the other 46 for translating (advancing or retracting) the drill shaft 42.

[0024] The plugging mechanism comprises a plug setting piston 48 and a plug magazine 50 carrying a number of plugs and mounted on a spring.

[0025] A flow line 52 connects to the fluid supply in the upper body section 34.

[0026] The drilling mechanism, plugging mechanism and flow line are all mounted in an inner housing 54 which can be translated relative to the main body 28 by means of a piston 56 so that the drill bit 40, flow line 52 or plug 50 can be positioned opposite an opening 58 in the tool body 28.

[0027] In use, the tool is lowered into a well where a loss of hydraulic isolation has been generally identified. The sensors are operated to identify the particular location where loss of isolation is believed to occur. Data is conveyed back to an operating system at the surface using conventional telemetry techniques to allow an operator to define a suitable location for the remdiation to take place. Once this location is identified, the tool is oriented in the appropriate direction by operation of the orienting head and the anchoring pistons deployed to secure the tool body in place in the well.

[0028] The inner housing 54 is then moved so that the drill bit 40 is adjacent the opening 58 and the motors 44, 46 operated to drill a hole through the casing 12 and into the cement 14. Once the hole is deep enough, the bit is withdrawn back into the tool and the inner body moved until the flow line 50 is adjacent the opening 58. At this point, a seal is established between the tool and casing, then cement or other remediation fluid can be pumped into the hole so as to fill any cracks or openings in the cement 14 causing the loss of zonal isolation. When pumping is finished, the inner housing is again moved and the plug piston operated to plug the hole in the casing.

[0029] The anchor pistons are then retracted and the tool passed past the remediation zone and the measurements repeated to determine whether or not the procedure has restored hydraulic isolation. If it has, a signal is sent to the operating systme and the tool can be retrieved. If not, the tool can be relocated to the treatment zone and reoriented to a different azimuth, the anchor pistons reset, and the process repeated until a satisfactory fluid placement has been achieved.

[0030] This process can be repeated as often as necessary until isolation is restored.

[0031] Various changes can be made within the scope of the invention. For example, the remediation fluid can be a hydraulic cement, a resin fluid or other such fluid for sealing the cement. Also, the data from the sensors can be used to reconstruct an image of the cement in the zone for remediation to help identify the appropriate location for placement of the fluid. Finally, the tool can be used to transmit a signal throug the casing to cause the remediation fluid to set. The tool can also include sensors for evauation purposes, e.g measuring zonal isolation or cement properties.

Claims

1. Apparatus for performing remedial zonal isolation in a well having a casing surrounded by a cement layer, the apparatus comprising a tool body that can be

positioned in the well adjacent a region to be treated, the tool body including;

- a measurement system for evaluating the cement around the casing in the region to be treated;
- a drilling system for drilling a hole in the casing;
- a system for pumping remediation fluid through the hole in the casing into the cement layer; and
- a system for plugging the hole in the casing after remediation fluid has been pumped into the cement layer.

2. Apparatus as claimed in claim 1, further comprising an orientation system for orienting the tool body to a predetermined azimuthal position.

3. Apparatus as claimed in claim 1 or 2, wherein the drilling system, pumping system and plugging system are operable more than once for any given trip in the well.

4. Apparatus as claimed in claim 1, 2 or 3, further comprising a telemetry system for providing data communication between the tool body and a control system at the well surface.

5. Apparatus as claimed in any preceding claim, wherein the measurement system comprises one or more acoustic and/or nuclear measurement systems.

6. Apparatus as claimed in any preceding claim, further comprising a conveyance system for the tool body, the conveyance system comprising drill pipe, coiled tubing or a wireline cable.

7. Apparatus as claimed in any preceding claim, wherein the tool body further comprises an anchoring system for securing the tool body in place while remedial operations are performed.

8. A method of performing remedial zonal isolation in a well having a casing surrounded by a cement layer, the method comprising:

- positioning an apparatus as claimed in any preceding claim in the well so as to position the tool body in a region to be treated;
- evaluating the cement layer in the region to be treated to identify a location loss of zonal isolation in the cement layer;
- drilling a hole in the casing adjacent to the location of the loss of zonal isolation;
- pumping remediation fluids through the hole into the cement layer at the location of the loss of zonal isolation; and
- plugging the hole in the casing.

9. A method as claimed in claim 8, further comprising re-evaluating the cement layer after the remediation fluids have been pumped and the hole plugged to determine if zonal isolation has been restored to the location.

10. A method as claimed in claim 9, wherein, following the step of re-evaluating the cement layer, the tool body is repositioned and the steps of drilling, pumping and plugging are repeated at a new location.

11. A method as claimed in claim 10, wherein the step of repositioning involves reorienting the tool body to a new azimuthal position.

12. A method as claimed in any of claims 8-12, comprising repeating the steps of positioning, evaluating, drilling, pumping and plugging at a number of locations in the same well.

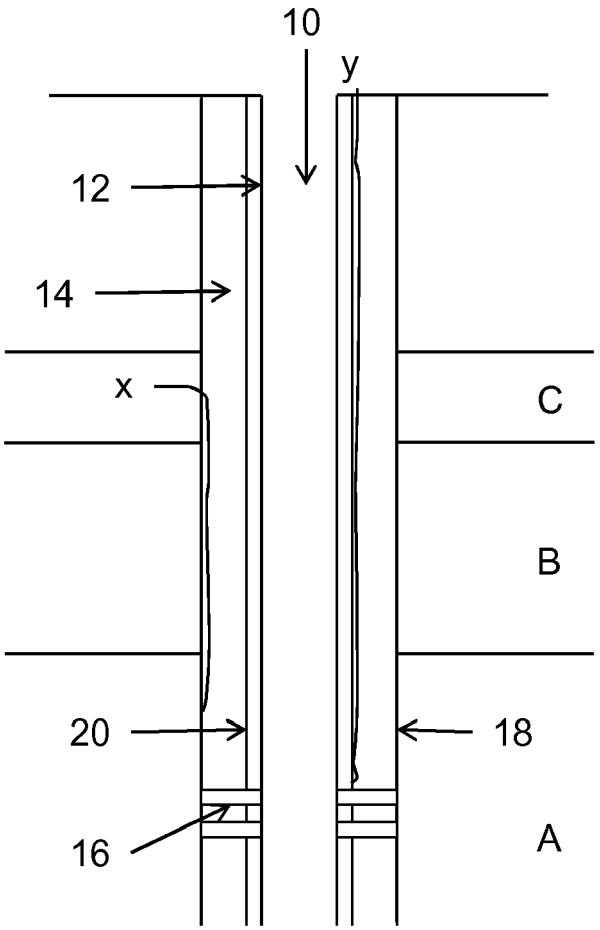

Figure 1

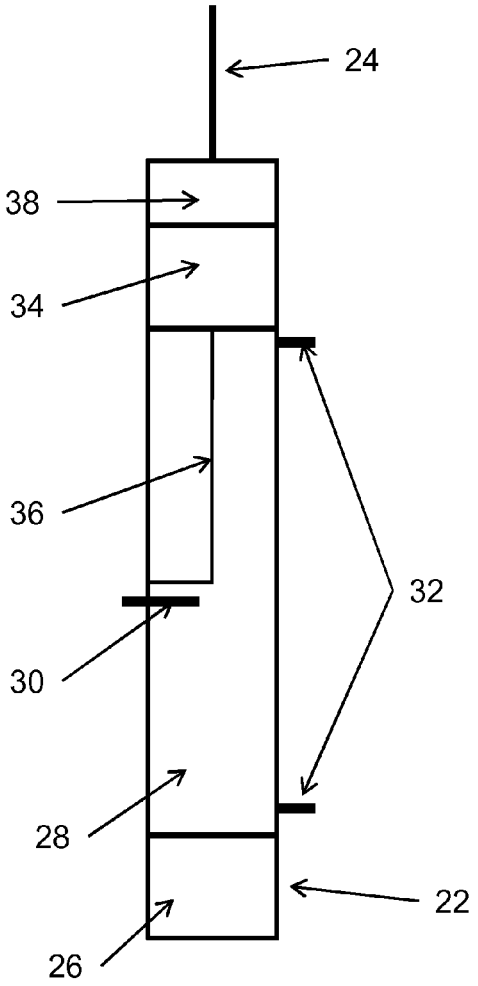

Figure 2

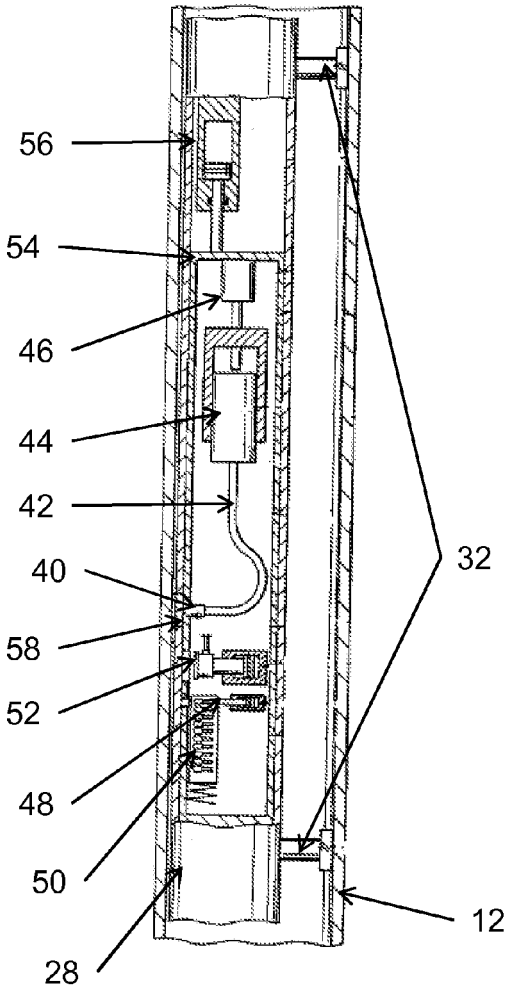

Figure 3

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EUROPEAN SEARCH REPORT

Application Number
EP 08 16 7441

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	9 March 2009	Georgescu, Mihnea

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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