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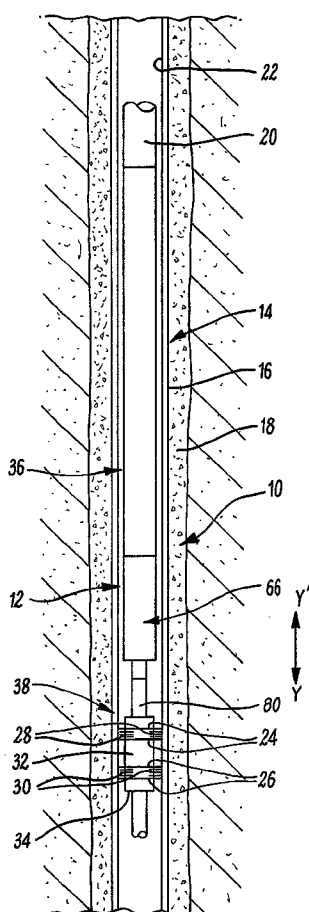
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(54) Title: WELLBORE CLEANING



(57) Abstract: The invention relates to a wellbore cleaning assembly, wellbore cleaning apparatus comprising a wellbore cleaning assembly, and to a method of cleaning a wellbore. In an embodiment of the invention, a wellbore cleaning assembly (10) is disclosed which is run into a wellbore (14) to be cleaned on a work string (20). The cleaning assembly (10) comprises a number of cleaning elements (24, 26, 28, 30) for cleaning a wall (22) of the wellbore (14); and an oscillator (36) coupled to the at least one cleaning element (24, 26, 28, 30), for generating an oscillating movement of the at least one cleaning element (24, 26, 28, 30) relative to the work string (20).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

1 **WELLBORE CLEANING**

2

3 The present invention relates to a wellbore cleaning
4 assembly, wellbore cleaning apparatus comprising a
5 wellbore cleaning assembly, and to a method of cleaning a
6 wellbore. In particular, but not exclusively, the
7 present invention relates to wellbore cleaning apparatus
8 comprising at least one cleaning element for cleaning a
9 wall of a wellbore, to wellbore cleaning apparatus
10 comprising such a wellbore cleaning assembly, and to a
11 method of cleaning a wellbore using such a cleaning
12 assembly.

13

14 In the oil and gas exploration and production industry, a
15 wellbore or borehole of an oil or gas well is typically
16 drilled from surface to a first depth and lined with a
17 steel casing. The casing is located in the wellbore
18 extending from a wellhead provided at surface or seabed
19 level, and is then cemented in place. Following testing
20 and other downhole procedures, the borehole is extended
21 to a second depth and a further section of smaller
22 diameter casing is installed and cemented in place. This
23 process is repeated as necessary until the borehole has

1 been extended to a location where it intersects a
2 producing formation. Alternatively, a final section of
3 tubing known as a liner may be located in the wellbore,
4 extending from the lowermost casing section or casing
5 'shoe' to the producing formation, and is also cemented
6 in place. The well is then completed by locating a
7 string of production tubing extending from surface
8 through the casing/liner to the producing formation.
9 Well fluids are then recovered to surface through the
10 production tubing.

11

12 However, before the well can be completed and well fluids
13 recovered to surface, it is necessary to clean the lined
14 wellbore and replace the fluids present in the wellbore
15 with a completion fluid such as brine. The cleaning
16 process serves, *inter alia*, to remove solids adhered to
17 the wall of the casing or liner; to circulate residual
18 drilling mud and other fluids out of the wellbore; and to
19 filter out solids present in the wellbore fluid. Much of
20 the solids present in the wellbore are found on the
21 surface of the casing/liner, and may be rust particles
22 and metal chips or scrapings originating from equipment
23 used in the well and from the casing/liner itself.

24

25 Various types of cleaning tools are known, including
26 mechanical cleaning tools which physically wipe or scrap
27 clean the surface of the casing/liner. One type of
28 mechanical cleaning tool is generically referred to as a
29 casing scraper. Casing scrapers typically incorporate
30 scraper blades designed to scrape the inner surface of
31 the casing/liner, for removing relatively large particles
32 of debris from the surface of the tubing. Other types of

1 mechanical cleaning tools incorporate brushes or other
2 abrading elements or surfaces.

3

4 Whilst these mechanical cleaning tools have been shown to
5 be effective in cleaning a wellbore, it is generally
6 desired to improve the cleaning action of tools of this
7 type.

8

9 It is therefore amongst the objects of at least one
10 embodiment of the invention to provide an improved
11 wellbore cleaning assembly.

12

13 According to a first aspect of the present invention,
14 there is provided a wellbore cleaning assembly adapted to
15 be run into a wellbore to be cleaned on a work string,
16 the cleaning assembly comprising:

17 at least one cleaning element for cleaning a wall of the
18 wellbore; and

19 an oscillator coupled to the at least one cleaning
20 element, for generating an oscillating movement of the at
21 least one cleaning element relative to the work string.

22

23 Oscillating at least one cleaning element relative to the
24 work string provides an enhanced cleaning action, by
25 effectively oscillating the cleaning element relative to
26 a wall of the wellbore during a cleaning operation, when
27 the cleaning assembly is being translated relative to and
28 thus along the wellbore.

29

30 It will be understood that tubing is typically located in
31 the wellbore and thus the cleaning assembly is adapted to
32 be run into a tubing lined wellbore for cleaning a wall
33 of the tubing. Typically the tubing takes the form of

1 casing and/or liner but in principle the wellbore
2 cleaning assembly may be utilised for cleaning any
3 downhole tubing.

4

5 Preferably, the oscillator is adapted to generate an
6 axial oscillating movement of at least one cleaning
7 element, relative to the work string. Accordingly, the
8 oscillator may be adapted to axially oscillate the at
9 least one cleaning element relative to the work string.

10 It will therefore be understood that, in use, axial
11 oscillation of the at least one cleaning element relative
12 to the work string may generate a scrubbing action of the
13 at least one cleaning element relative to a wall of the
14 wellbore, and thus optionally up and down the wellbore
15 wall.

16

17 The oscillator may alternatively be adapted to generate a
18 radial oscillating movement of the at least one cleaning
19 element, relative to the work string. Accordingly, the
20 oscillator may be adapted to radially oscillate the at
21 least one cleaning element relative to the work string.
22 It will but therefore be understood that, in use, the
23 oscillator may be adapted to oscillate the at least one
24 cleaning element towards and away from a wall of the
25 wellbore.

26

27 In a further alternative, the oscillator may be adapted
28 to generate a circumferential oscillating movement of the
29 at least one cleaning element, relative to the work
30 string. The oscillator may therefore be adapted to
31 circumferentially oscillate the at least one cleaning
32 element relative to the work string.

33

1 In a still further alternative, the oscillator may be
2 adapted to generate a plurality of oscillating movements
3 of the at least one cleaning element, relative to the
4 work string, the oscillating movements selected from the
5 group comprising an axial oscillating movement; a radial
6 oscillating movement; and a circumferential oscillating
7 movement.

8

9 The oscillator may be fluid actuated or activated and may
10 be a flow pulsing device. The flow pulsing device may
11 comprise a valve adapted to vary fluid flow through a
12 body of the device, to thereby pulse the flow of fluid
13 through the device. The fluid pulsing device may also
14 comprise a motor, which may be a fluid driven motor such
15 as a positive displacement motor (PDM) or Moineau motor,
16 the motor being coupled to the valve for actuating the
17 valve to vary fluid flow through the body. The valve may
18 be located in a throughbore of the device body, and may
19 comprise a valve member which is moveable to vary the
20 flow of fluid through the device. The valve member may
21 be coupled to and driven by the motor and, in particular,
22 may be coupled to a rotor of the motor.

23

24 The oscillator may be adapted to generate an oscillating
25 movement of the at least one cleaning element relative to
26 the workstring having a magnitude of at least 1cm from
27 one extreme of movement to another extreme. Preferably
28 however, the oscillator is adapted to generate an
29 oscillating movement of the at least one cleaning element
30 in the range of 5 to 100cm from one extreme to the other,
31 relative to the workstring. It will be understood,
32 however that the assembly may be configured to generate
33 larger oscillations of the cleaning element.

1

2 The oscillator may be adapted to be selectively actuated
3 during running of the cleaning assembly along a wellbore.

4 Where the oscillator is fluid actuated, the assembly may
5 comprise a valve arrangement for selectively directing
6 fluid flow through the oscillator. It will therefore be
7 understood that the valve arrangement may be utilised to
8 selectively actuate the oscillator, and thus to

9 selectively oscillate the at least one cleaning element.

10 The oscillator may comprise a bypass channel, passage or
11 the like for directing fluid flow to bypass the
12 oscillator.

13

14 The cleaning assembly may comprise a force transmission
15 element provided between the oscillator and the at least
16 one cleaning element, for transmitting an oscillating
17 force to the cleaning element. Alternatively, the
18 cleaning element may be mounted on or provided integrally
19 with the force transmission element. The force
20 transmission element may take the form of a fluid
21 actuated member and may be a piston mounted for
22 reciprocating movement (translation) relative to a bore
23 of the assembly, the piston transmitting an oscillating
24 force to the cleaning element in response to applied
25 fluid pressure. The piston may be biased towards a rest
26 position and may be urged away from the rest position
27 against a biasing force in response to a fluid pressure
28 force controlled by the oscillator. The piston may be
29 spring biased, and a spring force of the spring may be
30 selected such that a determined degree of movement of the
31 at least one cleaning element relative to the work string
32 is achieved in response to a specified fluid pressure
33 force applied to the piston. The piston may be an

1 annular or hollow piston defining a fluid flow passage
2 therethrough and an annular piston face. In use of the
3 piston, a fluid pressure force may be exerted on the
4 piston to translate the piston relative to the bore, so
5 that the piston is urged away from the rest position in
6 response to applied fluid pressure.

7

8 Preferably, the cleaning assembly comprises a plurality
9 of cleaning elements. The at least one cleaning element
10 may be selected from a group comprising a scraper, wiper,
11 brush, bristle or any other suitable mechanical/abrading
12 element. Where a plurality of cleaning elements are
13 provided, the cleaning assembly may comprise at least two
14 different types of cleaning element selected from the
15 above group.

16

17 Preferably also, the cleaning assembly comprises a
18 cleaning device, the cleaning device carrying the at
19 least one cleaning element. The cleaning device may be
20 any one of the mechanical wellbore cleaning devices
21 commercially available from the applicant. The cleaning
22 assembly may comprise a plurality of cleaning devices,
23 each cleaning device including at least one cleaning
24 element. Accordingly, a single oscillator may be
25 utilised for oscillating the cleaning elements of two or
26 more cleaning devices.

27

28 The oscillator may be provided as a separate device
29 coupled to the cleaning device. The cleaning device may
30 be coupled to the oscillator such that the entire
31 cleaning device is oscillated. Alternatively, the at
32 least one cleaning element may be mounted for movement
33 relative to a body of the cleaning device, such that the

1 body is stationary relative to the workstring and only
2 the at least one cleaning element is oscillated.

3

4 In an alternative, the at least one cleaning element may
5 be provided together with the oscillator. For example,
6 the cleaning element may be moveably mounted relative to
7 a body housing the oscillator.

8

9 According to a second aspect of the present invention,
10 there is provided wellbore cleaning apparatus comprising:
11 a work string;

12 a wellbore cleaning assembly coupled to the work string,
13 the cleaning assembly comprising at least one cleaning
14 element for cleaning a wall of a wellbore and an
15 oscillator coupled to the at least one cleaning element,
16 for generating an oscillating movement of the at least
17 one cleaning element relative to the work string.

18

19 Further features of the wellbore cleaning assembly of the
20 second aspect of the invention are defined above in
21 relation to the first aspect.

22

23 According to a third aspect of the present invention,
24 there is provided a method of cleaning a wellbore, the
25 method comprising the steps of:

26 mounting a wellbore cleaning assembly on a work string;
27 running the wellbore cleaning assembly into a wellbore to
28 be cleaned on the work string such that an at least one
29 cleaning element of the cleaning assembly cleans a wall
30 of the wellbore;

31 activating an oscillator coupled to the at least one
32 cleaning element, to oscillate the at least one cleaning

1 element relative to the work string, to thereby enhance
2 the cleaning action of the at least one cleaning element.

3

4 The method may comprise translating the cleaning assembly
5 relative to the wellbore wall, and oscillating the at
6 least one cleaning element relative to the work string,
7 to clean the wellbore wall.

8

9 The oscillator may generate an axial oscillating movement
10 of at least one cleaning element, relative to the work
11 string. Accordingly, the oscillator may axially
12 oscillate the at least one cleaning element relative to
13 the work string. The at least one cleaning element may
14 be actuated by the oscillator to clean the wellbore wall
15 in a scrubbing action, optionally up and down the
16 wellbore wall.

17

18 The oscillator may alternatively generate a radial
19 oscillating movement of the at least one cleaning
20 element, relative to the work string. Accordingly, the
21 oscillator may be radially oscillate the at least one
22 cleaning element relative to the work string. It will
23 but therefore be understood that, in use, the oscillator
24 may oscillate the at least one cleaning element towards
25 and away from a wall of the wellbore.

26

27 In a further alternative, the oscillator may generate a
28 circumferential oscillating movement of the at least one
29 cleaning element, relative to the work string. The
30 oscillator may therefore circumferentially oscillate the
31 at least one cleaning element relative to the work
32 string.

33

1 In a still further alternative, the oscillator may
2 generate a plurality of oscillating movements of the at
3 least one cleaning element, relative to the work string,
4 the oscillating movements selected from the group
5 comprising an axial oscillating movement; a radial
6 oscillating movement; and a circumferential oscillating
7 movement.

8

9 The method may comprise actuating the oscillator by
10 pumping fluid through the oscillator. The method may
11 comprise generating a pulsing fluid flow. To achieve
12 this, an oscillator in the form of a flow pulsing device
13 may be provided, and the method may comprise actuating a
14 valve of the device to vary fluid flow through a body of
15 the device, to thereby pulse the flow of fluid. The
16 method may comprise actuating and thus driving the valve
17 using a fluid driven motor, and may comprise coupling the
18 motor to the valve for actuating the valve to vary fluid
19 flow through the body. The motor may be actuated to
20 rotate a valve member of the valve which is coupled to
21 the motor and, in particular, which is coupled to a rotor
22 of the motor.

23

24 The oscillator may generate an oscillating movement of
25 the at least one cleaning element relative to the
26 workstring having a magnitude of at least 1cm from one
27 extreme of movement to another extreme. Preferably
28 however, the oscillator generates an oscillating movement
29 of the at least one cleaning element in the range of 5 to
30 100cm from one extreme to the other, relative to the
31 workstring. It will be understood, however that the
32 assembly may be configured to generate larger
33 oscillations of the cleaning element.

1
2 The oscillator may be selectively actuated during running
3 of the cleaning assembly along a wellbore. Where the
4 oscillator is fluid actuated, the fluid may be
5 selectively directed through the oscillator. It will
6 therefore be understood that a valve arrangement may be
7 provided and may be utilised to selectively actuate the
8 oscillator, and thus to selectively oscillate the at
9 least one cleaning element.

10
11 An oscillating force generated by the oscillator may be
12 transmitted to the at least one cleaning element by a
13 force transmission element provided between the
14 oscillator and the at least one cleaning element.
15 Alternatively, the oscillator may be mounted on or
16 provided integrally with the force transmission element.

17
18 The method may comprise providing a plurality of cleaning
19 devices, each cleaning device having at least one
20 cleaning element, the each cleaning device driven by and
21 thus oscillated by a single oscillator. It will be
22 understood, however, that an oscillator may be provided
23 for each cleaning device/element.

24
25 The cleaning element may be provided on a cleaning
26 device, and the oscillator may oscillate the entire
27 cleaning device. Alternatively, the at least one
28 cleaning element may be mounted for movement relative to
29 a body of the cleaning device, such that the body is
30 stationary relative to the workstring, and the oscillator
31 may only oscillate the at least one cleaning element
32 relative to the workstring.

33

1 An embodiment of the present invention will now be
2 described, by way of example only, with reference to the
3 accompanying drawings, in which:

4
5 Fig 1 is a longitudinal, partial cross-sectional view of
6 wellbore cleaning apparatus, comprising a wellbore
7 cleaning assembly, in accordance with an embodiment of
8 the present invention, the apparatus shown during the
9 cleaning of a wellbore;

10
11 Fig 2 is an enlarged, partial longitudinal sectional view
12 of an oscillator which forms part of the cleaning
13 assembly shown in Fig 1; and

14
15 Fig 3 is a longitudinal sectional view of a force
16 transmission element, forming part of the assembly of
17 Fig 1.

18
19 Turning firstly to Fig 1, there is shown a longitudinal
20 partial sectional view of wellbore cleaning apparatus
21 indicated generally by reference numeral 10, the cleaning
22 apparatus 10 including a wellbore cleaning assembly 12,
23 in accordance with an embodiment of the present
24 invention. The wellbore cleaning apparatus 10 is shown
25 in Fig 1 during the cleaning of a wellbore 14 which has
26 been lined with a metal casing 16 and cemented at 18, in
27 a fashion known in the art.

28
29 The cleaning apparatus 10 comprises a work string 20 on
30 which the wellbore cleaning assembly 12 is mounted and by
31 which the assembly 12 is run into and along the wellbore
32 14, for cleaning an inner wall 22 of the casing 16. As
33 will be appreciated by persons skilled in the art, the

1 workstring 20 may be formed from lengths of tubing
2 coupled together end-to-end, or may be coiled tubing.

3
4 The cleaning assembly 12 comprises at least one cleaning
5 element for cleaning the casing inner wall 22 and, in the
6 illustrated embodiment, the cleaning assembly 12
7 comprises a number of cleaning elements in the form of
8 casing wipers 24, 26 and a number of bristle packs 28, 30
9 which are arranged circumferentially around an outer
10 surface 32 of a body 34.

11
12 The cleaning assembly 12 also comprises an oscillator in
13 the form of a flow pulsing device 36 which is coupled to
14 the wipers 24, 26 and the bristle packs 28, 30 for
15 generating an oscillating movement of the wipers and
16 bristle packs relative to the workstring 20.

17
18 The casing wipers 24, 26 and bristle packs 28, 30 are in
19 fact provided as part of a cleaning device 38 which, in
20 the illustrated embodiment, takes the form of the
21 applicant's commercially available BRISTLE BACK ® RISER
22 BRUSH TOOL. However, as will be appreciated by persons
23 skilled in the art, many different types of mechanical
24 cleaning devices, optionally including alternative types
25 of cleaning elements such as scrapers or brushes, may be
26 utilised.

27
28 As will be described in more detail below, the cleaning
29 action of the casing wipers 24, 26 and the bristle packs
30 28, 30 is enhanced by oscillation of the wipers and packs
31 using the flow pulsing device 36. The flow pulsing
32 device 36, when actuated, axially oscillates the casing
33 wipers 24, 26 and the bristle packs 28, 30 in the

1 direction of the arrows Y-Y', relative to the workstring
2 20. This movement of the wipers 24, 26 and bristle packs
3 28, 30 enhances the cleaning action on the casing wall 22
4 during passage of the cleaning apparatus 10 through the
5 wellbore 14, by imparting a scrubbing action on the
6 casing wall.

7
8 In use, the wellbore cleaning assembly 12 is made up at
9 surface and coupled to a section of workstring tubing
10 which will form the lowermost end of the workstring 20.
11 The cleaning apparatus 10 is then run into the wellbore
12 casing 16, and successive lengths of workstring tubing
13 are connected together end-to-end to form the completed
14 string, in a fashion known in the art. The flow pulsing
15 device 36 is activated to generate an oscillating
16 movement, which is transmitted to the wipers 24, 26 and
17 bristle packs 28, 30. The cleaning assembly 12 is then
18 translated downhole relative to the casing 16 such that
19 the wipers 24, 26 and bristle packs 28, 30 together clean
20 the casing wall 22 with an enhanced cleaning action due
21 to oscillation of the cleaning elements. Debris
22 particles dislodged from the casing inner wall 22 may be
23 collected by a junk basket or the like provided as part
24 of the cleaning apparatus 10. The flow pulsing device 36
25 remains activated during pull-out of the cleaning
26 assembly 12, to further clean the casing wall 22 on
27 return to surface. Any remaining debris is then flushed
28 out by circulating a completion fluid into the borehole
29 14.

30

31 The flow pulsing device 36 will now be described in more
32 detail with reference to the enlarged, partial

1 longitudinal sectional view of Fig 2 and the longitudinal
2 sectional view of Fig 3.

3

4 As shown in Fig 2, the flow pulsing device 36 includes a
5 motor in the form of a positive displacement motor (PDM)
6 40 and a valve generally indicated by reference numeral
7 42. The PDM 40 is of a type known in the art and
8 includes a rotor 44 and a stator 46. The rotor 44 is
9 driven and rotated by fluid flowing down through cavities
10 defined between the rotor 44 and the stator 46 in the
11 direction of the arrow A, the fluid exiting a lower end
12 of the stator 46 as shown by the arrow B. The valve 42
13 is mounted in a bore 48 of the device 36 and includes a
14 rotatable valve member 50. The valve member 50 defines a
15 section 51 of an internal flow passage 52 and has a
16 number of openings, one of which is shown and given the
17 reference numeral 54. The openings 54 each extend
18 between the bore 48 and the internal flow passage section
19 51.

20

21 The valve member 50 is coupled to and rotatably driven by
22 the rotor 44 and follows an eccentric path around the
23 bore 48. A lower end of the flow passage section 51
24 forms an outlet 56 and, in use, fluid flowing into the
25 device bore 48 enters the openings 54, flows into the
26 internal flow passage 52 and out of the valve member 50
27 through the outlet 56. The fluid then flows into a body
28 58 through an inlet 60 and along section 62 of the flow
29 passage, exiting the valve 42 in the direction of the
30 arrow C.

31

32 In use, rotation of the valve member 50 by the rotor 44
33 causes a variation in the flow area 52 defined between

1 the valve member 50 and the body 58, which extends across
2 the outlet 56 and inlet 60. As a result, pressure
3 fluctuations are generated in the fluid flowing through
4 the valve 42, which are utilised to generate an
5 oscillating movement of the wipers 24, 26 and bristle
6 packs 28, 30 by oscillating the cleaning device 38, as
7 will now be described with reference to Fig 3.

8

9 Accordingly, turning to Fig 3, a force transmission
10 element in the form of a piston 64 is shown, provided
11 within a shock sub 66. The piston 64 comprises a mandrel
12 65 and a piston head 67 threaded onto an upper end of the
13 mandrel. The shock sub 66 is coupled to a lower end 68
14 of the PDM 40 (Fig 2), and fluid exiting the valve 42 in
15 the direction of the arrow C flows into an internal bore
16 70 of the shock sub 66. The shock sub 66 includes an
17 upper body 69, and a lower body 71 which is threaded to
18 the upper body 69, and which extends into a chamber 73
19 between the upper body 69 and the mandrel 65, and defines
20 a shoulder 75. The piston mandrel 65 is hollow, defining
21 an inner bore 74, and is mounted for movement within a
22 section 72 of the bore 70. The piston head 67 defines an
23 upper piston face 76, and Belleville washers 78 are
24 located in the chamber 73 between the piston head 67 and
25 the shoulder 75 of the sub lower body 71.

26

27 In use, fluid entering the enlarged lower section 72 of
28 the bore 70 exerts a fluid pressure force on the piston
29 face 76, due to the differential area of the enlarged
30 lower section 72 relative to an upper section 79 of the
31 bore 70. As a result, the piston head 67 is urged
32 downwardly, against the biasing force of the Belleville

1 washers 78, which are compressed between a lower face 81
2 of the piston head 67 and the shoulder 75.

3

4 On rotation of the valve member 50, causing a reduction
5 in the flow passage area and thus a decrease in the fluid
6 pressure entering the shock sub 66, the Belleville
7 washers 78 act on the piston head 65 to return the piston
8 64 upwardly. It will therefore be understood that the
9 piston 64 is oscillated back and forth in the direction
10 of the arrows Y-Y' (Fig 1), dependent upon the pressure
11 of fluid entering the shock sub 66. The frequency of
12 these oscillations is controlled by the frequency of
13 rotation of the valve member 50, which is ultimately
14 dependent upon the frequency of rotation of the rotor 44,
15 and thus of the fluid flow rate through the PDM 40.

16

17 The piston 64 is connected to a mandrel 80 of the
18 cleaning device 38 and thus the oscillating movement of
19 the piston 64 is transmitted to the cleaning device 38,
20 to oscillate the wipers 24, 26 and bristle packs 28, 30
21 as described above. The extent of axial oscillation of
22 the wipers 24, 26 and bristle packs 28, 30 relative to
23 the work string 20 is governed by a number of factors
24 including the dimensions of the piston 64, shock sub 66
25 and Belleville washers 78; the inherent spring force of
26 the Belleville washers 78; and the fluid pressure force
27 acting on the piston 64 (and thus the pressure of fluid
28 passing down through the PDM 40 into the shock sub 66).
29 Typical oscillations of the wipers 24, 26 and bristle
30 packs 28, 30 relative to the work string 20 will be of
31 the order of several cm from one extreme or extent of
32 motion to the other. However, appropriate dimensioning

1 and pressure control will enable a wide range of
2 oscillation amplitudes to be provided.

3

4 Various modifications may be made to the foregoing
5 without departing from the spirit and scope of the
6 present invention.

7

8 For example, it will be readily understood by persons
9 skilled in the art that alternative oscillator structures
10 may be provided. To achieve this, different structures
11 or types of downhole motor may be provided, and different
12 structures and arrangements of valves.

13

14 The oscillator may be alternatively adapted to generate a
15 radial oscillating movement of the at least one cleaning
16 element, relative to the work string. Accordingly, the
17 oscillator may be adapted to radially oscillate the at
18 least one cleaning element relative to the work string.
19 Thus, in use, the oscillator may be adapted to oscillate
20 the at least one cleaning element towards and away from a
21 wall of the wellbore.

22

23 This may be achieved by mounting the wipers 24, 26 and/or
24 bristle packs 28, 30 on inclined ramps. In this fashion,
25 frictional contact between the wipers 24, 26 and/or
26 bristle packs 28, 30 and the casing wall 22, combined
27 with an oscillating movement of the cleaning tool body
28 34, progressively axially advances and retracts the
29 wipers 24, 26 and/or bristle packs 28, 30 along the
30 ramps, radially oscillating them towards and away from
31 the casing wall 22.

32

1 In a variation, the wipers 24, 26 and/or bristle packs
2 28, 30 may be mounted on pads which are radially movable
3 relative to a body of a cleaning tool, the pads forming
4 pistons which are effectively oscillated by variations in
5 fluid pressure through the tool bore. Alternatively, a
6 mandrel having an angled ramp is mounted in the tool
7 bore, and is oscillated up and down against a biasing
8 spring, by variations in fluid pressure, to urge the pads
9 in and out. The mandrel may carry keys that engage in
10 channels in the pads, to actively carry the pads in and
11 out when the mandrel is cycled up and down. In both
12 cases, the pads could be initially held by shear pins to
13 ensure that they are not released until a predetermined
14 pressure is applied.

15
16 In a further alternative, the oscillator may be adapted
17 to generate a circumferential oscillating movement of the
18 at least one cleaning element, relative to the work
19 string. The oscillator may therefore be adapted to
20 circumferentially oscillate the at least one cleaning
21 element relative to the work string. This may be
22 achieved by providing a cam arrangement between the
23 piston 64 and the shock sub upper body 69, such that
24 axial movement between the piston 64 and the upper body
25 69 also rotates the piston within the body 69.
26 Accordingly, repeated axial oscillation of the piston 64
27 within the upper body 69 may also rotate the piston.

28
29 In a variation, circumferential oscillation may be
30 achieved by mounting the wipers 24, 26 and/or bristle
31 packs 28, 30 on a sleeve around a body of the tool. An
32 indexing channel and indexing pin arrangement may be
33 provided between the sleeve and a mandrel in the tool

1 bore. Indexing pins/dogs engage in the indexing channel,
2 and cycling the mandrel up and down rotates the sleeve
3 back and forth within the wellbore.

4
5 In a still further alternative, the oscillator may be
6 adapted to generate a plurality of oscillating movements
7 of the at least one cleaning element, relative to the
8 work string, the oscillating movements selected from the
9 group comprising an axial oscillating movement; a radial
10 oscillating movement; and a circumferential oscillating
11 movement. This may be achieved by providing a cleaning
12 tool combining one of more of the above features.

13
14 Where the oscillator is fluid actuated, the assembly may
15 comprise a valve arrangement for selectively directing
16 fluid flow through the oscillator. The valve arrangement
17 may be utilised to selectively actuate the oscillator,
18 and thus to selectively oscillate the at least one
19 cleaning element. The oscillator may comprise a bypass
20 channel, passage or the like for directing fluid flow to
21 bypass the oscillator.

22
23 The at least one cleaning element may be mounted on or
24 provided integrally with the force transmission element.
25 Alternatively, the at least one cleaning element may be
26 mounted for movement relative to a body of the cleaning
27 device, such that the body is stationary relative to the
28 workstring and only the at least one cleaning element is
29 oscillated. Alternatively, the at least one cleaning
30 element may be provided together with the oscillator.
31 For example, the cleaning element may be moveably mounted
32 relative to a body housing the oscillator.

CLAIMS

1. A wellbore cleaning assembly adapted to be run into a wellbore to be cleaned on a work string, the cleaning assembly comprising:
at least one cleaning element for cleaning a wall of the wellbore; and
an oscillator coupled to the at least one cleaning element, for generating an oscillating movement of the at least one cleaning element relative to the work string.
2. An assembly as claimed in claim 1, wherein the oscillator is adapted to generate an axial oscillating movement of at least one cleaning element, relative to the work string.
3. An assembly as claimed in claim 1, wherein the oscillator is adapted to generate a radial oscillating movement of the at least one cleaning element, relative to the work string.
4. An assembly as claimed in claim 1, wherein the oscillator is adapted to generate a circumferential oscillating movement of the at least one cleaning element, relative to the work string.
5. An assembly as claimed in claim 1, wherein the oscillator is adapted to generate a plurality of oscillating movements of the at least one cleaning element, relative to the work string, the oscillating movements selected from the group comprising an axial oscillating movement; a radial

1 oscillating movement; and a circumferential
2 oscillating movement.

3

4 6. An assembly as claimed in any preceding claim,
5 wherein the oscillator is fluid actuated.

6

7 7. An assembly as claimed in claim 6, wherein the
8 oscillator is a flow pulsing device.

9

10 8. An assembly as claimed in claim 7, wherein the flow
11 pulsing device comprises a valve adapted to vary
12 fluid flow through a body of the device, to thereby
13 pulse the flow of fluid through the device.

14

15 9. An assembly as claimed in claim 8, wherein the flow
16 pulsing device comprises a fluid driven motor
17 coupled to the valve for actuating the valve to vary
18 fluid flow through the body.

19

20 10. An assembly as claimed in either of claims 8 or 9,
21 wherein the valve is located in a throughbore of the
22 device body, and comprises a valve member which is
23 moveable to vary the flow of fluid through the
24 device.

25

26 11. An assembly as claimed in claim 10, when dependent
27 on claim 9, wherein the valve member is coupled to
28 and driven by a rotor of the motor.

29

30 12. An assembly as claimed in any preceding claim,
31 wherein the oscillator is adapted to generate an
32 oscillating movement of the at least one cleaning
33 element relative to the workstring, the oscillating

1 movement having a magnitude of at least 1cm from one
2 extreme of movement to another extreme.

3

4 13. An assembly as claimed in claim 12, wherein the
5 oscillator is adapted to generate an oscillating
6 movement of the at least one cleaning element in the
7 range of 5 to 100cm from one extreme of movement to
8 the other.

9

10 14. An assembly as claimed in any preceding claim,
11 wherein the oscillator is adapted to be selectively
12 actuated during running of the cleaning assembly
13 into and along a wellbore.

14

15 15. An assembly as claimed in any preceding claim,
16 wherein the oscillator is fluid actuated, and
17 wherein the assembly comprises a valve arrangement
18 for selectively directing fluid flow through the
19 oscillator.

20

21 16. An assembly as claimed in claim 15, comprising a
22 bypass channel for directing fluid flow to
23 selectively bypass the oscillator.

24

25 17. An assembly as claimed in any preceding claim,
26 comprising a force transmission element provided
27 between the oscillator and the at least one cleaning
28 element, for transmitting an oscillating force to
29 the cleaning element.

30

31 18. An assembly as claimed in any one of claims 1 to 16,
32 comprising a force transmission element for
33 transmitting an oscillating force to the cleaning

1 element, and wherein the cleaning element is coupled
2 to the force transmission element.

3

4 19. An assembly as claimed in either of claims 17 or 18,
5 wherein the force transmission element takes the
6 form of a fluid actuated piston mounted for
7 reciprocating movement relative to a bore of the
8 assembly, the piston transmitting an oscillating
9 force to the cleaning element in response to applied
10 fluid pressure.

11

12 20. An assembly as claimed in claim 19, wherein the
13 piston is biased towards a rest position and adapted
14 to be urged away from the rest position against a
15 biasing force in response to an applied fluid
16 pressure force.

17

18 21. An assembly as claimed in claim 20, wherein the
19 piston is spring biased, and a spring force of the
20 spring is selected such that a determined degree of
21 movement of the at least one cleaning element
22 relative to the work string is achieved in response
23 to a specified fluid pressure force applied to the
24 piston.

25

26 22. An assembly as claimed in either of claims 20 or 21,
27 wherein the piston is a hollow piston defining a
28 fluid flow passage therethrough and an annular
29 piston face and wherein, in use, a fluid pressure
30 force is exerted on the piston to translate the
31 piston relative to the bore, such that the piston is
32 urged away from the rest position in response to
33 applied fluid pressure.

1

2 23. An assembly as claimed in any preceding claim,
3 comprising a plurality of cleaning devices, each
4 cleaning device carrying an at least one cleaning
5 element, and wherein the oscillator is adapted to
6 oscillate the cleaning elements of each cleaning
7 device simultaneously.

8

9 24. A wellbore cleaning apparatus comprising:
10 a work string;
11 a wellbore cleaning assembly coupled to the work
12 string, the cleaning assembly comprising at least
13 one cleaning element for cleaning a wall of a
14 wellbore and an oscillator coupled to the at least
15 one cleaning element, for generating an oscillating
16 movement of the at least one cleaning element
17 relative to the work string.

18

19 25. Apparatus as claimed in claim 24, wherein the
20 cleaning assembly is a cleaning assembly according
21 to any one of claims 2 to 23.

22

23 26. A method of cleaning a wellbore, the method
24 comprising the steps of:
25 mounting a wellbore cleaning assembly on a work
26 string;
27 running the wellbore cleaning assembly into a
28 wellbore to be cleaned on the work string such that
29 an at least one cleaning element of the cleaning
30 assembly cleans a wall of the wellbore; and
31 activating an oscillator coupled to the at least one
32 cleaning element, to oscillate the at least one
33 cleaning element relative to the work string, to

1 thereby enhance the cleaning action of the at least
2 one cleaning element.

3

4 27. A method as claimed in claim 26, comprising
5 translating the cleaning assembly relative to the
6 wellbore wall, and oscillating the at least one
7 cleaning element relative to the work string, to
8 clean the wellbore wall.

9

10 28. A method as claimed in either of claims 26 or 27,
11 wherein the oscillator generates an axial
12 oscillating movement of at least one cleaning
13 element, relative to the work string.

14

15 29. A method as claimed in claim 28, wherein the at
16 least one cleaning element is actuated by the
17 oscillator to clean the wellbore wall in a scrubbing
18 action up and down the wellbore wall.

19

20 30. A method as claimed in either of claims 26 or 27,
21 wherein the oscillator generates a radial
22 oscillating movement of the at least one cleaning
23 element, relative to the work string.

24

25 31. A method as claimed in either of claims 26 or 27,
26 wherein the oscillator generates a circumferential
27 oscillating movement of the at least one cleaning
28 element, relative to the work string.

29

30 32. A method as claimed in either of claims 26 or 27
31 wherein the oscillator generates a plurality of
32 oscillating movements of the at least one cleaning
33 element, relative to the work string, the

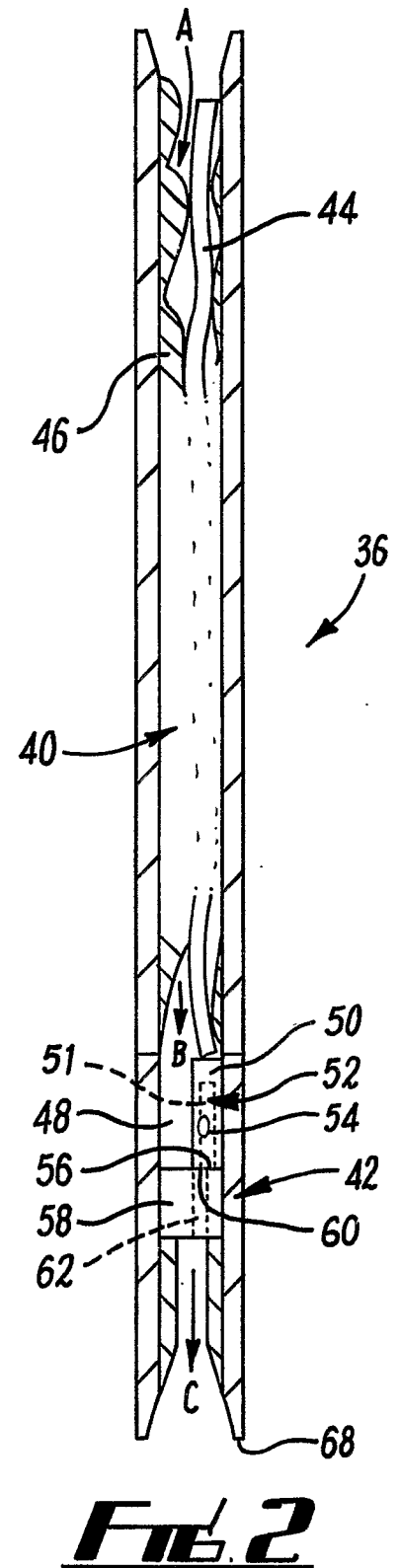
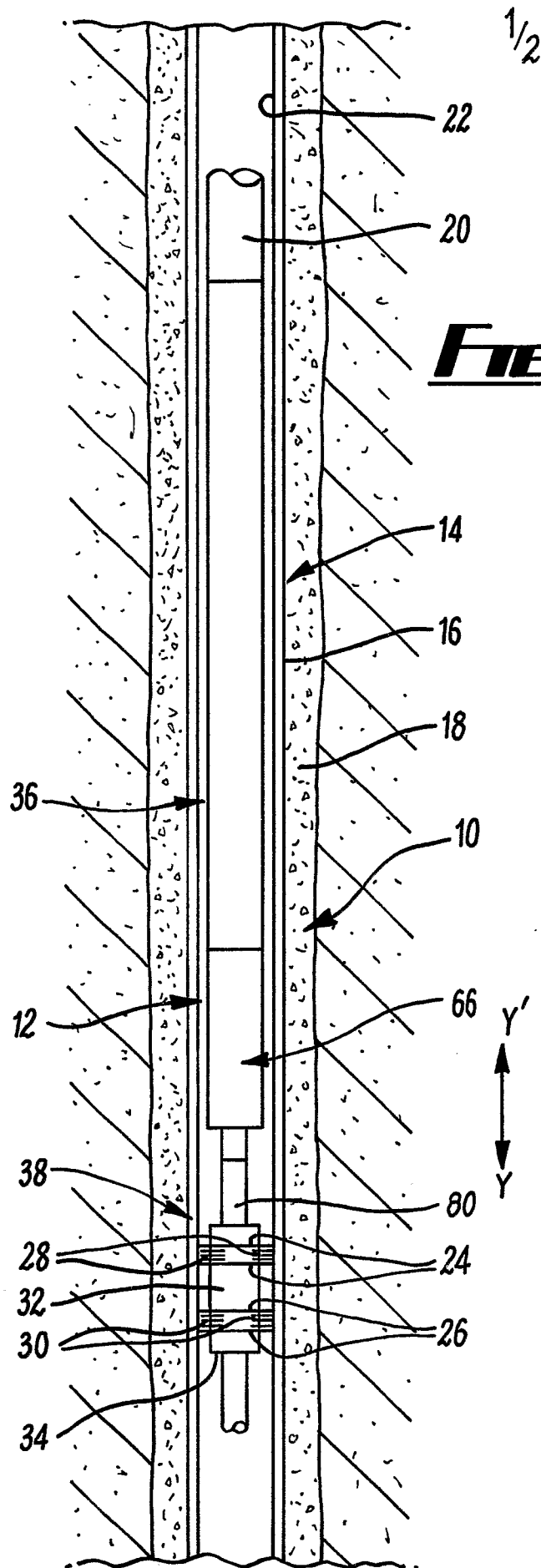
1 oscillating movements selected from the group
2 comprising an axial oscillating movement; a radial
3 oscillating movement; and a circumferential
4 oscillating movement.
5

6 33. A method as claimed in any one of claims 26 to 32,
7 comprising actuating the oscillator by pumping fluid
8 through the oscillator.
9

10 34. A method as claimed in claim 33, comprising
11 providing an oscillator in the form of a flow
12 pulsing device, and generating a pulsing fluid flow
13 by actuating a valve of the device to vary fluid
14 flow through a body of the device.
15

16 35. A method as claimed in any one of claims 26 to 34,
17 comprising selectively actuating the oscillator
18 during running of the cleaning assembly along a
19 wellbore.
20

21 36. A method as claimed in any one of claims 26 to 35,
22 comprising oscillating a plurality of cleaning
23 devices, each cleaning device having an at least one
24 cleaning element, using a single oscillator.



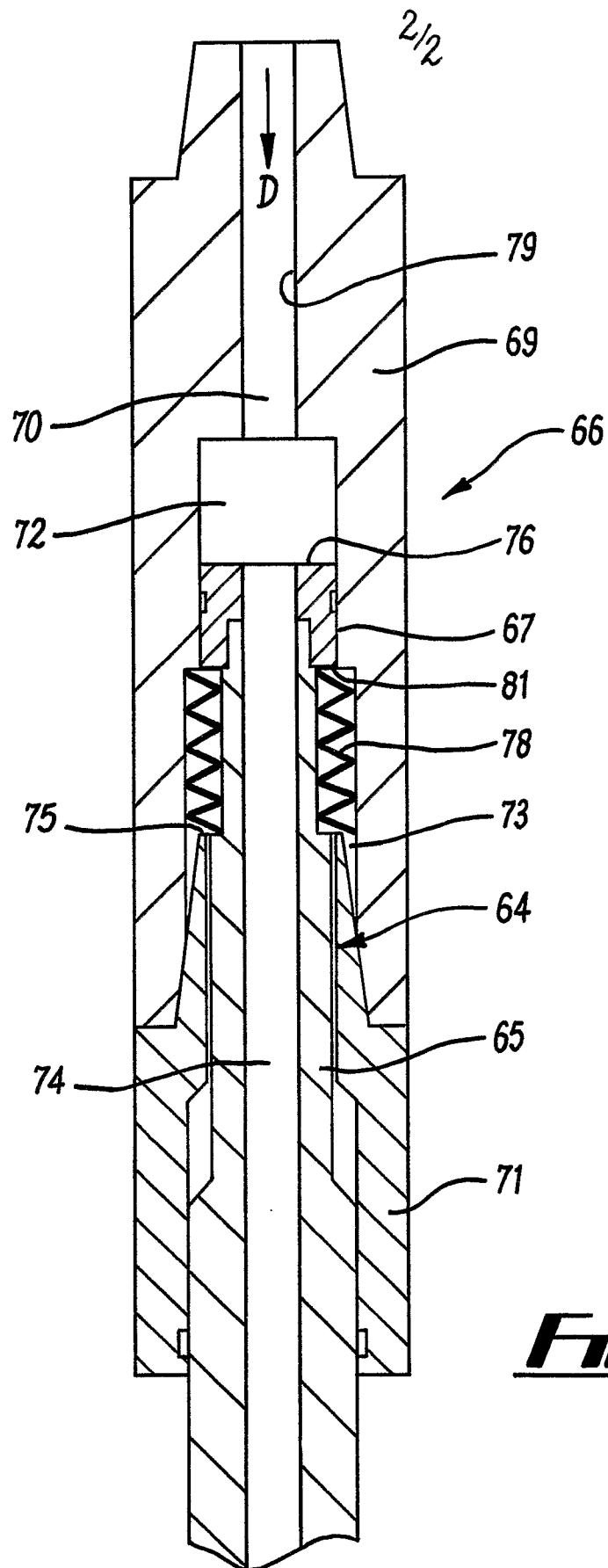


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2007/001048

A. CLASSIFICATION OF SUBJECT MATTER
INV. E21B28/00 E21B37/00 E21B37/02 E21B37/04

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

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Y	the whole document	6-8, 10, 33, 34
X	WO 2005/093264 A (HALLIBURTON ENERGY SERV INC [US]; SCHULTZ ROGER L [US]; MICHAEL ROBERT) 6 October 2005 (2005-10-06) page 10, paragraph 1; figure 3	1, 6, 24, 26
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

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Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

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