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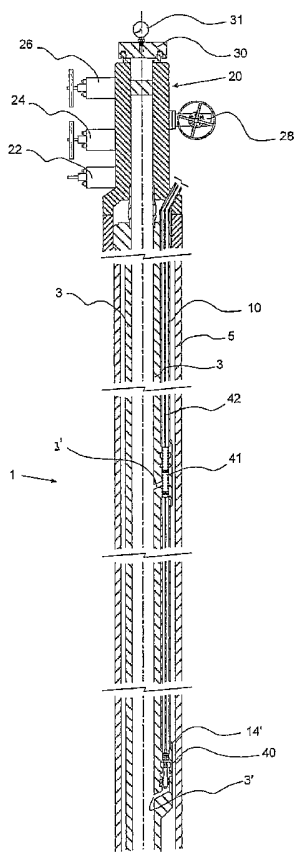
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(54) Title: CONVEYOR TUBE FOR USE IN INSTALLING OR REPLACING A WELL TOOL IN A PRODUCING WELL AND PROCEDURES FOR USE OF THE SAME



(57) Abstract: This invention describes a conveyor tube (10) for use in installing or replacing a well tool (40) in a producing well (10), wherein the well tool (40) is fed into the conveyor tube (10) which at least runs between a valve tree (20) and at least one receiving unit (12, 13, 14) in the well (10), and wherein the conveyor tube (10) is 13 installed on the outside of and in fluid communication 14 with a production tube (30) in the well (1). A method for using same is also described.



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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 Conveyor tube for use in installing or replacing a well
2 tool in a producing well and procedures for use of the
3 same
4

5 This invention relates to a conveyor tube for use in
6 installing or replacing a well tool in a producing well.
7 More specifically it is a conveyor tube which runs along
8 the outside of the production tube of the producing well,
9 wherein the conveyor tube is designed to be able to move
10 well tools, which may be for example, but are not limited
11 to, sensors for sensing well parameters and/or flow
12 directors for guiding circulation in sections of the
13 production tube, to a predetermined position. The
14 invention also relates to procedures for using it.

15
16 The object of the invention is to provide a device and
17 method for installing and replacing well tools in a
18 producing well without the need for complicated and
19 demanding well completion work.

20
21 In the petroleum industry it is desirable, for economic
22 reasons among others, to maintain production to the
23 maximum possible degree.

1 It is also necessary to conduct measurements of
2 parameters in the well that are important for controlling
3 production, calculating the present reservoir fluid,
4 drainage efficiency and so on. To sense the desired
5 parameters it is now normal practice to install sensors
6 permanently in wells. The sensors communicate through
7 cables laid through the valve tree of the well to a
8 surface installation from which the well is monitored and
9 controlled.

10

11 The well environment has been shown to have a degrading
12 effect on the sensors used due, among other things, to
13 the harsh environment that frequently prevails in a well.
14 The failure of sensors after being installed in wells is
15 therefore felt to be a problem. In order to replace a
16 sensor that has failed the entire well completion must be
17 pulled to the surface to provide access to the sensor.
18 When this takes place the well must be protected against
19 leakage, and barriers must be fitted against the
20 reservoir. Such barriers result in stoppage of production
21 whilst the replacement operation is being carried,
22 resulting in economic loss.

23

24 To reduce some of the disadvantages of the above-
25 mentioned method of prior art attempts have been made to
26 develop procedures for carrying out an intervention in a
27 well to replace a damaged measuring instrument that has
28 been installed in a so-called side pocket ("side pocket
29 mandrel"). In this case a tool is inserted which pulls
30 out the measuring instrument installed in a pocket in the
31 production tube. A new intervention (operation) is then
32 carried out to insert a new measuring instrument. This is
33 done by means of a cable ("wireline") or coiled tubing.

1 One major drawback of this procedure is that an expensive
2 electrical or fibre optic coupling must be used which is
3 connected in the "wet" condition in the well fluid. This
4 coupling has proved to be unreliable and the procedure is
5 therefore little used in the petroleum industry.

6
7 In the petroleum industry it is also necessary to pump
8 different types of auxiliary tools into the well
9 production tube. After this, the pumped-in auxiliary tool
10 must be circulated until it reaches the desired position
11 in the well. In this specialist field this is called TFL
12 ("Through Flow Line") or Pump Down Tools, and it is based
13 on running an insert line parallel with the production
14 tube, and has the same diameter as it. The two tubes
15 mentioned are connected at a circulation point in the
16 well, the circulation point being installed as far down
17 in the well as possible, normally just above the
18 production packing. A major disadvantage of the TFL
19 technology of prior art is that the possibility of
20 circulation is lost if the production tube is blocked
21 above the circulation point.

22
23 American patent US 4,940,094 shows a procedure and a
24 device for operating a circulating valve down in a well
25 using TFL technology, as described above, wherein
26 production takes place through the insert line through
27 which the device is fed to operate the aforementioned
28 circulating valve.

29
30 The object of the invention is to obviate or at least
31 reduce one or more disadvantages of the method of prior
32 art.

33

1 This invention comprises a conveyor tube for use when
2 installing or replacing a well tool in a producing well,
3 wherein the well tool is fed in the conveyor tube which
4 at least runs between a valve tree and at least one
5 receiving unit in the well, the conveyor being installed
6 on the outside of a production tube in the well. The
7 conveyor tube may consist, for example, but not are not
8 limited to, tubes screwed together or coiled tubes, which
9 are preferably installed at the same time as the well
10 completion. In a preferred design the well is provided
11 with two or more receiving units, which are installed so
12 that they connect to fluid connection ducts which create
13 a fluid connection between the inside of the conveyor
14 tube and the inside of the production tube. When a
15 certain well tool approaches a predetermined receiving
16 unit the well tool and the receiving unit are designed to
17 engage with each other so that the well tool mentioned is
18 blocked from further movement in the receiving unit. In a
19 preferred design at least one receiving unit is provided
20 with a unique locking profile which is designed to engage
21 with an approaching well tool which is provided with a
22 locking profile which is complementary to the unique
23 locking tool mentioned. A well tool may therefore be fed
24 down through the conveyor tube and pass through one or
25 more non-complementary locking profiles before it
26 finally, and preferably, locks into a receiving unit.

27

28 In a preferred design the well tool is arranged to be
29 pumped down through the conveyor tube by a known method
30 using a fluid which is pumped by means of a pump device
31 and packing system installed on the valve tree, for
32 example. In an alternative design the well tool is
33 arranged for lowering into the conveyor tube, where the

1 well tool is attached to a wire or control cable which
2 may be, for example, but is not limited to, an electric
3 cable, a fibre optic cable or a combination of these.

4

5 The well tool is released from the lock in the receiving
6 unit and is moved up through the conveyor tube under the
7 influence of fluid pressure or, in cases where wires or a
8 control cable are used, when the wire or control cable is
9 pulled against the surface.

10

11 In a first embodiment of the invention the conveyor tube
12 is designed to receive one or more sensors designed for
13 sensing one or more well parameters, in one or more
14 receiving units. At least one sensor senses the current
15 well parameter or parameters from the well fluid present
16 at any time in the fluid connection duct between the
17 production tube and conveyor tube. In one design the
18 sensor is held in position in the receiving unit by the
19 differential pressure between the conveyor tube and the
20 production tube. In this design there is no need for the
21 sensor to be provided with a locking device that keeps
22 the sensor steady in relation to the receiving unit. In a
23 preferred design the sensor is provided with a locking
24 device which engages with a complementary locking device
25 in the receiving unit mentioned, as previously described.

26

27 In a second embodiment of the invention the conveyor tube
28 is designed to receive one or more flow correctors in the
29 receiving unit to which the conveyor tube is connected.
30 The flow corrector is designed to engage with the locking
31 device of a predetermined receiving unit. In one design
32 the flow corrector is designed to conduct a fluids flow
33 in the conveyor tube down through the conveyor tube. In

1 another design the flow corrector is designed to conduct
2 the fluid flow in the conveyor tube out through the fluid
3 connection duct, which opens to the fluid connection
4 between the conveyor tube and the production tube. In a
5 further design the flow corrector is designed to conduct
6 the fluid flow in the conveyor tube both down through the
7 conveyor tube and out through the aforementioned fluid
8 connection duct. In yet a further design the flow
9 corrector is designed to block all further flow.

10

11 In a third embodiment of the invention the conveyor tube
12 is designed to receive both one or more sensors and one
13 or more flow correctors.

14

15 Non-limiting examples of preferred designs illustrated on
16 the accompanying drawings are described in the following,
17 and in these drawings:

18

19 Figure 1 shows a conveyor tube according to this
20 invention, where the conveyor tube projects from a valve
21 tree to the bottom of a well. The conveyor tube is
22 installed in the annular space between a production tube
23 and a production casing, and is in fluid connection with
24 two receiving units.

25

26 Figure 2 shows the arrangement in Figure 1 after a sensor
27 has been fed through a first receiving unit and on down
28 through the conveyor tube and into a second receiving
29 unit. A flow corrector has been fitted in the first
30 receiving unit.

31

32 Figure 3 shows, on a larger scale, an explanatory sketch
33 of a device for introducing a sensor in an upper section

1 of the conveyor tube. This device is fitted at the outlet
2 of the conveyor tube, which opens up into an available
3 area near the valve tree.

4

5 Figure 4 shows, on a larger scale, a section of the
6 sensor in Figure 2, which has been installed in a second
7 receiving unit.

8

9 Figure 5 shows, on a smaller scale, a section of a well
10 in which two different types of flow correctors have been
11 fed down through the conveyor tube in the well and which
12 have been installed in their own receiving units.

13

14 The same or corresponding components are designated by
15 the same reference numbers in the figures.

16

17 Some of the figures show a valve tree 20 of the vertical
18 type, provided with valves of a known type which are
19 known in the specialist field as "hydraulic master valve"
20 22, a "master valve" 24, a "swab valve" 26 and a side
21 valve 28, through which the production fluids in the well
22 flow on out to a tube arrangement not shown. The valve
23 tree 20 is provided in an upper end section with a top
24 cover 30, to which is secured a pressure gauge 31. An
25 expert in the field will be aware of the function of
26 valve tree 20, and for this reason it will not be
27 described in more detail.

28

29 In Figure 1 the reference number 1 designates a section
30 of a well consisting of a production tube 3 and a feeds
31 tube 5. In the annular space between production tube 3
32 and feed tube 5 is installed a conveyor tube is installed
33 10, which projects from a valve tree 20 down into well 1

1 via a first receiving unit 12, which is provided with a
2 through hole 16, and down to a second receiving unit 14,
3 in which conveyor tube 10 has its lower end connection
4 point 14'. Conveyor tube 10 is connected to the first
5 receiving unit 12 in an upper connection point 12' and a
6 lower connection point 12''. The connection between
7 conveyor tube 10 and receiving units 12, 14 can be made,
8 for example, by means of a screw connection or welded
9 joint. The second receiving unit is provided with a non-
10 through hole 16', which is in fluid communication with a
11 side hole 16'' made in the receiving unit.

12

13 Although only two receiving units 12, 14 are shown in the
14 figure, it must be understood that conveyor tube 10 can
15 be connected to any number of receiving units. Receiving
16 units 12, 14 are shown in the design examples as
17 integrated with production unit 3. In alternative designs
18 (not shown) the receiving units can be secured to a
19 section of production tube 3.

20

21 When reference is made in the following to conveyor tube
22 10, this is also interpreted as including receiving units
23 12, 14, since in the operating situation they constitute
24 a section of conveyor tube 10.

25

26 Production tube 3 is provided with holes which in turn
27 provide fluid connection ducts 3' between production tube
28 3 and holes 16, 16' in receiving units 12, 14. Each
29 receiving element 12, 14 is shown in Figure 1 as being
30 provided with one fluid connection duct 3'. In an
31 alternative design (not shown) production tube 3 may be
32 provided with two or more holes 3', which in turn provide

1 a fluid connection between production tube 3 and each of
2 receiving units 12, 14 of conveyor tube 10.
3
4 Each of receiving units 12, 14 of conveyor tube 10 are
5 provided with a unique locking profile 18, see Fig. 4,
6 which is designed to receive a well tool 40, see Fig. 2,
7 which is provided with a locking element 18'
8 complementary to the aforementioned unique locking
9 profile 18, which element can best be seen in Fig. 4 and
10 Fig. 5. Locking element 18' of well tool 40 is arranged,
11 in a preferred design, to be able to pass through a non-
12 complementary locking profile 18 in receiving units 12,
13 and is fed on through the conveyor tube to the next
14 receiving unit 14, as shown in Fig. 2, where the well
15 tool consists of a sensor 40 which is installed in
16 receiving unit 14 and which communicates with the surface
17 via a sensor cable 42. Fluid connection duct 3' to upper
18 receiving unit 12 is blocked by a well tool comprising a
19 flow corrector 41, which will be described in more detail
20 later.
21
22 Well tool 40 can be lowered down into a well 1 by
23 gravity. In wells with a deviation (not shown) relative
24 to the vertical plane it may be difficult or impossible
25 to feed a well tool 40 along conveyor tube 3 solely on
26 the basis of gravity. An intrinsically known method that
27 is difficult to use to convey well tools in tubes
28 involves using a fluid flow which is brought about by a
29 pumping device (not shown).
30
31 Figure 3 shows the upper end section of conveyor tube 10,
32 see Figs. 1 and 2, connected to a known introducing
33 arrangement 50, where well tool in the form of a sensor

1 40 is introduced into a sluice chamber 52. In the
2 specialist field such a sluice chamber is often referred
3 to as a "lubricator". Cable 42 of sensor 40 is fed
4 through a sealing arrangement 54 in an upper end section
5 of sluice chamber 52. The sealing arrangement consists of
6 a sealing housing 56, which in the specialist field is
7 known as a "stuffing box", and packings and tightening
8 devices of known type, which are shown in the drawings
9 but which will not be described further. Fluid, for
10 example a liquid, is pumped into sluice chamber 52 via a
11 valve 58, which fluid will drive sensor 40 into conveyor
12 tube 10 and on down through it by a known method. Fig. 3
13 also shows a valve 60 for isolating conveyor tube 3 and
14 an outlet tube 62, with outlet valve 64 for pressure
15 control and monitoring of conveyor tube 10.

16

17 The device shown in Figure 3 may in principle also be
18 used for pumping in a cable-free flow regulator. However,
19 the sealing housing, the so-called "stuffing box", must
20 in this case be replaced with a tight end plug of a known
21 type.

22

23 Sensor 40, shown in Fig. 3, is provided in its free end
24 section with a plurality of circular elastic elements 44
25 designed to be supported against the inner wall of sluice
26 chamber 52 and conveyor tube 10, so that as much of the
27 fluid as possible which is pumped into sluice chamber 52
28 and on into conveyor tube 10 drives sensor 40 down into
29 conveyor tube 10 until sensor 40 engages with a
30 predetermined receiving unit 12, 14, see Fig. 1.

31

32 Fig. 4 shows a section of Fig. 2 on a larger scale, in
33 which sensor 40, shown in outline, has been installed in

1 the second receiving unit 14, and where locking element
2 18' of sensor 40 engages with the complementary locking
3 profile 18 of receiving unit 14. A closing valve 46 of a
4 known type, fitted in receiving unit 14, is rotated by
5 sensor 40 to the open position. In a preferred design
6 closing valve 46 is provided with a pre-tensioning device
7 such as an intrinsically known spring device (not shown).
8 The purpose of closing valve 46 is to prevent production
9 fluids from being forced up through conveyor tube 10 when
10 sensor 40 is withdrawn from receiving unit 14, and
11 closing valve 46 of the pre-tensioning device is rotated
12 and blocks fluid flow through hole 16' and on up through
13 conveyor 10, since it will not normally be produced
14 through conveyor tube 10.

15

16 Figure 5 shows a first flow corrector 41 installed in a
17 receiving unit 12, and a second flow corrector 43
18 installed in a receiving unit 13 at the bottom. As shown
19 in Figure 5, first flow corrector 41, aforementioned, is
20 provided with an essentially central through hole 41'
21 which, when locking element 18' of flow corrector 41
22 engages with locking profile 18 of receiving unit 12,
23 conducts fluid flow F past fluid connection duct 3' and
24 on down through conveyor tube 10. Second flow corrector
25 43 is provided with an essentially central blind hole
26 43', which communicates with a side hole 43''. When
27 locking element 18' of flow corrector 43 engages with
28 locking profile 18 of receiving unit, fluid flow F is fed
29 out through fluid connection duct 3'. Fluid flow F is
30 prevented by the undrilled end section of flow corrector
31 434 from flowing on down through conveyor tube 10.

32

1 Well tools 40, 41, 43 are disengaged from receiving units
2 12, 14 by a known method, for example by, but not limited
3 to, carrying out repeated pressure settings and bleeding
4 of the conveyor tube, or by using mechanical devices,
5 e.g. setting/pulling tools (not shown) designed to
6 release locking elements 18' from engagement with locking
7 profiles 18. This is well known to an expert in the
8 field, and will not be described in greater detail.

9
10 By feeding flow correctors 41, 43 down through a well 1
11 to the desired location or locations, tools may be
12 circulated up and/or down into conveyor tube 10 and
13 production tube 3, even though there is a plug, or other
14 barrier fitted over the lowest circulation point. This
15 affords major advantages compared to the prior art, which
16 only has one circulation point in a well.

1 **CLAIMS**

2
3 1. Conveyor tube (10) for use in installing or replacing a
4 well tool (40) in a producing well (1), wherein the
5 well tool (40) is fed into the conveyor tube (10) which
6 at least runs between a valve tree (20) and at least
7 one receiving unit (12, 13, 14) in the well,
8 characterised in that the conveyor tube (10) is
9 installed on the outside of a production tube (30) in
10 the well (1).

11
12 2. Conveyor tube (10) according to claim 1, characterised
13 in that the inside of the conveyor tube (10) is in
14 fluid communication with the inside of the production
15 tube (30) by means of at least one fluid connection
16 duct (3') fitted so that it connects to each of at
17 least one receiving unit (12, 13, 14).

18
19 3. Conveyor tube (10) according to claim 1 or 2,
20 characterised in that the conveyor tube (10) is
21 designed to block the well tool (40) from further
22 movement in the conveyor tube (10) when the well tool
23 (40) is in a predetermined position.

24
25 4. Conveyor tube (10) according to claim 3, characterised
26 in that the aforementioned predetermined position is in
27 one at least one of the receiving units (12, 13, 14).

28
29 5. Conveyor tube (10) according to claim 3 or 4,
30 characterised in that each of at least one of the
31 receiving units (12, 13, 14) is provided with a unique
32 locking profile (18) which is designed to receive a
33 well tool (40) with a locking profile (18')

1 complementary to the aforementioned unique locking
2 profile (18).
3

4 6. Conveyor tube (10) according to any of the preceding
5 claims, characterised in that the conveyor tube (10) is
6 designed to receive a well tool comprising one or more
7 sensors (40) which are designed to sense one or more
8 well parameters.
9

10 7. Conveyor tube according to claim 6, characterised in
11 that at one of sensors (40) is provided with a cable
12 (42) designed to bring about communication between at
13 least one of sensors (40) and a surface control unit.
14

15 8. Conveyor tube (10) according to any of claims 1-4,
16 characterised in that the conveyor tube (10) is
17 designed to convey and lock a well tool comprising one
18 or more flow correctors (41, 43).
19

20 9. Conveyor tube (10) according to claim 8, characterised
21 in that the flow corrector (41) consists of an
22 essentially cylindrical element provided with a central
23 through hole (41').
24

25 10. Conveyor tube (10) according to claim 8,
26 characterised in that the flow corrector (43) consists
27 of an essentially cylindrical element which is provided
28 with a central blind hole (43') which is in fluid
29 communication with a side hole (43''), wherein the side
30 hole (43') corresponds to the fluid connection duct
31 (3') when the locking element (18') of the flow
32 corrector (43) engages with the locking profile (18) of
33 the receiving unit (13), and wherein the holes (43',

1 43'), 3') are designed to maintain fluid communication
2 between a section of the conveyor tube (10) and the
3 production tube (3).
4

5 11. Method for installing or replacing a well tool (40)
6 in a producing well (1), wherein the well tool (40) is
7 fed into a conveyor tube (10) which at least runs
8 between a valve tree (20) and at least one receiving
9 unit (12, 13, 14) in the well (1), characterised in
10 that the conveyor tube (10) is installed on the outside
11 of a production tube (3) in the well (1).
12

13 12. Method according to claim 11, characterised in that
14 the well tool (40) is pumped down through the conveyor
15 tube (10).
16

17 13. Method according to claim 11, characterised in that
18 the well tool (40) is conveyed out of the conveyor tube
19 (10) under the influence of fluid pressure.
20

21 14. Method according to claim 11, characterised in that
22 the well tool (40) is lowered down through the conveyor
23 tube (10) after a pulling element (42) which has been
24 fitted between the well tool (40) and an inlet end of
25 the conveyor tube (10).
26

27 15. Method according to claim 11, characterised in that
28 the well tool (40) is conveyed out of the conveyor tube
29 (10) by applying a compressive force to the application
30 of a pulling element (42) fitted between the well tool
31 (40) and an inlet end of the conveyor tube (10).
32

1 16. Method according to any of claims 11 to 15,
2 characterised in that the well tool (40) is designed
3 for selective engagement with one section of the
4 conveyor tube (10).

5

6

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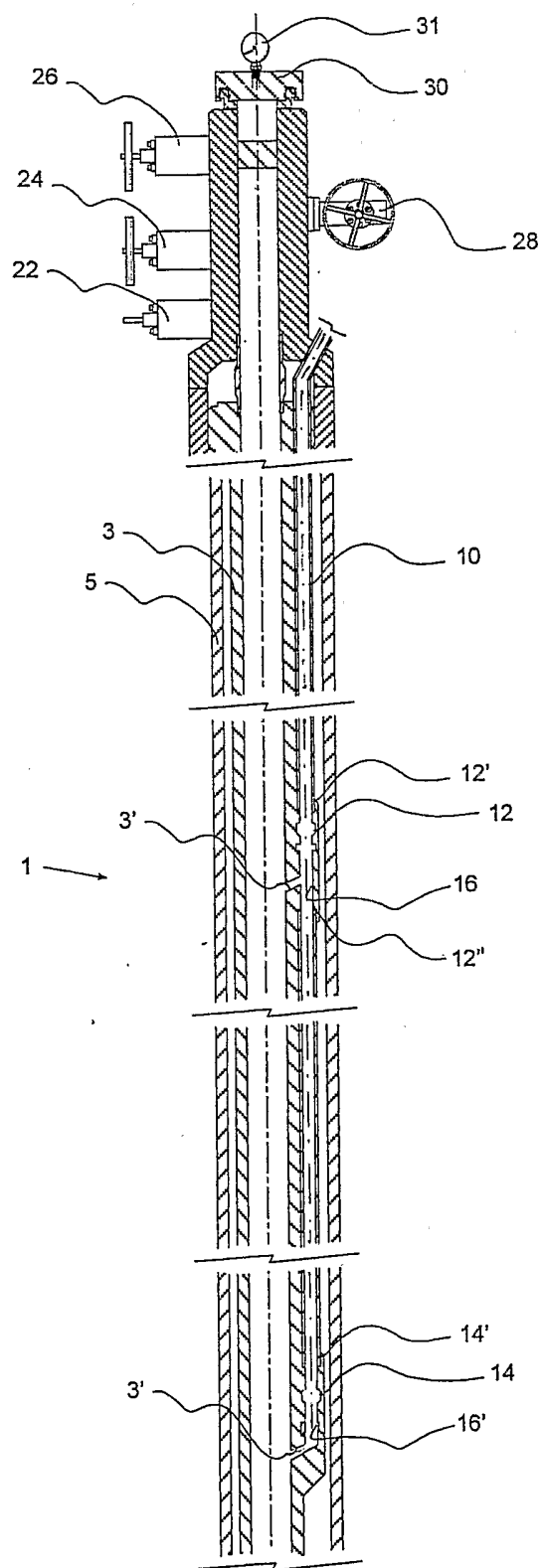


Fig. 1

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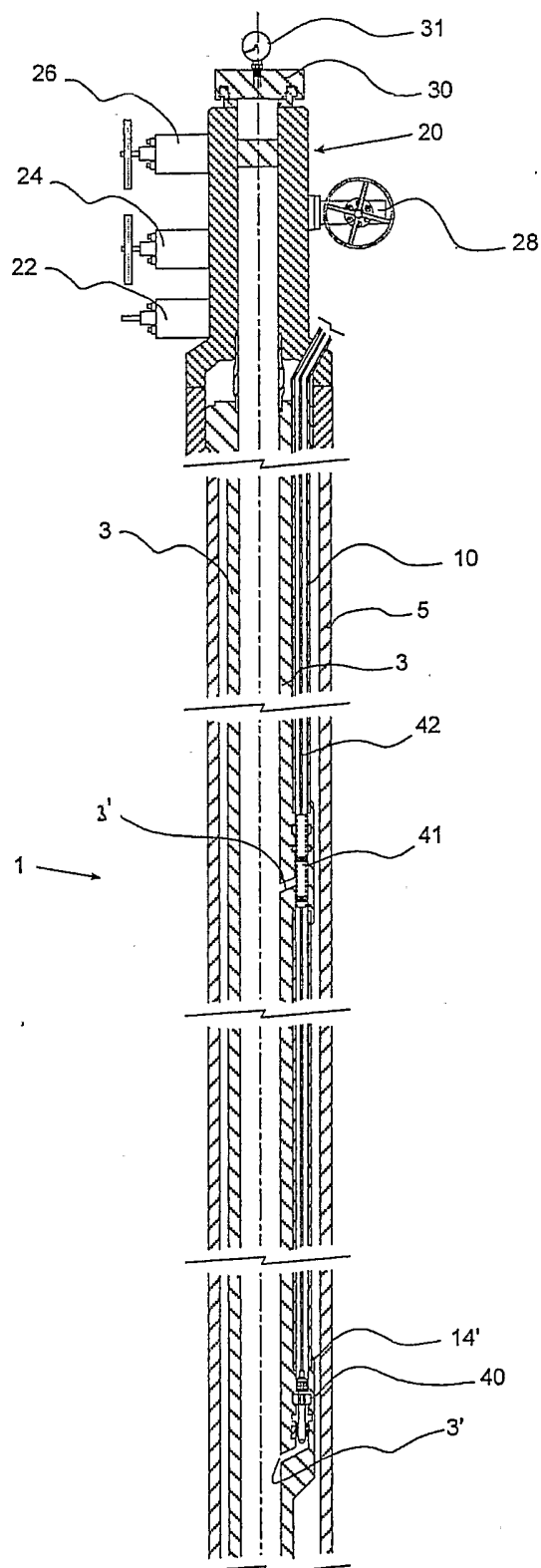


Fig. 2

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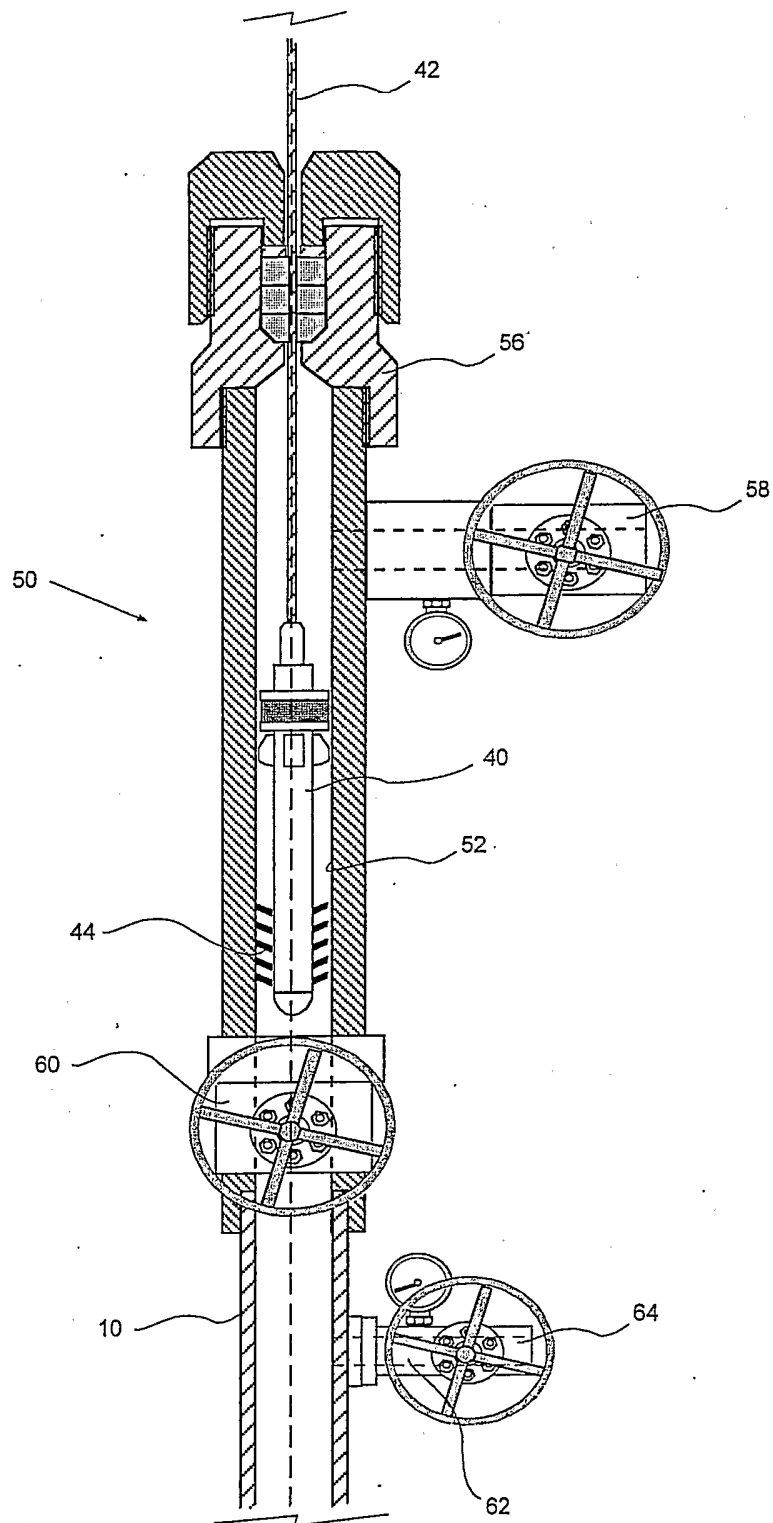


Fig. 3

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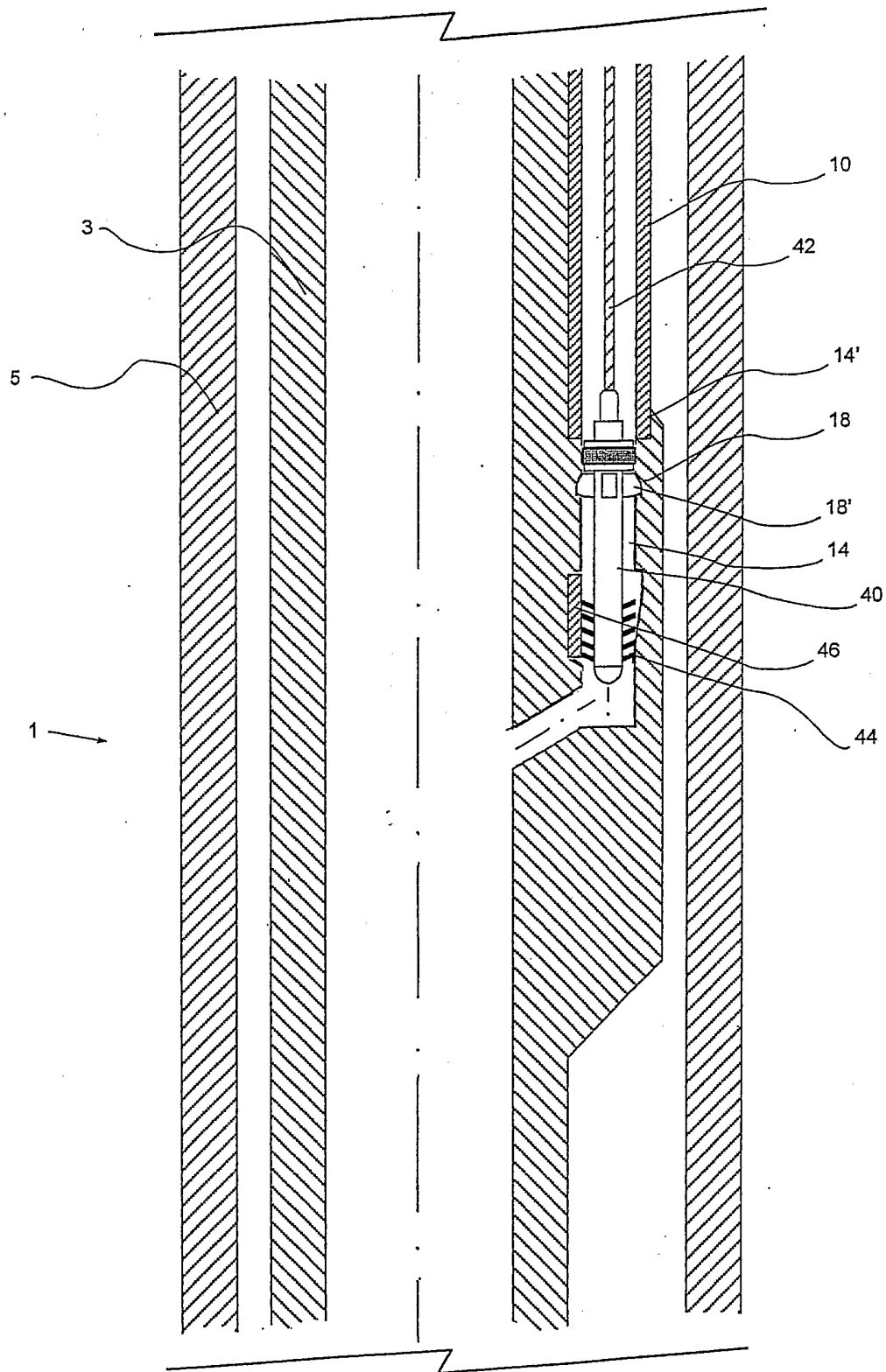


Fig. 4

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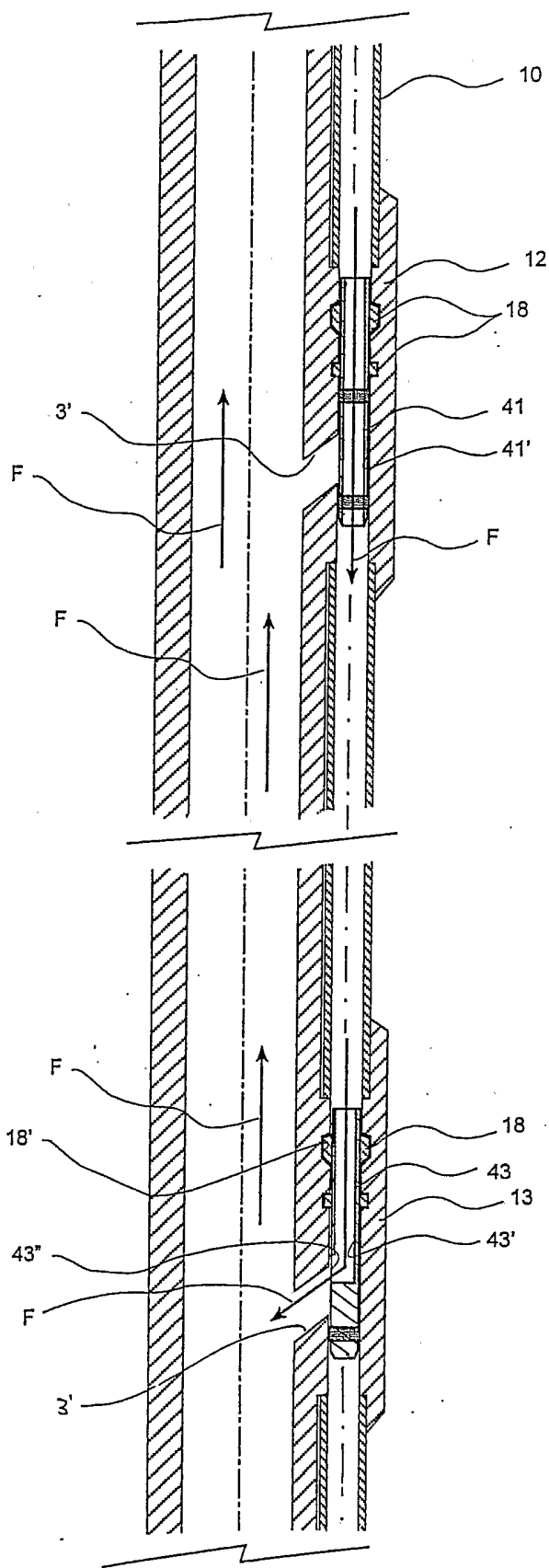


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No

PCT/JP2005/004207

A. CLASSIFICATION OF SUBJECT MATTER

E21B23/08

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	WO 2004/066000 A (SABEUS PHOTONICS, INC; BOWKER, THOMAS; GOLDNER, ERIC, L; SHAW, MICHAEL) 5 August 2004 (2004-08-05)	1,3-16
Y	pages 6-7; figure 1	2
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	claim 1; figures 1,4	
X	CA 2 339 715 A1 (CADRIN, DAVID; HAYES, KIRBY) 2 September 2002 (2002-09-02)	1,11
	abstract; figure 1	
Y	US 6 230 812 B1 (REAUX JAMES) 15 May 2001 (2001-05-15)	2
	figure 21	



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See patent family annex.

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Date of the actual completion of the international search

27 January 2006

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06/02/2006

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

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