

12 **EUROPEAN PATENT APPLICATION**

21 Application number: 84300664.4

51 Int. Cl.³: **E 21 B 21/10**
E 21 B 33/127

22 Date of filing: 02.02.84

30 Priority: 04.02.83 US 463674

43 Date of publication of application:
22.08.84 Bulletin 84/34

84 Designated Contracting States:
AT BE CH DE FR GB IT LI LU NL SE

71 Applicant: van Gils, Adrianus Wilhelmus
Kreek 5
NL-1231 NM Loosdrecht(NL)

71 Applicant: van den Boogaart, Abraham
Neerhof 8
NL-1316 CT Almere(NL)

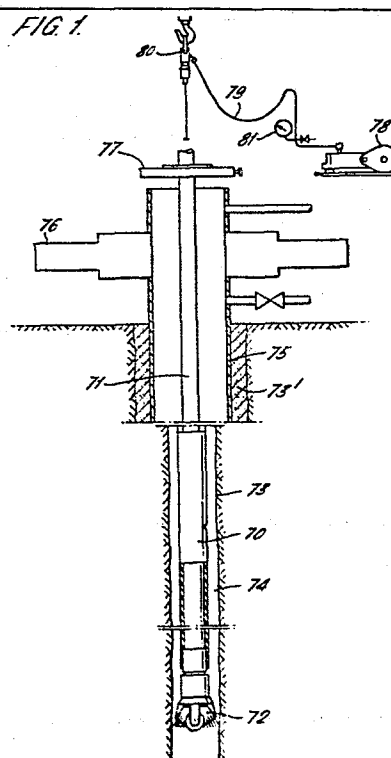
72 Inventor: van Gils, Adrianus Wilhelmus
Kreek 5
NL-1231 NM Loosdrecht(NL)

72 Inventor: van den Boogaart, Abraham
Neerhof 8
NL-1316 CT Almere(NL)

74 Representative: Mayes, Stuart David et al,
BOULT, WADE & TENNANT 27 Furnival Street
London, EC4A 1PQ(GB)

54 Down hole blow out preventer and method of use.

57 A down hole blow out preventer which can be installed at the lower end of a drill string (71) as close as possible to the drill bit (72) and which can isolate an unexpected producing zone in a bore hole (73) from the rest of the hole by closing off the annulus (74) between the drill string and the wall of the bore by means of an inflatable packer (54). The packer can be operated when a predetermined pressure difference exists between the annulus and the mud column inside the tool.



"DOWN HOLE BLOW OUT PREVENTER AND METHOD OF USE"

The invention relates to a down-hole blow-out preventer for use in drilling oil and gas wells and wells that may be drilled for recovery of geothermal energy, etc.

Surface blow-out preventers are in common use in the oil industry but so far no blow-out preventer is in commercial use which can be used successfully to block off the oil well down the drill hole and close to the drill bit.

10 Various proposals have been made for closing the drill hole but none has ever been used successfully commercially for various reasons.

For example U.S. Specification No. 3908769 shows a drill hole packer to be carried by a drill string but this packer is dependant for its operation upon a high flow rate of fluid in the reverse direction on encountering a kick. The device according to the invention works on detection of a static pressure difference.

U. S. Specifications Nos. 3941190 and 3503445 both show down hole packers but both packers are operated by tools which have to be pumped down the hole which would take several hours.

5 The invention provides a down hole blow out preventer comprising an elongated tubular housing having a through bore for the passage of drilling mud and means for connecting the ends of the housing into a drilling string, a packer element arranged
10 circumferentially around the housing and inflatable into engagement with the bore hole to seal the hole, passage means extending through the housing wall for connecting the bore of the housing with the packer element to inflate the element by mud pressure from
15 within the housing, a cylindrical valve sleeve mounted inside the housing for movement between a drilling position when the sleeve closes said passage means and an inflating position when the passage means is open, a one-way valve for closing the housing bore on the
20 side of the sleeve to be nearer the drill bit, said valve means being operable to allow the passage of mud under pump pressure, but not allowing reverse flow of mud, said valve sleeve providing a through bore for the passage of mud, second valve means for closing
25 the bore in the valve sleeve and means to close said

second valve means automatically when pressure in the housing is reduced to a level below the pressure in the bore hole by a predetermined amount, the arrangement being such that after closing of the second valve means 5 the pressure in the housing can be re-applied to urge the valve sleeve to its inflating position allowing the packer element to be inflated, means to prevent closure of the second valve means during running-in, a mud circulation channel extending through the housing 10 on the side of the sleeve valve nearer the surface, means being provided to open said channel when the packer element is inflated whereby mud may be circulated through the drill string, the channel and the bore hole to increase the mud density, and means for deflating 15 the packer element only when the mud density is sufficient to balance the pressure below the packer element.

The invention is also concerned with a method of using such a device.

20 A specific embodiment of a down hole blow out preventer (D.H. BOP) in accordance with the invention will now be described in detail with reference to the drawings in which:-

Figure 1 shows the D.H. BOP connected in a 25 drill pipe-string run into a hole;

Figure 2 is a vertical sectional view of the D.H.BOP in the running-in position;

Figure 3 is a horizontal cross-section along line III-III in Figure 2;

5 Figure 4 is a horizontal cross-section along line IV-IV in Figure 2;

Figure 5 is a horizontal cross-section along line V-V in Figure 2;

Figure 6 shows a vertical cross-sectional
10 view of the D.H.BOP, in drilling position;

Figure 7 is a horizontal cross-section along line VII-VII in Figure 6;

Figure 8 shows a vertical cross-sectional view of the D.H.BOP during a wellkick after closing
15 the flapper valve.

Figure 9 shows a vertical cross-sectional view of the D.H.BOP, with the packer inflated;

Figure 10 shows a vertical cross-sectional view of the D.H.BOP, with the circulating port open;

20 Figure 11 is a horizontal cross-section along line XI-XI in Figure 10;

Figure 12 is a horizontal cross-section along line XII-XII in Figure 10;

Figure 13 shows a vertical cross-sectional
25 view of the D.H.BOP, deflating the packer; and

Figure 14 shows a horizontal cross-section on the line XIV-XIV in Figure 13.

As can be seen from Figure 2 the D.H.BOP comprises two barrels an outer barrel 1 and an inner
5 barrel 2.

The inside of the outer barrel 1 and the outside of the inner barrel 2 are fine machined to the required tolerances.

The various channels and holes are milled and
10 drilled in the inner barrel 2 and after being machined the two barrels are shrunk together by undercooling of the inner barrel 2.

The position of the two barrels in relation to each other must be precise.

15 After shrinking the two barrels 1 and 2 together, the various radial holes can be drilled and the channels for the fill-up valve assembly 41, the grease bolt 1', the check valve 53, the circulating valve 57 and the equalising valve 62 can be drilled
20 and machined.

The top of the outer barrel 1 is provided with an external thread 4 for connection with an API threaded substitute 3 to enable the insertion of the inner parts of the D.H.BOP from the top.

25 The outer barrel 1, is provided at its lower

end with an internal thread 4' to connect it with a packersleeve 5.

The packersleeve 5 is at its bottom-end provided with a threaded API box connection 6 to
5 connect it with the drilling bit.

Inside the packersleeve 5 a chamber is machined which is nearly as long as the packersleeve 5, and in which a floatvalve assembly 7 is inserted for sliding movement from a lower to an elevated position.

10 Floatvalve assembly 7 comprises a piston-like substantially hollow body 7' in which is mounted a conical valve 8 spring-loaded by spring 9 into sealing engagement with a valve seat, formed inside body 7'. Valve 8 is fixed to valve stem 10 which is guided for sliding up
15 and down movement in guiding sleeve 11 mounted in bushing 12 which is fixed inside body 7 by means of a spider.

A snapring sleeve 13 is inserted into the top of packersleeve 5. The top of packersleeve 5 is
20 provided with four pressure equalising channels 15 in the snapring sleeve 13.

Around snapring sleeve 13 a helical spring 16 is inserted before a snapring 17 is pressed over the snapring sleeve 13.

25 A flappervalue sleeve 18 is pressed over the

snapring 17 mounted around snapring sleeve 13 until it sits in a snapring recess 19.

Flappervalue sleeve 18 is provided with a friction cam 20 which can be forced over the snapring 17 until snapring 17 snaps into snapring slot 21 of flappervalue sleeve 18, by pump pressure when the flappervalue 22 is closed. The flappervalue 22 is pivotally mounted on top of flappervalue sleeve 18 and spring biased towards a closed position in which it is in sealing engagement with the top edge 18' of flappervalue sleeve 18. Closing movement is prevented by a flappervalue release sleeve 23 during circulating and drilling.

The flappervalue release sleeve 23 comprises a plunger holder 24 to which are fixed two plungers 25 which are received into bores formed in a plunger housing 26.

The plunger holder 24 and the plunger housing 26 are provided with four pressure equalising channels 27 and 28 respectively.

A helical spring 29 bears with its cover end against the top of the plunger holder 24 with its upper end against a retainer ring 30 by which the tension of spring 29 can be adjusted. The retainer ring 30 is also provided with four pressure equalising channels 31. A steel arresting ball biased inwardly by a calibrated helical spring rests in a circumferential groove in plunger holder 24.

By stopring 32 upward movement of the plunger holder 24 is limited to keep the plungers 25 inside the plunger housing 26.

Against the top of retainer ring 30 bears a
5 helical spring 33 which bears with its other end against a shut-off sleeve 34 to keep the sleeve 34 in its highest position in which a channel 35 and a fill-up channel 36 are open (see Figure 3).

The fill-up valve assembly 41 is shown in
10 running-in position in Figures 2 and 3 and in circulating or drilling position in Figures 6 and 7. It comprises a gate 41' having a substantially rectangular cross-section and running in a hole 42 which hole is closed at one end by locking nut 45 having a slotted part 46
15 in communication with a bore 35 in the body part 2. A screen 47 covers a recess, formed in outer barrel 1 which is in communication with fill-up channel 36, and an inlet 48 which opens into flappervalue release channel 49. Channel 49 extends through inner barrel 2 and
20 opens into circumferential groove 50 formed in plunger housing 26 and ports 51 extend from groove 50 into the plunger cylinders.

The first purpose of the fill-up valve assembly 41 is to be in open position (Figure 3) to fill up the
25 drill pipe when running the drill pipe into the hole and simultaneously to close off the flappervalue release

channel 49 when running into the hole so that no pressure difference between the annulus and drillpipe can lift the plungers 25 and accidentally cause the flapper valve 22 to close.

5 Its second purpose is to close off the fill-up channel 36 once circulation or drilling has commenced. The greater pressure inside the drill pipe is propagated through channel 35 to gate 41 and moves the gate 41 to close the fill-up channel 36, against the lesser pressure
10 in the annulus as shown in Figure 7. When the gate 41 moves it also closes the fill up channel 36 and mud will fill the fluid lock 52.

 The shut-off sleeve 34 is moved downwardly when circulation is started and to increase the pressure drop
15 an aluminium disc 37' with an orifice may be provided by means of threaded ring 37 which disc will be disintegrated during circulation. The position is shown in Figure 6.

 When the shut-off sleeve 34 moves downwardly
20 against the tension of spring 33, the locking spring snaps into the locking groove 39 formed in the inner wall of inner barrel 2 and shuts off the channels 35 and 36. The shut-off sleeve 34 is provided with three pressure equalising channels 40.

25 After the shut-off sleeve 34 has moved

downwardly to close channel 35 the entrapped mud in the fluid lock 52 will cause the fill-up channel 36 to be permanently closed while the flapper valve release channel 49 remains open. The plungers 25
5 are from now on permanently connected to and subjected to the pressure in the annulus through inlet 48 and channel 49.

Another purpose of the fill-up valve assembly is to provide the possibility to calibrate the tension of the spring loaded steel ball 23' (Figure 2)
10 and the spiral spring 29 before running the D.H.BOP into the hole. The spring loaded steel ball 23' is there to prevent fluttering of the flapper valve release sleeve 23 by pressures lower than the setting of the spring 29 for releasing the flapper valve 22.

15 To enable calibration of the spring loaded steel ball 23' and the spiral opening 29 the fill-up valve gate 41 is set in the drilling position as shown in Figure 7 whereafter a grease pump with a pressure gauge is connected to the threaded inlet 48 leading to
20 flapper valve release channel 49. The tension set for the spiral spring 29 depends on the maximum expected penetration rate per hour, the hole size, the depth of the hole, the pump volume and the cross sectional area of the plungers 25.

25 Easy to read charts can be developed for this

purpose.

The required spring tension is the tension required to overbalance the greater hydrostatic head of the mud column in the annulus caused by the presence of drilled formation cuttings when the pump is stopped. 5 A checkvalve 53 is provided to allow mud to enter and to inflate the inflatable packer element 54 when the flappervalue 22 has been released and closed, and the flappervalue sleeve 18 has been pumped down to 10 uncover the inflating port 55. This operation will be described later. Mud can then be pumped through port 55 and channel 56 into packer element 54. The check valve 53 closes and retains the mud in the inflatable packer element 54 when the pressure in the 15 drillpipe drops.

It will be seen that the outside diameter of the outer barrel 1 has a partly enlarged diameter 1a, which is provided with spiral grooves 16 (Figure 4) like an undersized solid body stabilizer.

20 The enlarged diameter provides protection for the packer element 54. Furthermore a steel ring 54' at the bottom end of the packer element 54 is connected to the packer sleeve 5 by means of shearpins 54''. This to protect the packer element whilst running into 25 the hole and to withstand rotational forces when drilling.

The shearpins 54'' are sheared when the packer 54 is inflated say at a pressure of 700 psi.

A shut-off valve assembly 57 is provided which is composed of a shut-off piston 57' with O-ring seals, a helical pressure spring 58 and a bushing 59 with a thread 59' for a grease nipple.

When running in and drilling (Figure 5), the shut-off piston 57' is isolated from the pressure inside the tool by the flappervalue sleeve 18 with which is provided O-ring seals (Figure 2). It is exposed to the pressure inside the tool when in inflating the packer element 54 the flappervalue sleeve 18 is pushed downwardly and its friction cam 20 rides over the snapping 17 which then snaps into the slot 21 as will be described later.

The object of the shut-off piston 57' is to close the channel 60 while pump pressure is present within the tool, and to open the channel 60 when the pump is stopped. This is achieved by the pressure within the tool moving the piston 57' against the spring 58 to close the channel 60 from the annulus.

An equalising valve 62 is provided (Figure 5) which comprises an equalising piston 62, having a conical nose, a helical pressure spring 63 and a threaded bushing 64 in which bolt 65 is screwed.

The purpose of the equalising valve is to open the packer element to the channel 60 when the pressure in the annulus below the packer (which is fed to the valve via channel 66) is exceeded by 300 psi
5 by the mud pressure which is above the packer. The mud pressure is present in channel 60 when piston 57' opens the channel 60 to the annulus.

When a kick is encountered and the packer element 54 has been inflated (Figure 10) then during
10 circulation through the circulating channels 61 the equalising channel 60 is closed and no extra circulation pressure is behind the equalising piston 62. However when the pump is stopped and the shut-off piston 57' is pushed back by spring 58 then the equalising channel
15 60 is open to the mud pressure in the annulus so that the hydrostatic pressure acts on the conical nose of the equalising piston 62.
On the opposite side of the equalising piston 62 the formation pressure below the packer is received via
20 equalising port 64 and aligned ports 67 and 68 formed in flappervalue sleeve 18 and snapping sleeve 13 respectively.

If now the mud weight is sufficiently increased to overbalance the formation porepressure and the pump
25 is stopped then the hydrostatic head of the mud column

in the annulus above the packer exerts pressure against the equalising piston 62 and moves this piston until it opens the deflating channel 69 so that the pressure inside the packer element escapes into the annulus through equalising channel 60 assisting the equalising piston 62 to remain in open position (Figure 4).

The overpressure required to move and open the equalising piston 62 can be adjusted by means of the spring loaded ball 84 resting in groove 92 and can be tested with a grease pump having a pressure gauge when the grease nipple is screwed into the thread 57.

When the flappervalue sleeve 18 is pumped down after the packer element has been inflated, the mud below the flappervalue is trapped and, although of very small volume, the closed floatvalve 7 will move downwardly and compress the gas or liquid or squeeze it back into the formation against the formation pore pressure.

After the D.H.BOP is prepared for running in, the D.H.BOP can be run into the hole, so that it reaches eventually the position as shown in Figure 1. In Figure 1 is shown the D.H.BOP 70, interconnected between the drillpipe-string 71 and drillbit 72 and run into hole 73 so that annulus 74 is formed. A casing 75 is

cemented in the upper portion 73' of the hole 73, while at the surface a surface blow out preventer 76 of known type is provided below rotary table 77. Mud can be pumped by pump 78 through hose 79 and swivel 80
5 down into drillpipe-string 71, which mud then is ejected from drillbit 72 and flows upwardly through annulus 74. With reference numeral 81 a pressure gauge is shown.

When running in, the drillpipe is empty and
10 the floatvalve 7 is closed and in its highest position (see Figure 2) so that no mud can enter the drillpipe through the bit nozzles and no formation cuttings can settle down inside the bit on top of the bit nozzles causing the bit to become plugged when circulation is
15 started. The filling of the drillpipe takes place through the fill-up opening 36 and hole 42 of the fill-up gate 41.

The mud is screened by the mudscreen 47. Figures 1 and 3 give a clear insight on the operation
20 and position of each valve and part when running into the hole.

Attention should be given to the fact that when for one reason or the other circulation has been established during running into the hole, it will be
25 necessary that the drillpipe will be filled from the

top of every stand to be run into the hole because after circulation the fill-up valve will be permanently closed as described herein above.

When the bit has reached the bottom of the
5 hole the mudpumps are started and circulation is established through the floatvalve 7 and the bit nozzles. Figure 6 gives a clear insight on the operation and position of each valve and part when circulating or drilling. Drilling may continue without encountering a kick and
10 a roundtrip to change the bit is then made without having used the D.H.BOP.

When the bit is pulled and unscrewed, the floatvalve 7, the valve seat inside body 7' and the valve assembly circumferential body seals should be
15 inspected and be in a good condition or changed for new ones before making-up a new bit.

Next, take out the threaded ring 37 from shut-off sleeve 34 with a set and pulling tool, and screw a set and pulling tool into the same thread and
20 pull the shut-off sleeve 34 up until its highest position unscrew tool and screw in threaded ring 37 again.

The fill-up valve gate 41 has to be cleaned and to be reset after each roundtrip. Unscrew locking
25 nut 45, put grease nipple in the thread, pump out the

housing 44 for gate piston 43 together with the gate 41,
clean and reinsert gate 41 and housing 44, use grease,
set gate 41 in fill-up position with a set bolt "s"
and screw in locking nut 45, take out set bolt and
5 tighten locking nut 45. The D.H.BOP can be run again
and is ready to operate again when necessary.

Figure 8 gives a clear insight of the operation
and the position of each valve and part when a kick is
encountered and the annulus is closed in by the surface
10 BOP 76.

If a kick is encountered during drilling then the
pumps are stopped, the standard pipe valve closed, the kelly
picked-up and the annular BOP closed. The closed-in
drill pipe pressure is then read and recorded. As soon as
15 the pumps are stopped the floatvalve 7 will close due to
the tension of spring 9.

As the well is completely closed-in, now
pressure will be built-up inside the well.

The floatvalve assembly 7 was in its lowest
20 position when circulating. Now the pumps 78 (Figure 1)
are stopped so that the closed floatvalve assembly 7
acts like a floating piston and when pressure below
it is building up it can move upwardly making it possible
to read the closed in drillpipe pressure (C.I.D.P.P.)
25 from the pressure gauge 81 (Figure 1).

The C.I.D.P.P. + hydrostatic head of the mud column in the drillpipe = formation pore pressure.

If the kick is observed at an early stage then the time required for the C.I.D.P.P. to build up
5 should be about ten (10) minutes, depending on the column of gas already produced in the annulus 74 (compression).

The C.I.D.P.P. is recored and the required mud weight calculated with sufficient overbalance over
10 the formation pore pressure.

Now the C.I.D.P.P. is slowly bled-off at the drillpipe. Wait a few seconds and start pump 78 slowly.

In the meantime the following occurs downhole:
When the well is closed in, the C.I.D.P.P. + hydrostatic
15 head of the mud column in the drillpipe = closed in annular pressure + hydrostatic head of mud column in the annulus because these are communicating vessels with the floating floatvalve assembly 7 between them.

Say that the C.I.D.P.P. is 300 psi. and
20 the pressure is bled-off at the drillpipe, now the annular pressure at the bottom of the hole is 300 psi. higher than in the drillpipe. The floatvalve assembly 7 moves into its highest position and the pressure in the annulus 74 is propagated via the inlet 48 and through
25 hole 42 in fill-up valve gate 41 through the flappervalue

release channel 49 underneath the plungers 25, which are then moved upwardly lifting the flappervalue release sleeve 23 until the spring biased flappervalue 22 falls on the seat 18' formed by the upper edge of flappervalue sleeve 18, which is then closed off (see Figure 8).

All above occurs when the C.I.D.P.P. is bled-off at the drillpipe.

Now the pump 78 is started very slowly.

Pressure builds up to abt. 1500 pse. and drops. Pump speed is increased to 100-200 gln/min. depending on the size of the D.H.BOP and the size of the circulating channels 59.

As shown in Figure 9 downhole the following occurs:

15 The flappervalue 22 is already closed. Pump 78 runs slowly. The flappervalue sleeve 18 is pushed downwardly by the pump pressure against the helical spring until the inlet 55 of the check valve 53 is uncovered and the flappervalue sleeve 18 hits the snapring 17 with the calibrated friction cam 20. Pressure is now building up and the packer element 54 is inflated through inflation channel 56.

At about 1500 psi. the flappervalue sleeve 18 snaps with its friction cam 20 over the snapring 17 which is locked in the snapring slot 21 and the packer 52 is set.

As shown in Figure 10 when the snapring 17 is snapped into the snapring slot 21 the mud pushes shut-off piston 57' (Figure 8, 52) outwardly so that piston 57 closes channel 60.

5 In this position of the sleeve 18 mud can be circulated through the circulation ports 61. When circulation is established the drillstring is lowered to put some weight on the packer to make certain that the packer 54 is set.

10 The packer 54 is now isolating the producing zone from the remaining portion of the hole.

The tool is closed-off at the bottom by the float valve assembly 7 and from the top by the flapper valve 22.

15 When the mudweight has been increased by circulation to the required weight so that the hydrostatic pressure of the mud column above the packer 54 is overbalancing the pore pressure of the formation below the packer the pump should be stopped.

20 The channel 60 will then be opened by the piston 57' and the equalising valve so that the packer is deflated and the string can be pulled out of the hole.

As shown in Figure 13 the following occurs downhole when the mud is overbalancing the formation pore pressure and the pump is stopped.

25

When the pump is stopped the shut-off piston
57 opens the equalising channel 60.

The hydrostatic pressure of the mud column
5 above the packer 54 acts on the one side of the equalising
piston 62 which normally shuts off deflating channel 69.

The other side of the equalising piston 62
is connected through channel 66 and ports 67, 68 with
the space between the flappervalue 22 and the float
10 valve assembly 7, below which the formation pore
pressure acts.

If now the hydrostatic pressure of the mud
column in the annulus above the packer 54 overbalances
sufficiently the formation pore pressure below the packer
15 then the equalising piston 62 moves and opens the
deflating channel 69. The pressure of abt. 1500 psi.
behind the packer element 54 is now released in the
annulus through channels 69 and 60 and the packer elements
deflates and the packer is free.

20 If the packer does not deflate then the recorded
C.I.D.P.P. was not correct and the mudweight should be
increased gradually and the pumps stopped at intervals.

When a well starts coming in during roundtripping
the same procedure should be followed as during drilling
25 but instead of pulling out continuously one should kill

the well, unseat the packer and run back to bottom decreasing the mudweight when going deeper and circulating at intervals.

Circulating takes then place through the
5 circulating ports instead of through the bit nozzles.

When the bottom of the hole is reached, condition the mud and pull-out to inspect all parts of the D.H.BOP.

An alternative use of the D.H.BOP is when
10 drilling on the sea bed with a surface BOP positioned on the sea bed and it is desired to suspend drilling operations e.g. when weather is bad.

The surface BOP is first closed and the mud pressure within the string is bled down. Mud under
15 pressure is then forced into the annulus whereby the pressure in the annulus exceeds the pressure setting of the arresting ball and helical spring in the tool by at least the amount necessary to operate the D.H.BOP to close the flapper valve. The packer element can
20 then be inflated as before and this will seal the bottom end of the casing and the drill string and the surface pipe from the sea bed to the drilling vessel can be removed.

Reconnecting the surface pipe and the drill
25 pipe and releasing the packer can be achieved by closing

the drill pipe at the surface and pressurising the annulus, below the closed BOP rams at the surface, to open the equalising valve, whereafter the rams are opened.

- 5 An advantage of the DHPOP described is that in addition to controlling a well in a novel manner, a well can be brought under control in the conventional manner. In this case on detecting a kick the surface BOP is closed and the closed in drill pipe pressure is
- 10 read. Instead of lowering the closed in pressure to close the flapper valve, the closed in pressure is maintained. The flapper valve does not close and the well can be brought under control in the normal way by the introduction of heavier mud.

CLAIMS:

1. A down-hole blow-out preventer comprising
an elongated tubular housing having a through bore for
the passage of drilling mud and means for connecting
5 the ends of the housing into a drilling string, a packer
element arranged circumferentially around the housing
and inflatable into engagement with the bore hole to
seal the hole, passage means extending through the
housing wall for connecting the bore of the housing with
10 the packer element to inflate the element by mud
pressure from within the housing, a cylindrical valve
sleeve mounted inside the housing for movement between
a drilling position when the sleeve closes said passage
means and an inflating position when the passage means
15 is open, a one-way valve for closing the housing bore on
the side of the sleeve to be nearer the drill bit, said
valve means being operable to allow the passage of mud
under pump pressure, but not allowing reverse flow of
mud, said valve sleeve providing a through bore for the
20 passage of mud, second valve means for closing the bore
in the valve sleeve and means to close said second valve
means automatically when pressure in the housing is
reduced to a level below the pressure in the bore hole
by a predetermined amount, the arrangement being such
25 that after closing of the second valve means the

pressure in the housing can be re-applied to urge the valve sleeve to its inflating position allowing the packer element to be inflated, means to prevent closure of the second valve means during running-in, 5 a mud circulation channel extending through the housing on the side of the sleeve valve nearer the surface, means being provided to open said channel when the packer element is inflated whereby mud may be circulated through the drill string, the channel 10 and the bore hole to increase the mud density, and means for deflating the packer element only when the mud density is sufficient to balance the pressure below the packer element.

15 2. A device as claimed in claim 1 wherein there is means to allow mud to flow through the housing during running in whereby to allow the drill string to be filled during running in.

20 3. A device as claimed in claim 1 or claim 2 in which the second valve means is biased towards its closed position and there is means to hold the said valve means open which means is releasable on detection of a predetermined pressure difference between the 25 bore hole and the bore of the housing.

4. A device as claimed in claim 3 in which the second valve means comprises a flapper valve member at the upper end of the valve sleeve and the releasable holding means comprises an upper flapper valve sleeve
5 within the housing which sleeve is slidable axially within the housing between a first position in which the flapper valve is held open and a second position in which the flapper valve is released for movement to its closed position.

10

5. A device as claimed in claim 4 in which the means to move the second sleeve to its second position comprises a piston and cylinder device which is open to the pressure in the bore hole.

15

6. A device as claimed in any of claims 1 to 5 in which means are provided to retain the valve sleeve in its inflating position and there is means operable when the sleeve is in its inflating position
20 to deflate the packer element when the density of the mud reaches a value sufficient to overcome the pressure at the bore hole below the first valve means.

7. A device as claimed in any of claims 1 to
25 6 in which there is means to prevent deflation of the

packer element when the mud is being circulated.

8. A device as claimed in any of claims 1 to 7 in which the first valve means comprises a valve body which is slidably axially in the housing between end stops and in sealing engagement with the housing whereby the pressure below the first valve means may be measured at the well head.

9. A device as claimed in any of the preceding claims wherein an axially extending passageway in the housing is provided by making the housing of two concentric sleeves, machining the passageway in one of the sleeves on the surface of the sleeve to be adjacent the other sleeve and then joining the two sleeves together by a shrinking or expanding process.

10. A method of drilling using a drill hole blow out preventer as claimed in any of the preceding claims in conjunction with a surface blow out preventer wherein on a kick being detected, the surface blow out preventer is closed to close the bore hole at the surface, the pressure of the kick is measured at the surface, the drill string is depressurised so that the pressure in the bore hole is greater than that on the

drill string which closes the second valve, pressure is then applied within the drill string to move the valve sleeve to its inflating position whereby the pressure within the drill string inflates the packer element, a valve with an orifice by passing the
5 surface blow out preventer is opened and mud of an increased density is circulated through the drill string and the bore hole via the circulation channel, and the packer element is deflated when the pressure
10 generated by the mud is sufficient to overbalance the pressure generated by the kick.

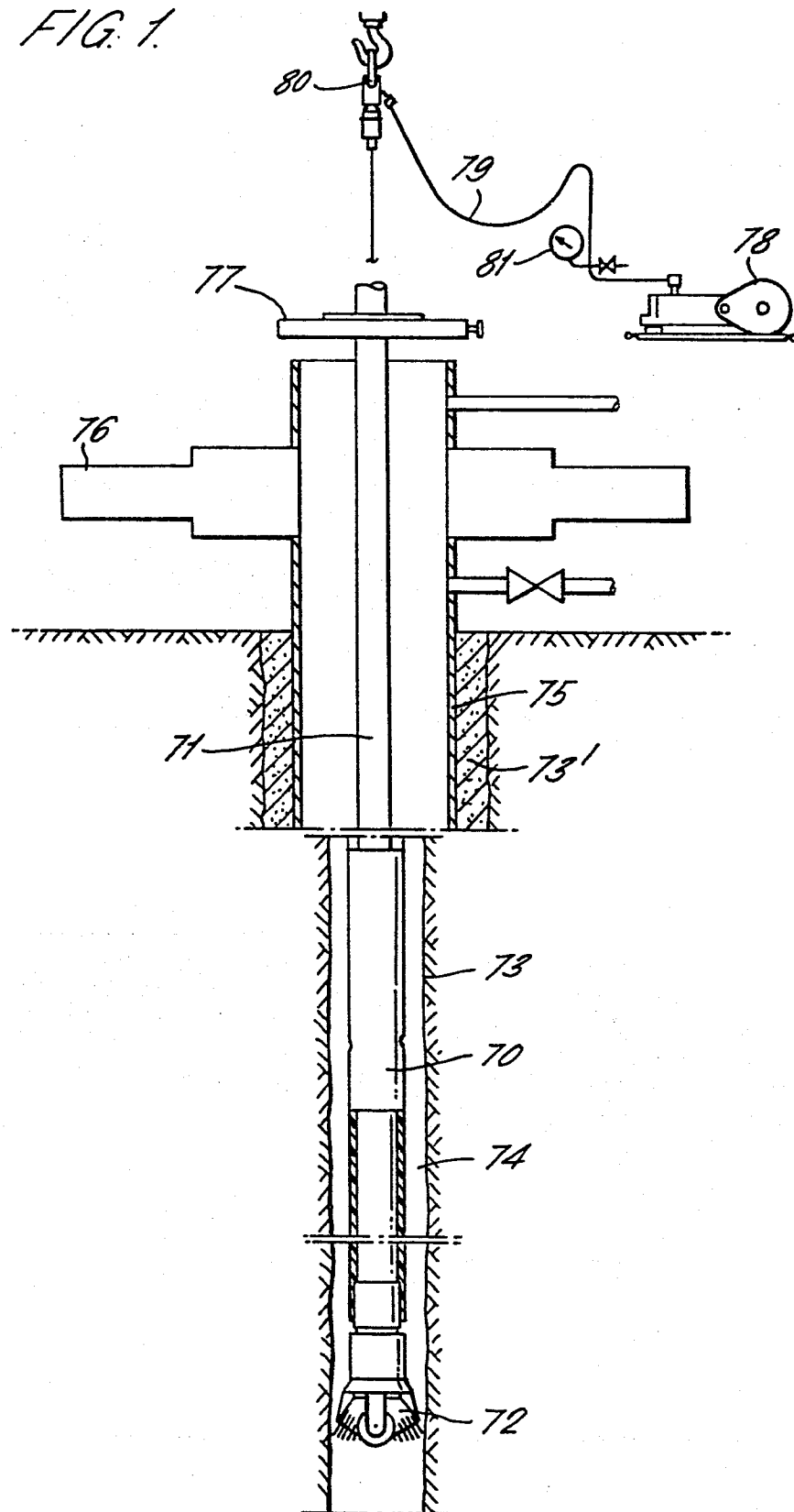
11. A method of using a drill hole blow out preventer as claimed in any of claims 1 to 9 to close
15 off a bore hole in conjunction with a surface blow out preventer wherein the surface blow out preventer is closed, mud is pumped into the bore hole at a pressure sufficient to close the second valve means, and mud is then circulated to the inside of the blow out
20 preventer to inflate the packer element to close off the bore hole.

12. A method of drilling using a drill hole blow out preventer as claimed in any of the preceding
25 claims in conjunction with a surface blow out preventer

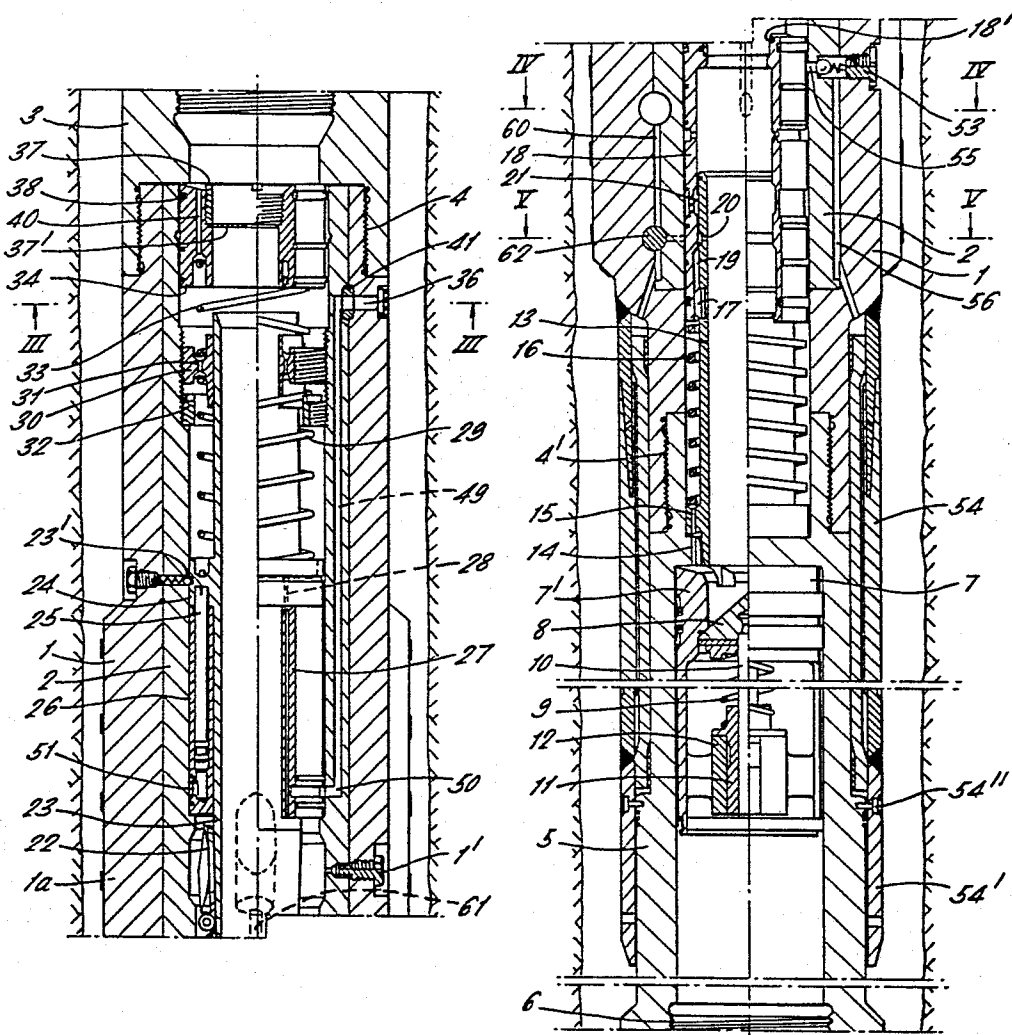
wherein on a kick being detected, the surface blow out preventer is closed to close the bore hole at the surface, the pressure of the kick is measured at the surface, and the well is brought under control in the

5 conventional manner.

FIG. 1.



2110



110

FIG. 3.

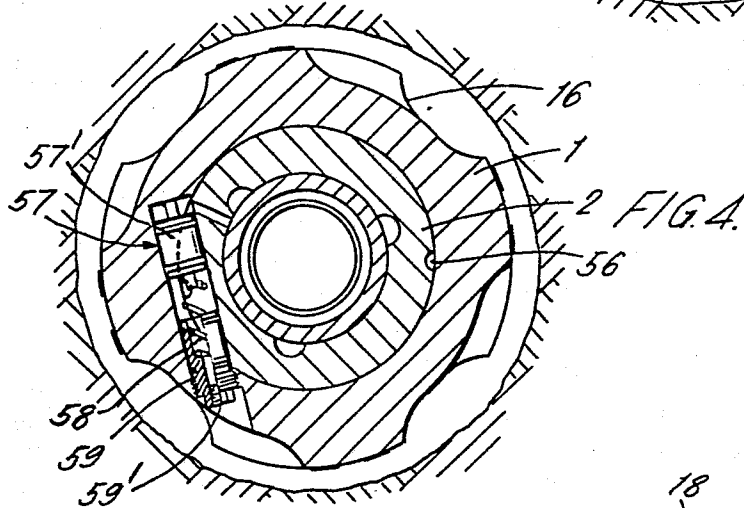
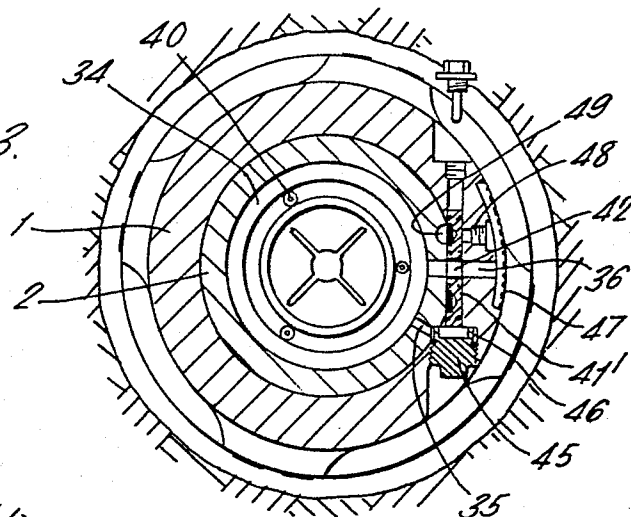
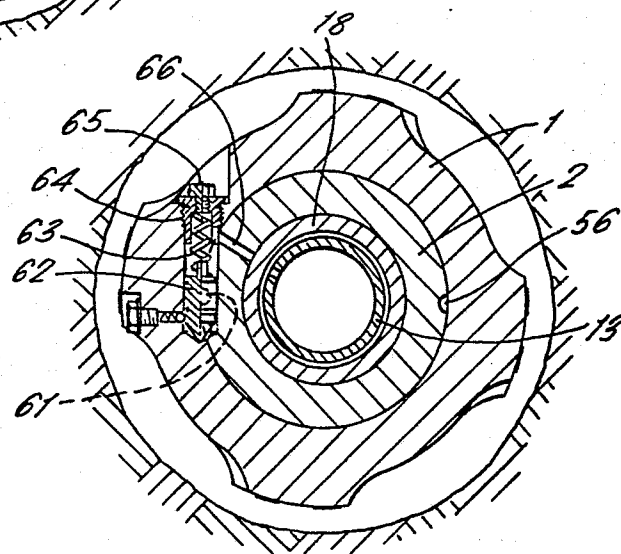


FIG. 5.



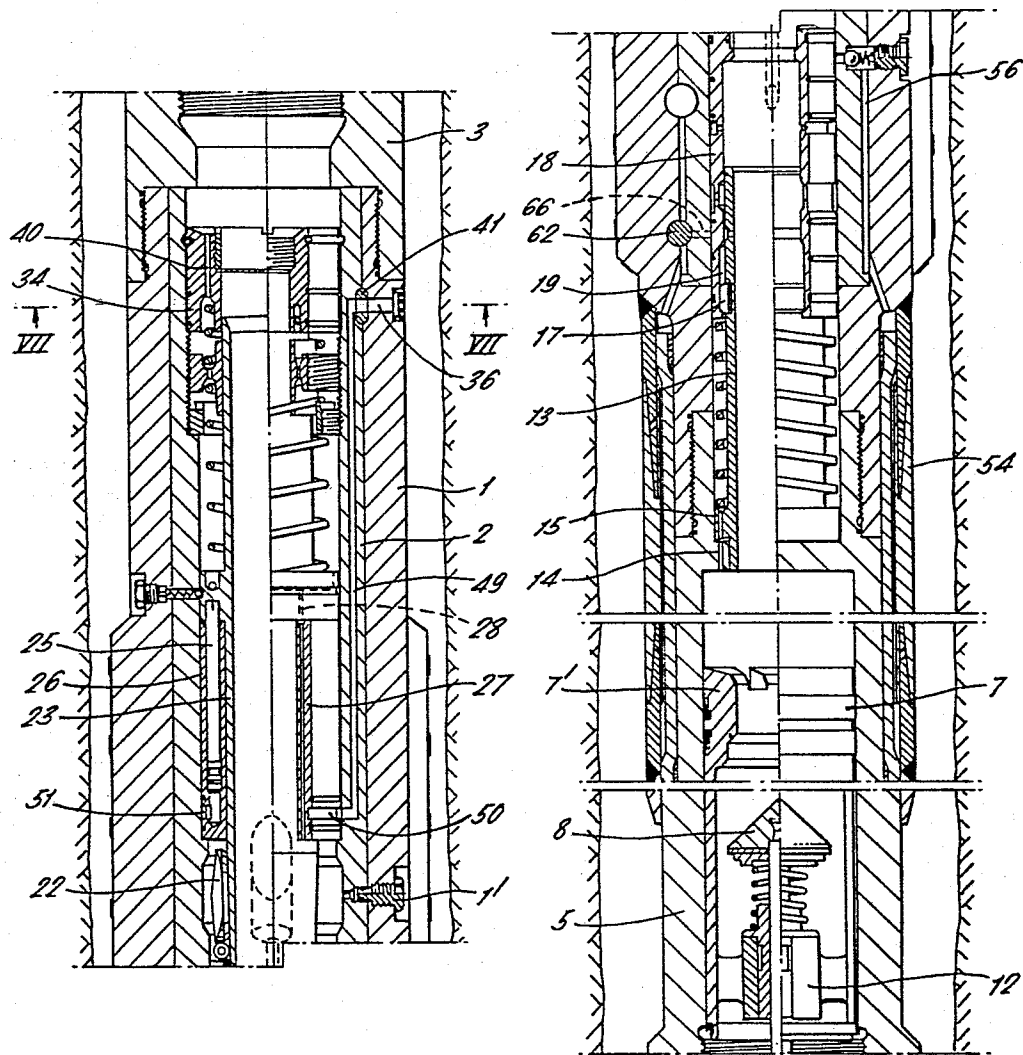


FIG. 6.

FIG. 7.

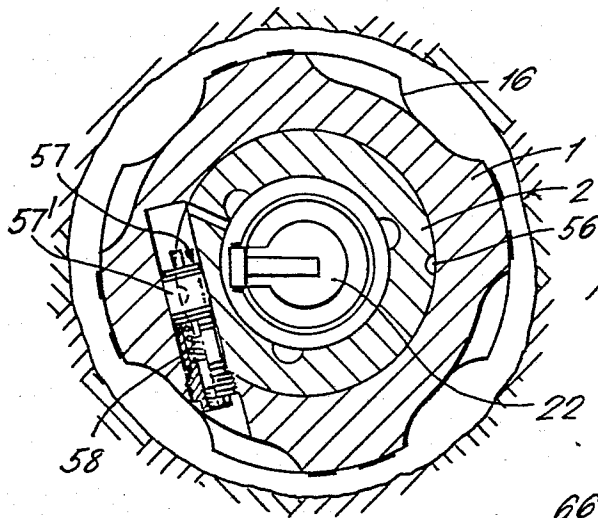
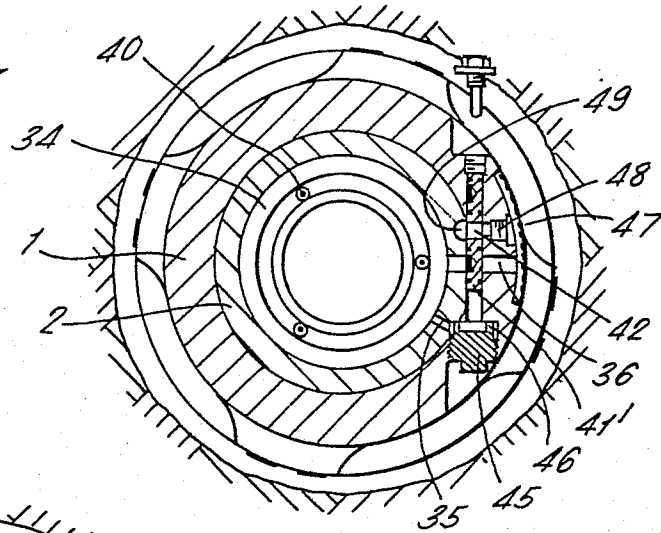
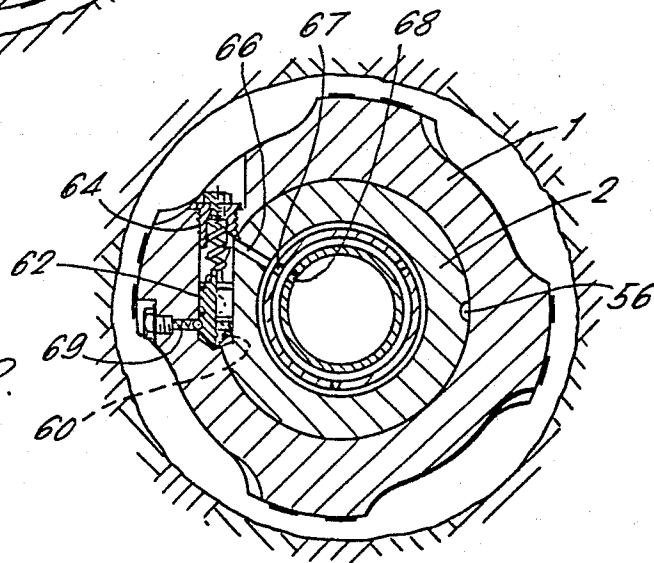


FIG. 11.

FIG. 12.



6/10

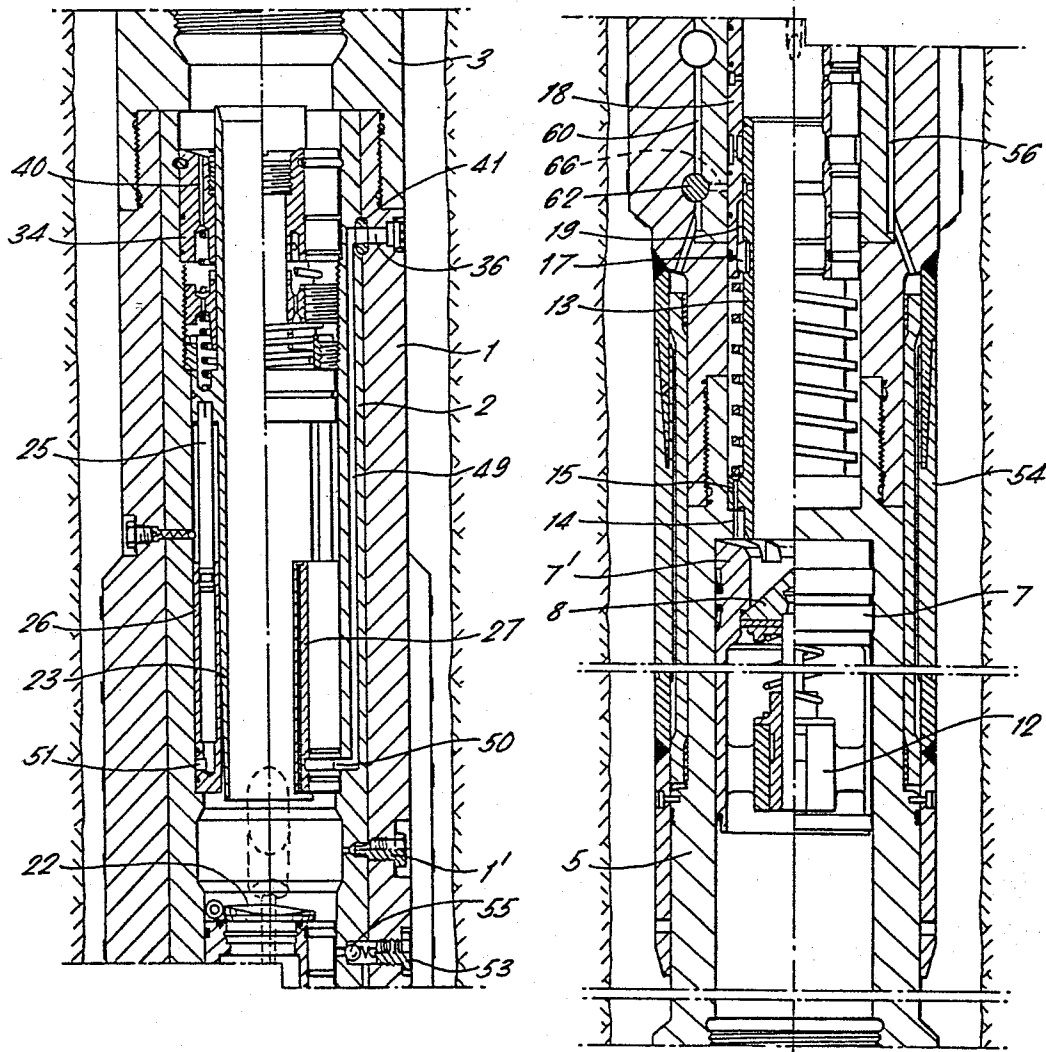


FIG. 8.

7/10

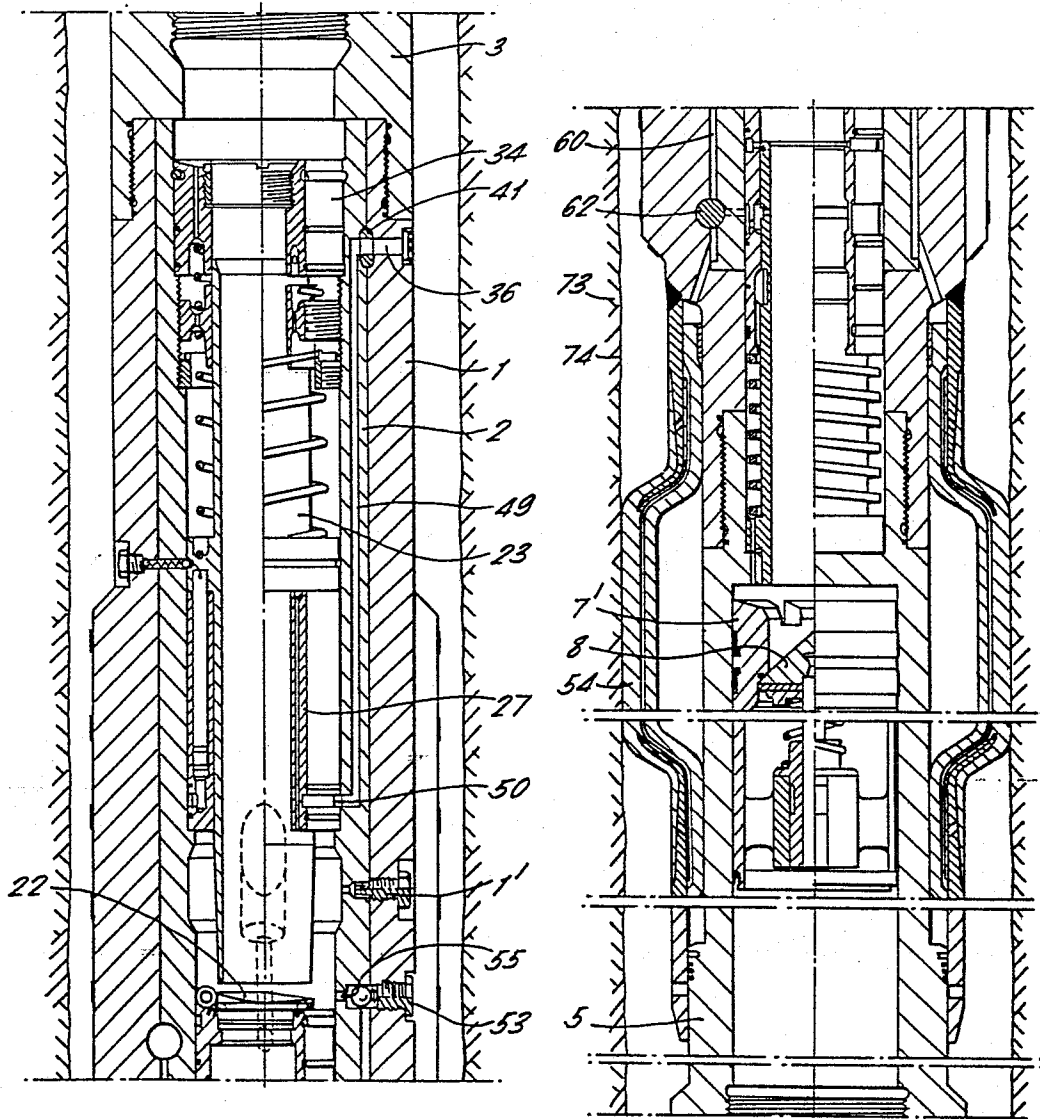


FIG. 9.

3/10

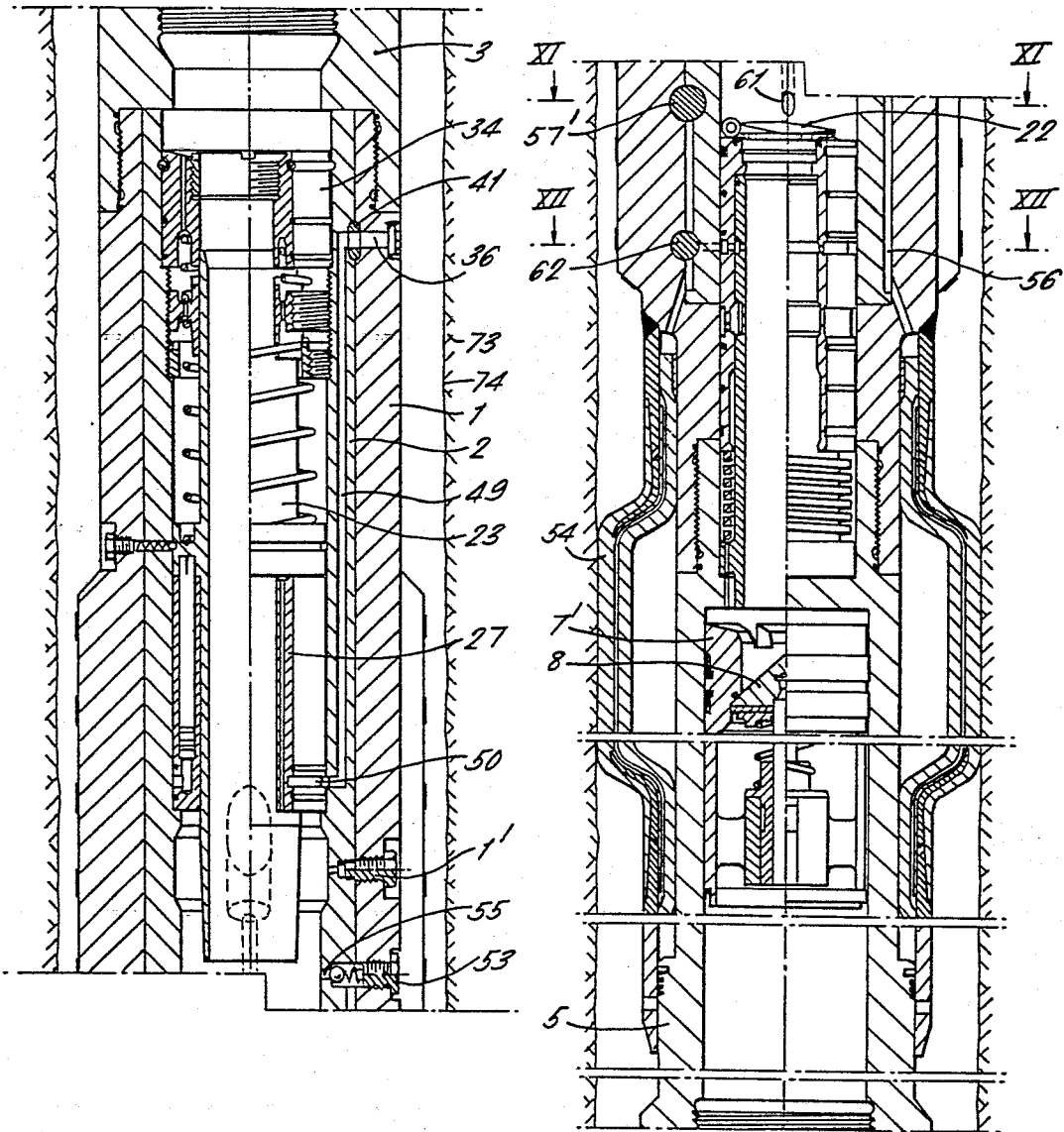


FIG. 10.

3/10

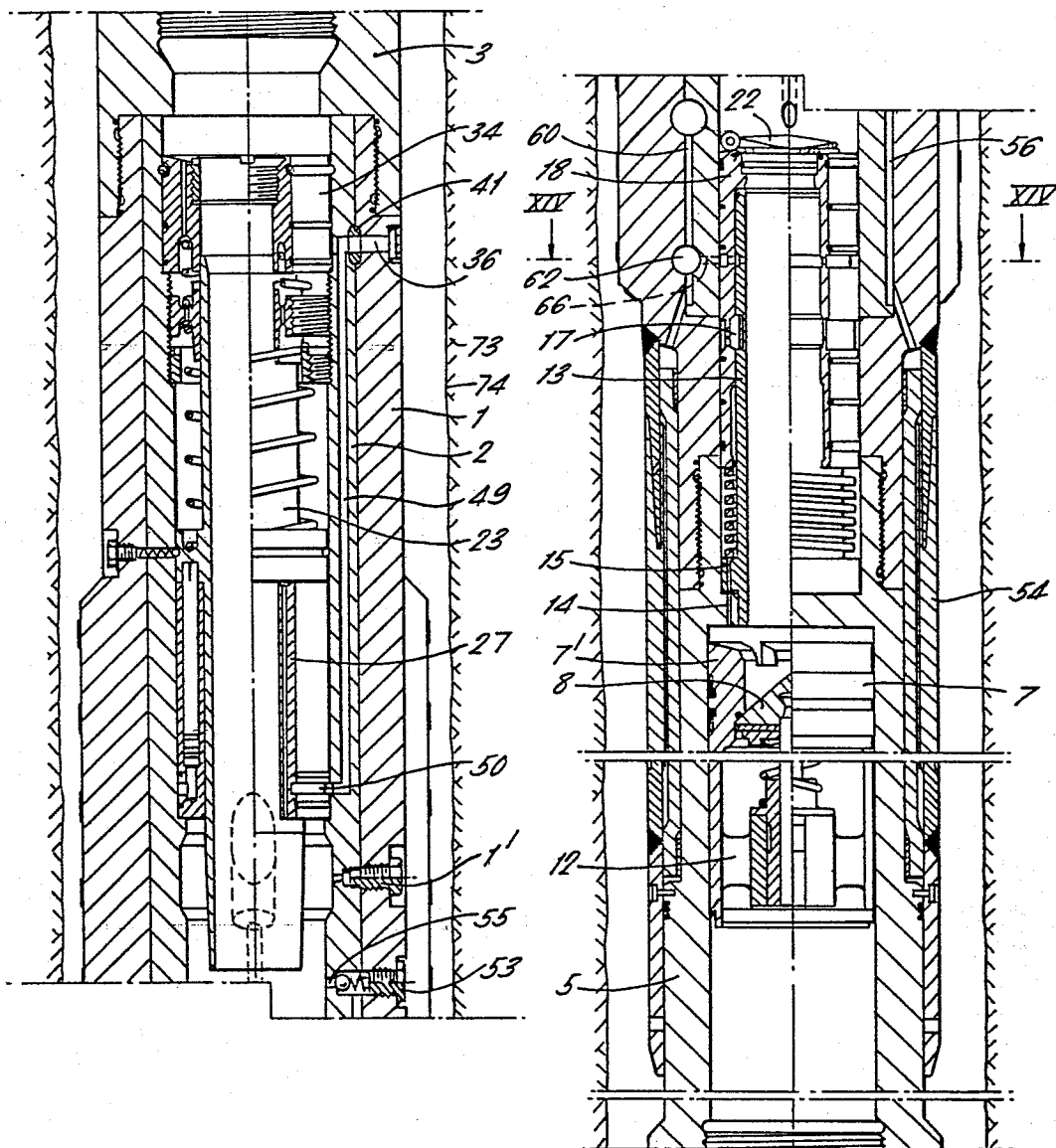
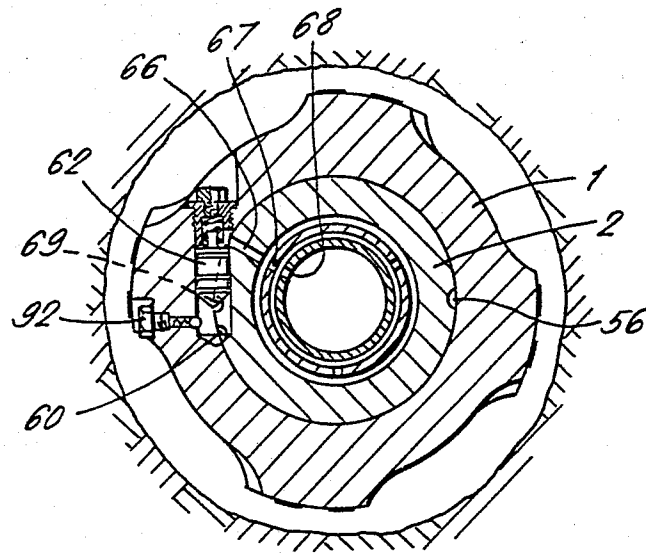


FIG. 13.

10/10

FIG. 14.





European Patent
Office

EUROPEAN SEARCH REPORT

0116443

Application number

EP 84 30 0664

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
A,D	US-A-3 908 769 (SCHUYF) * Column 6, line 21 - column 7, line 8 *	1	E 21 B 21/10 E 21 B 33/127
A,D	--- US-A-3 503 445 (COCHRUM) * Column 4, line 61 - column 5, line 22 *	1	
A,D	--- US-A-3 941 190 (CONOVER) * Claim 1; column 9, lines 39-51 *	1	
A	--- US-A-4 294 314 (MIYAGISHIMA) * Abstract *	1	
A	--- US-A-3 419 040 (THIBODEAUX) * Column 3, lines 4-60 *	1	TECHNICAL FIELDS SEARCHED (Int. Cl. 3)
A	--- US-A-2 858 838 (SCARAMUCCI) * Column 2, lines 28-70 *	1	E 21 B

The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 25-04-1984	Examiner SOGNO M.G.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	