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Borsheim

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(54) **METHOD AND DEVICE FOR SUPPLY OF LIQUIDS FOR KILL AND SCALE TO A SUBSEA WELL**

(75) Inventor: **Torfinn Borsheim**, Sandnes (NO)

(73) Assignee: **Subsea Solutions AS**, Sandnes (NO)

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(58) **Field of Classification Search**
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USPC 166/75.13, 351, 344, 368
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,552,419 A * 1/1971 Weston, Jr. 137/236.1
3,894,560 A * 7/1975 Baugh 137/606
(Continued)

FOREIGN PATENT DOCUMENTS

WO 2005/047646 A1 5/2005

OTHER PUBLICATIONS

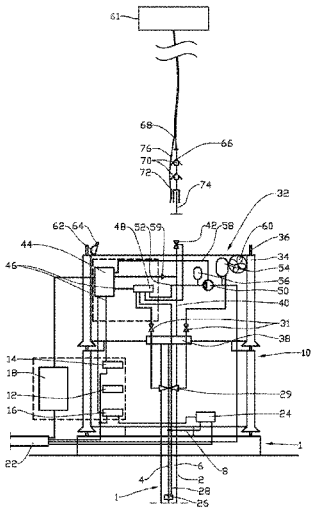
International Search Report for parent application PCT/NO2012/050093, having a mailing date of Jul. 13, 2012.
(Continued)

Primary Examiner — James G Sayre
(74) *Attorney, Agent, or Firm* — Andrus Intellectual Property Law, LLP

(57) **ABSTRACT**

A method and apparatus are for supplying liquids for scale treatment and killing to a subsea well, where the subsea well is provided with a tree which has a swab valve and a coupling for a tree cap. The method comprises: arranging an upgrading module on the tree after the tree cap has been removed, the upgrading module comprises an electric control unit and a tree cap which via an intermediate conduit is coupled to a top valve at the upper portion of the upgrading module, coupling a coupling column comprising at least two column valves and a quick-releasable coupling to the top valve, the coupling column communicates with a vessel via a hose connection; coupling the control unit to the vessel via a signal wire running within or close to the hose connection, thereafter the tree and the upgrading module is controlled via the signal wire; opening the swab valve, the top valve and column valves; and pumping liquid from the vessel via the hose connection, coupling column and upgrading module down into the subsea well.

11 Claims, 4 Drawing Sheets



(51) **Int. Cl.**

E21B 34/04	(2006.01)
E21B 41/04	(2006.01)
E21B 41/08	(2006.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,046,192	A *	9/1977	Darnborough et al.	166/337
4,174,000	A	11/1979	Milberger	
5,010,956	A *	4/1991	Bednar	166/344
2003/0136927	A1	7/2003	Baugh	
2009/0293957	A1 *	12/2009	White	137/1
2011/0300008	A1 *	12/2011	Fielder et al.	417/410.3

OTHER PUBLICATIONS

Written Opinion for parent application PCT/NO2012/050093, having a mailing date of Jul. 13, 2012.

* cited by examiner

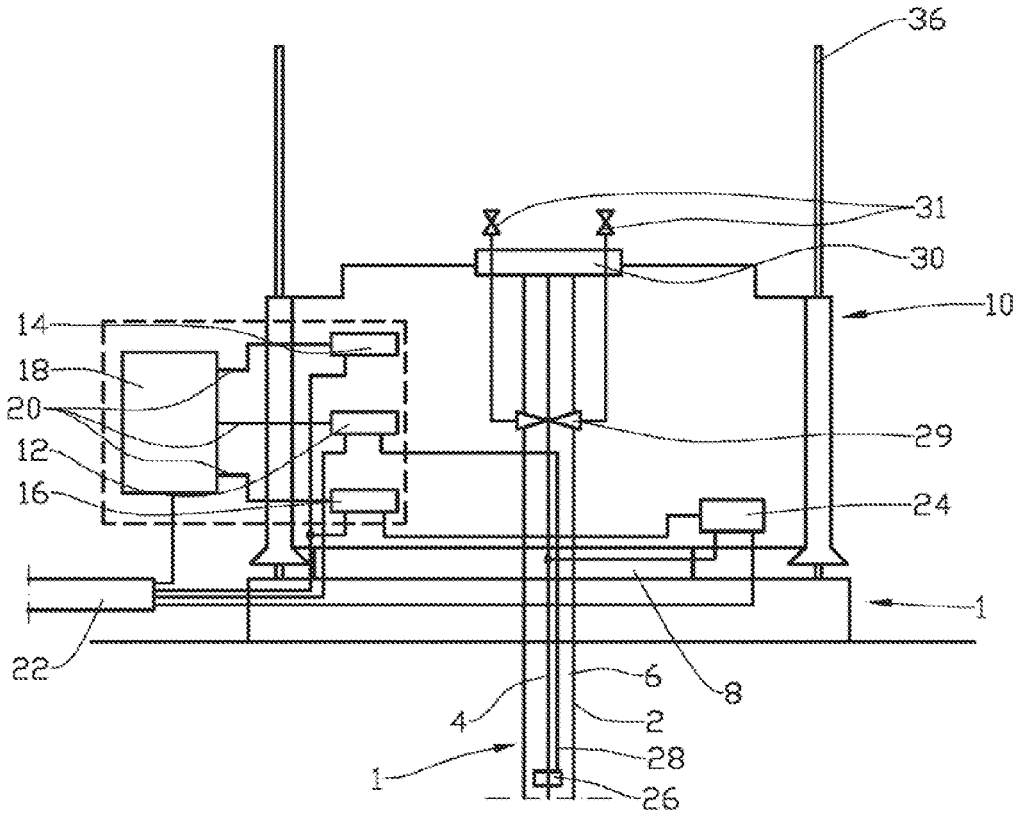


Fig. 1

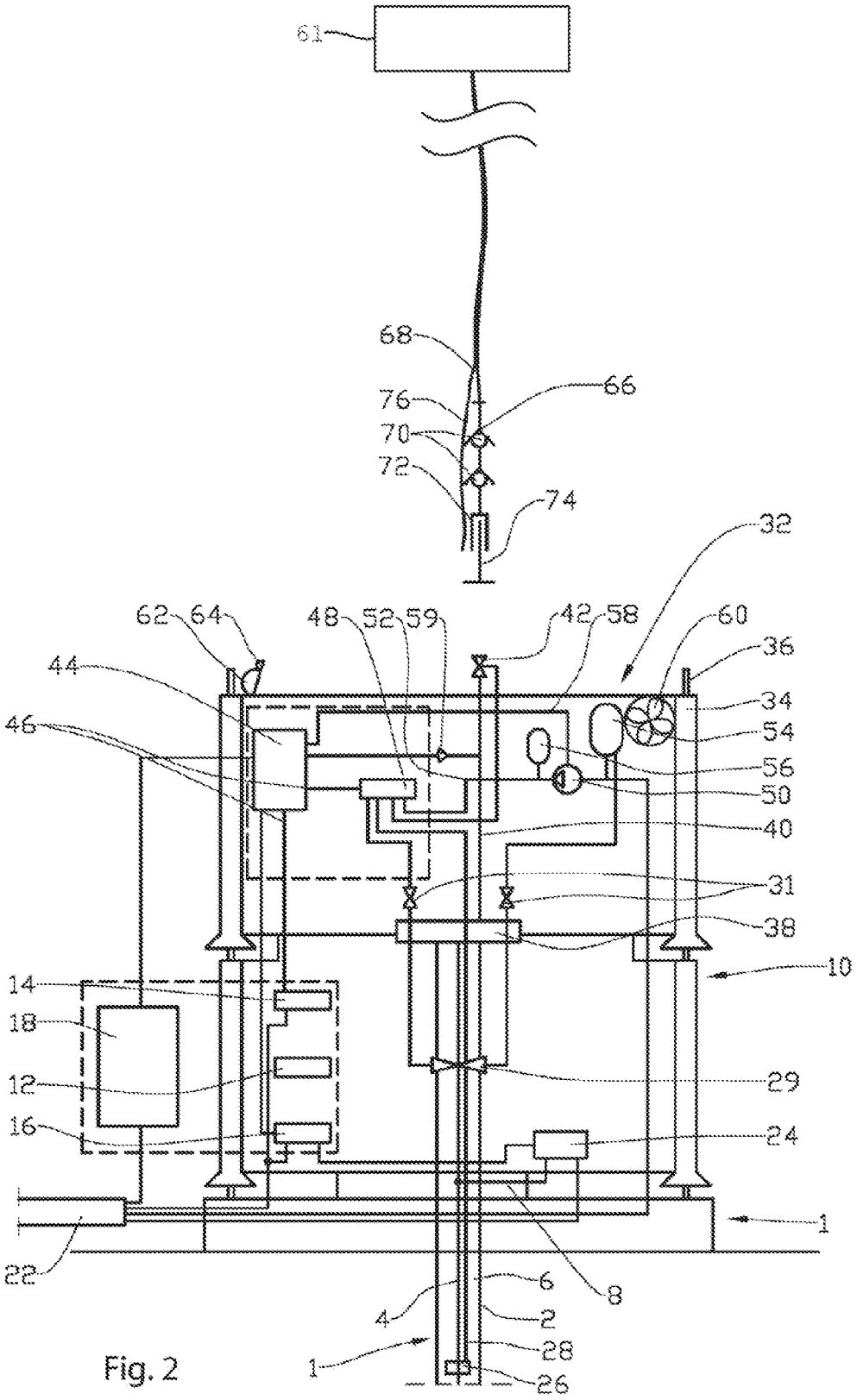

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Fig. 2

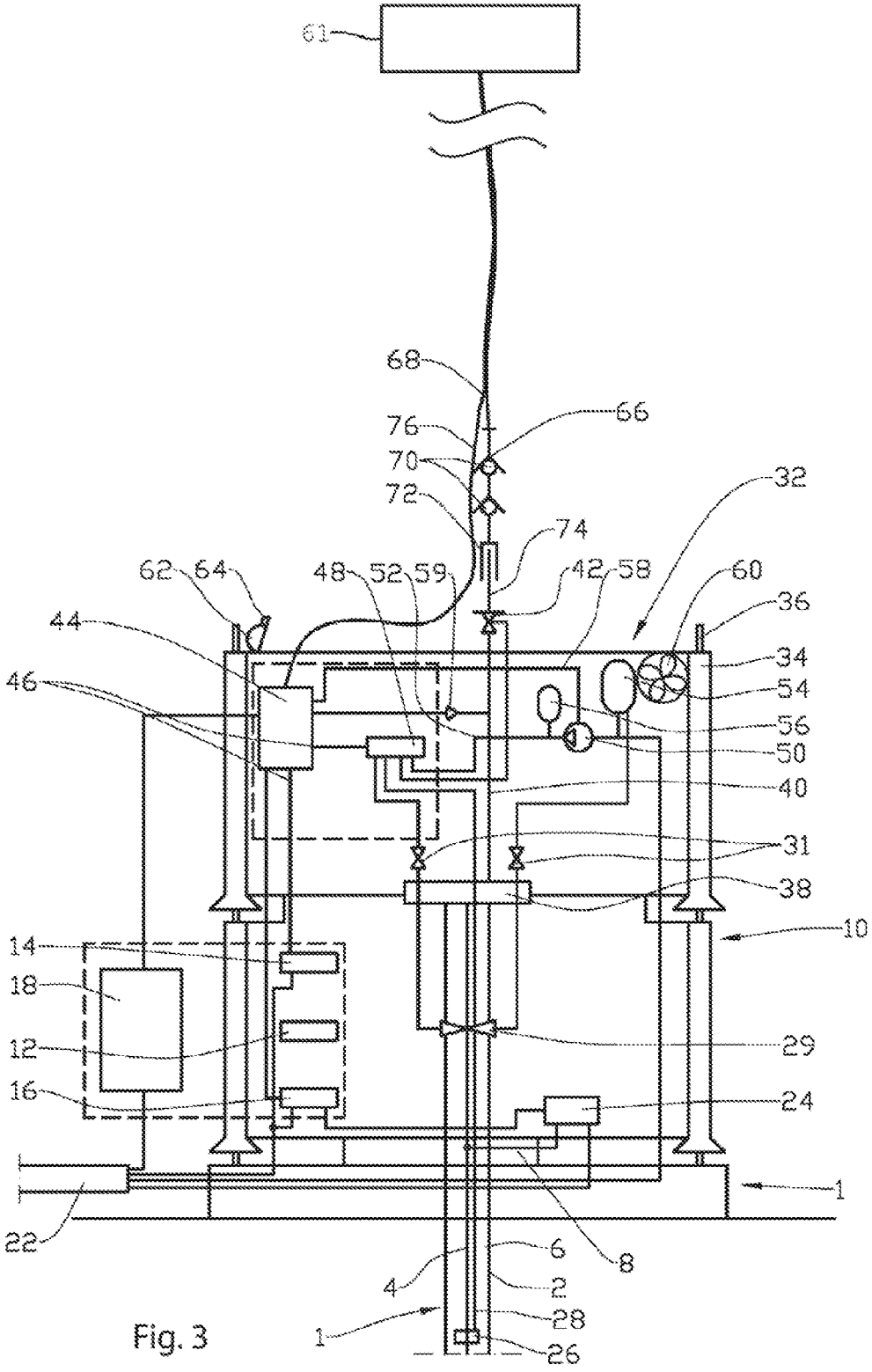
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Fig. 3

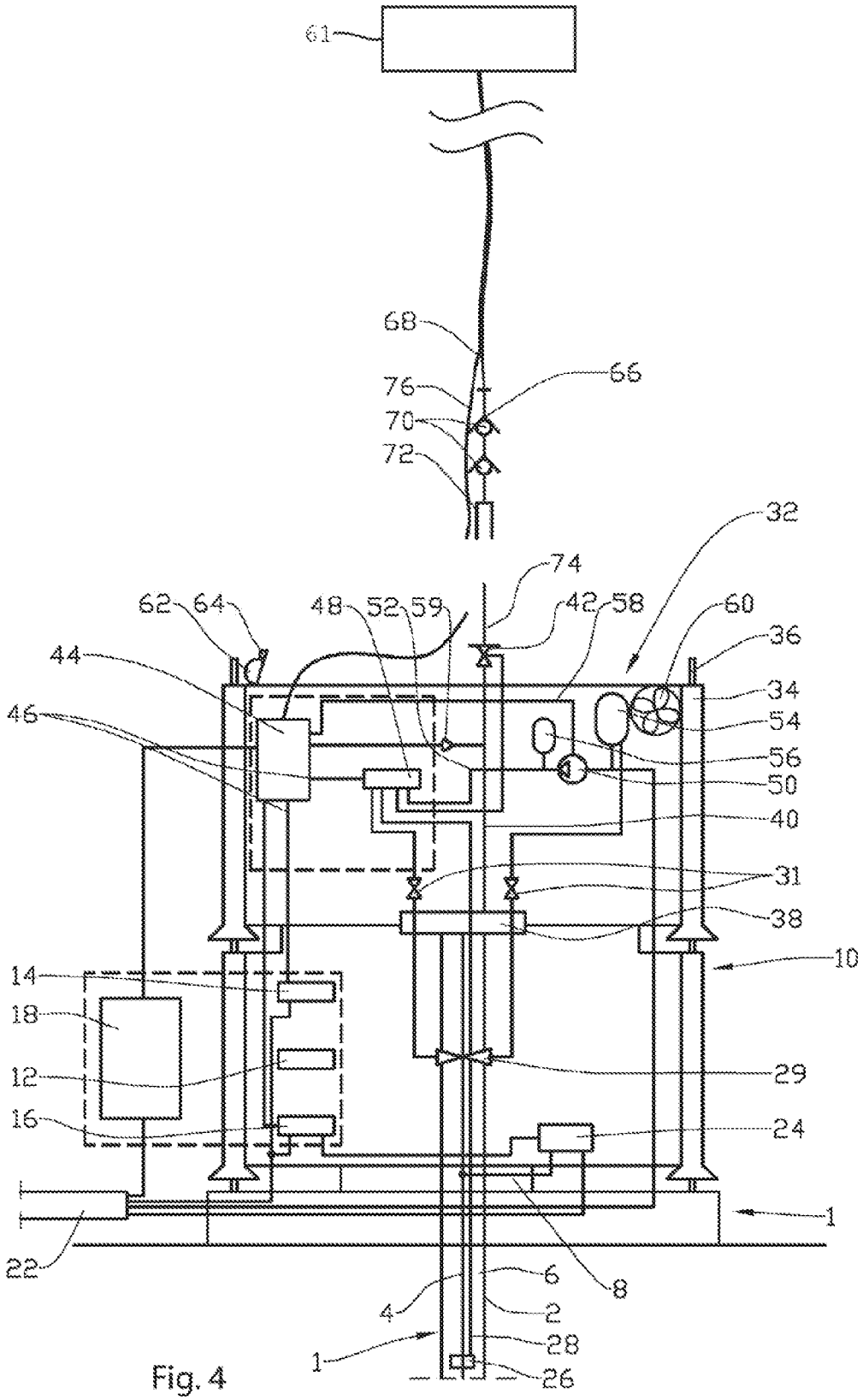
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Fig. 4

METHOD AND DEVICE FOR SUPPLY OF LIQUIDS FOR KILL AND SCALE TO A SUBSEA WELL

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is the U.S. national stage application of International Application No. PCT/NO2012/050093, filed May 21, 2012, which International application was published on Nov. 29, 2012 as International Publication No. WO 2012/161585 A1 in the English language and which application is incorporated herein by reference. The International application claims priority of Norwegian Patent Application No. 20110765, filed May 24, 2011, which application is incorporated herein by reference.

BACKGROUND

The invention relates to a method for supply of liquid for scale treatment and killing to a subsea well. More particularly it relates to a method for supply of liquids for scale treatment and killing to a subsea well, where the subsea well is provided with a tree which has a swab valve and a coupling for a tree cap. The invention also relates to a device for practicing the method.

During petroleum recovery it has proven necessary to supply liquid to wells in order to treat them, i.e. to prevent the formation of or remove scale. It has also proven necessary to be able to supply heavy liquid to the well for so-called killing.

According to prior art such work is carried out on subsea wells by removing a tree cap from a tree mounted on the subsea well by means of a suitable tool. Then a so-called "kill and scale" tool which has a hose connection to a vessel, is lowered and coupled to the tree, whereupon pumping of liquid into the subsea well may take place.

This prior art has several drawbacks. A considerable drawback is that the tree cap must be removed, which reduces the number of barriers between the well flow and the surroundings.

If a leakage in the valves of a subsea well such as a downhole safety valve is detected, it may be that the only barrier is the swab valve of the tree and the tree cap. Then, due to safety reasons, the tree cap cannot be removed.

The only possibility then is to supply heavy liquid via the production tubing, which implies that neighboring wells must also be shut down.

US-document 2003/0136927 describes a coupling for scale treatment and killing where the coupling is provided with a pressure balanced slide valve in order to avoid potentially large forces which may occur in such couplings.

SUMMARY

The invention has for its object to remedy or reduce at least one of the drawbacks of the prior art.

According to the invention the object is achieved through features which are specified in the description below and in the claims that follow.

There is provided a method for supply of liquids for scale treatment and killing to a subsea well where the subsea well is provided with a tree which has a swab valve and a coupling for a tree cap, and where the method comprises:

- arranging an upgrading module on the tree after removal of the tree cap, the upgrading module comprises an electric control unit and a tree cap which via an intermediate conduit is coupled to a top valve at the upper portion of the upgrading module;
- coupling a coupling column comprising at least two column valves and a quick-releasable coupling to the valve, as the coupling column communicates with a vessel via a hose connection;
- coupling the control unit to the vessel via a signal wire running within or close to the hose connection, as thereafter the well head and the upgrading module is controlled via the signal wire;
- opening the swab valve, the top valve and the column valve; and
- pumping liquid from the vessel via the hose, coupling column and upgrading module down into the subsea well.

The upgrading module may be arranged on the tree at an earlier time. It is typically used to overcome weaknesses in existing equipment, and may also comprise high pressure hydraulic pumps and valves, low pressure hydraulic pumps and valves and other useful equipment such as chemical pumps and valves.

Together with the swab valve the top valve constitutes two barriers. The coupling column may be coupled to the top valve without first having to remove a tree cap. The integrity of the subsea valve is therefore maintained during coupling of the coupling column even if the other valves of the subsea valve have failed or leak.

The method may at drift of the vessel from the subsea well comprise:

- ending the pumping down of liquid;
- closing the swab valve, the top valve and the column valves;
- uncoupling the signal wire from the control unit; and
- uncoupling the coupling column from the upgrading module in the quick-releasable coupling.

The coupling column may thereby in a fast way temporarily be uncoupled from the upgrading module.

At completed operation the method typically comprises:

- ending the pumping down of liquid;
- closing the swab valve, top valve and the column valves;
- uncoupling the signal wire from the control unit; and
- uncoupling the coupling columns from the upgrading module at the top valve.

The top valve is well suited for mounting of a combined lid and lifting lug when it is closed.

The method may be practiced by means of an apparatus for supply of liquids for scale treatment and killing to a subsea well where the well is provided with a valve tree which has a swab valve and a coupling for a tree cap, and where the apparatus is characterized in that an upgrading module is arranged on the tree, the upgrading module comprises an electric control unit and a tree cap which via an intermediate conduit is coupled to a top valve at the upper portion of the upgrading module, and where a coupling column comprising at least two column valves and a quick-releasable coupling can be coupled to the top valve, and where the coupling column is communicatively coupled to a vessel via a hose connection, and where the control unit can be coupled to the vessel via a signal wire running within or close to the hose connection, after coupling the well head and the upgrading module can be controlled via the signal wire.

The quick-releasable coupling may comprise a releasable portion which can be coupled to the top valve, the releasable coupling is arranged to be able to release at unforeseen events.

The high-pressure pump and corresponding components may be replaced by a pressure riser which e.g. is supplied with fluid from a low-pressure system.

At least one of the column valves may be a check valve, a hydraulically controlled valve or an ROV-operable valve (ROV: remotely operated vehicle).

Moreover this applies to valves in general. Some operators prefer ROV-operable valves, while others prefer actuator-operated valves, where e.g. hydraulics is used.

Thus the method and the apparatus according to the invention solves some relatively serious weaknesses of subsea wells operated according to prior art.

BRIEF DESCRIPTION OF THE DRAWINGS

In what follows an example of a preferred method and embodiment is described, which is visualized in the accompanying drawings, where:

FIG. **1** schematically illustrates a subsea well with tree according to prior art;

FIG. **2** schematically illustrates an upgrading module according to the invention, where the upgrading module is located on the tree and where a coupling column is ready to be mounted to the upgrading module;

FIG. **3** schematically illustrates the upgrading module in FIG. **2** when the coupling column is coupled to the upgrading module; and

FIG. **4** schematically illustrates a coupling column temporarily uncoupled from the upgrading module.

DETAILED DESCRIPTION OF THE DRAWINGS

In the drawings reference numeral **1** designates a subsea well with an outer tubular **2** e.g. formed by a casing, and a production tubing **4**, where an annulus **6** is formed between the outer tubular **2** and the production tubing **4**.

The production tubing **4** is suspended from a production tubing head **8**, and a tree **10** is arranged on the production tubing head **8**.

The tree **10** is provided with a high-pressure hydraulic valve package **12**, a low-pressure hydraulic valve package **14** and a chemical valve package **16**.

The various valve packages **12**, **14**, **16** are controlled from a control module **18** located on or at the tree **10** via control lines **20**. The valve packages **12**, **14**, **16** and the control module **18** are often formed by a mounting which in the figures is indicated by means of a dashed rectangle.

The valve packages **12**, **14**, **16** are supplied liquid in a per se known way via an umbilical **22** running to a not-illustrated installation on the surface, and which also supplies the control module **18** with electric power and control signals, and a chemical valve **24** with chemicals.

The high-pressure hydraulic valve package **12** is coupled to a downhole safety valve **26** by means of a safety valve conduit **28**. The low-pressure hydraulic valve package **14** is coupled to other not-illustrated valves and actuators of the tree **10**.

A swab valve **29** is in a per se known way controlled via ROV-operated valves **31**.

The tree **10** is provided with a tree cap **30** and additionally comprises a large number of not-illustrated components known to a man skilled in the art.

Reference is now made to FIG. **2**. An upgrading module **32** is arranged on the tree **10** by means of guides **34** which fit on guide posts **36** of the well **1**. The upgrading module **32** is provided with an embedded tree cap **38** which complementary fits on the tree **10** and which has the same functions as the tree cap **30**, but which in addition is provided with an intermediate conduit **40** with a top valve **42** for liquids which are used to remove scale and for killing. The top valve **42** may be ROV-controlled, but is in FIG. **2** illustrated as a hydraulically actuated valve.

The upgrading module **32** is provided with a control unit **44**, the control unit **44** is directly or via the control module **18** coupled to the not-illustrated installation on the surface via the umbilical **22**. The control unit **44** controls the various valve packages **12**, **14**, **16** via control lines **46**.

The upgrading module **32** is in this illustrated embodiment provided with a second high-pressure hydraulic valve package **48** controlled from the control unit **44** via the control line **46**. The high-pressure hydraulic valve package **12** is uncoupled.

A high-pressure pump **50** is located in the upgrading module **32** and is provided with hydraulic liquid with reduced pressure via the umbilical **22**. The high-pressure pump **50** is coupled to the second high-pressure hydraulic valve package **48** by means of a high-pressure conduit **52**. A reservoir **54** is coupled to the inlet-side of the high-pressure pump **50**, while an accumulator **56** is coupled to the outlet-side of the high-pressure pump **50**. The high-pressure pump **50** is controlled from the control unit **44** via a control wire **58**.

The swab valve **29** is hydraulically controlled via the ROV-operated valves **31**. FIG. **4** illustrates that it is controlled from the high-pressure hydraulic valve package **48**, but depending on valve type it might as well be controlled by a low-pressure hydraulic valve package. The swab valve is drained to the reservoir **54** via the ROV-valve **31**. A pressure sensor **59** is coupled to the intermediate conduit **40** and sends measuring signals to the control unit **44**. The pressure sensor **59** is particularly useful to see if underlying valves, e.g. the swab valve **29**, leaks.

Per se necessary valves which are not required to explain the invention is not illustrated, since a man skilled in the art will know their purpose and function.

The upgrading module **32** comprises in this preferred embodiment also a thruster **60**, a light **62** and a camera **64**.

A tubular coupling column **66** is connected to a vessel **61** by means of a hose connection **68**. The coupling column **66** is due to safety reasons provided with two column valves **70**, here formed by check valves which allow flow directed from the vessel to the subsea well **1**.

At a level, in operation, below the column valves **70** the coupling column is provided with a quick-releasable coupling **72**. The quick-releasable coupling **72**, of a per se known design, comprises a lower releasable portion **74** which complementary fits to the top valve **42**.

A signal wire **76** which can be coupled to the control unit **44** runs from the not-illustrated vessel within or close to the hose connection **68** and to the coupling column **66**.

When the upgrading module **32** shall be installed, the original tree cap **30** is removed by means of suitable not-illustrated tooling. The upgrading module **32** is hoisted down to the tree **10**, whereupon the upgrading module **32** remotely controlled by means of the thruster **60**, the light source **62** and the camera **64**, is positioned in such a way that the guides **34** correspond with the guide posts **36**. Alternatively a mini-submarine can be used for the positioning operation.

After the upgrading module **32** has been put down on the tree **10**, the tree cap **38** is coupled to the tree **10**. In this illustrated embodiment including a high-pressure pump **50**, the supply to the high-pressure pump **50** is coupled to the high-pressure conduit of the umbilical **22**, and the outlet from the high-pressure pump **50** is coupled to the other high-pressure hydraulic valve package **48**. The electric power and control cables of the umbilical **22** is coupled to the control

unit **44**, and control lines **46** between the control unit **44** and valves in the hydraulic valve packages **14**, **16**, **48** not already connected, are connected.

The control unit **44** has thus during operation taken over at least the control functions of the control module **18**, while the high-pressure conduit of the umbilical **22** may work at a considerably reduced pressure.

When there is a need for treatment of scale or to kill the well **1**, the coupling column **66** is lowered down towards the upgrading module **32**, see FIG. **2**. Then the releasable portion **74** is coupled to a top valve **42** and the signal wire **76** is coupled to the control unit **44**, which then changes operational mode from production mode where the control unit **44** is controlled via the umbilical **22** from the not-illustrated installation on the surface, to so-called "kill and scale" mode where the control unit **44** is controlled from the not-illustrated vessel.

The tree **10** and the upgrading module **32** are now controlled from the not-illustrated vessel, and liquid may be pumped from the not-illustrated vessel and down into the subsea well **1** after the swab valve **29**, the top valve **42** and the column valves **70** have been opened.

If the not-illustrated vessel should drift from the subsea well **1** and the signal wire **76** is torn or uncoupled from the control unit **44**, closing of the downhole safety valve **26**, the swab valve **29**, the top valve **42** and the column valves **70** is commenced. The quick-releasable coupling **72** is released, see FIG. **4**.

When the conditions are normalized, the coupling column **66** is recoupled to the releasable portion **74**, the signal wire **76** is recoupled to the control unit **44**, and the work is resumed.

When the work is carried out, the coupling column **66** is uncoupled from the upgrading module **32** in reverse order of the first coupling. The control unit **44** then again assumes production mode.

The invention claimed is:

1. A method for supply of liquids for scale treatment and killing to a subsea well, the subsea well is provided with a tree which has a swab valve and a coupling for a tree cap, the method comprising:

arranging an upgrading module on the tree, wherein the upgrading module comprises a tree cap which via an intermediate conduit is coupled to a top valve at an upper portion of the upgrading module,

coupling a coupling column comprising at least two column valves and a quick-releasable coupling to the top valve, wherein the coupling column communicates with a vessel via a hose connection;

controlling at least the upgrading module or the tree from the vessel;

opening the swab valve, the top valve and the column valves; and

pumping liquid from the vessel via the hose connection, coupling column and upgrading module down into the subsea well.

2. The method in accordance with claim **1**, further comprising arranging an upgrading module on the tree after an existing tree cap has been removed.

3. The method in accordance with claim **1**, further comprising providing the upgrading module with an electric control unit, and coupling the control unit to the vessel via a signal wire running within or close to the hose connection, wherein at least the tree or the upgrading module is thereafter controlled via the signal wire.

4. The method in accordance with claim **3**, wherein the method at drift of the vessel from the subsea well further comprises:

ending the pumping down of liquid;

closing the swab valve, the top valve and column valves;

uncoupling the signal wire from the control unit; and

uncoupling the coupling column from the upgrading module in the quick-releasable coupling.

5. The method in accordance with claim **3**, further comprising:

ending the pumping down of liquid;

closing the swab valve, the top valve and column valves;

uncoupling the signal wire from the control unit; and

uncoupling the coupling column from the upgrading module at the top valve.

6. An apparatus for supply of liquids for scale treatment and killing to a subsea well, wherein the subsea well is provided with a tree which has a swab valve and a coupling for a tree cap, comprising an upgrading module arranged on the tree, the upgrading module comprising a tree cap which via an intermediate conduit is coupled to a top valve at an upper portion of the upgrading module, and where a coupling column comprising at least two column valves and a quick-releasable coupling can be coupled to the top valve, and where the coupling column is communicatively coupled to a vessel via a hose connection, after coupling at least the tree or the upgrading module can be controlled.

7. The apparatus in accordance with claim **6**, the upgrading module comprising an electric control unit and where the control unit can be coupled to the vessel via a signal wire running within or close to the hose connection, after coupling at least the tree or the upgrading module can be controlled via the signal wire.

8. The apparatus in accordance with claim **6**, the quick-releasable coupling comprising a releasable portion which can be coupled to the top valve, wherein the releasable coupling is arranged to be able to release at unforeseen events.

9. The apparatus in accordance with claim **6**, wherein at least one of the column valves is a check valve.

10. The apparatus in accordance with claim **6**, wherein at least one of the column valves is a hydraulically controlled valve.

11. The apparatus in accordance with claim **6**, wherein at least one of the column valves is an ROV-operated valve.

* * * * *