

SAFETY VALVE FOR PRODUCTION WELLS

The present invention relates to a safety valve for extraction wells of hydrocarbons, such as, for example, 5 extraction wells of petroleum and/or natural gas. In particular, the present invention relates to a safety valve to be installed on the well head beneath the conventional safety systems, called "*blow-out preventers*" or BOPs, or below the production cross. The 10 present invention is to be used in the case of emergency during drilling, production and maintenance operations.

An extraction well of hydrocarbons is similar to a pipe having a substantially circular section or, in 15 other words, a long pipeline. During drilling, the formation fluids are contained in the pores of the subsoil rock, they are subjected to the formation pressure and are retained in the rock by the counter-pressure exerted on the walls of the well hole by the 20 drilling muds.

Should the formation fluids rise from the well towards the surface uncontrollably, there would be an eruption (blow-out) of said fluids in correspondence with the drilling plant, which is usually situated at 25 the surface on the well head.

The systems currently used for the prevention of blow-out prevalently consist in the installation of blow-out preventers or BOPs. BOPs consist of a certain number of devices called "*rams*", configured for 30 surrounding the tubular drilling material. Ram devices are capable of exerting, by means of a suitable element made of metallic or elastomeric material, a closing and

hydraulic sealing action on the tubular drilling material present in their interior without necessarily shearing the tubular drilling material itself. Some ram devices, called "blind", close the well if no tubular material is present in the BOPs. Other ram devices which can be activated as an extreme possibility are so-called "shear rams" (shearing) which shear the drill pipe and allow the closing and sealing element to be inserted.

10 At present, blow-out preventers or BOPs have the following limits:

- they are capable of shearing only the body of the drill pipes; they cannot shear the ends, called "tool joints" of said pipes, which have a larger diameter with respect to the pipe bodies;

- they require maintenance and substitution of the sealing elements at the end of the drilling phases;

- in the case of shear rams, the shearing action is only optimal when the pipe is centered inside the BOPs.

BOPs also have additional problems in critical situations. If the drill string is compressed upwards by the well pressure, or if it is diverted laterally, for example, the type of shearing of the BOPs may not ensure the shearing of the drill pipes and the passage of the closing element. Furthermore, the passage of the shear rams envisages that the pipe be cut after a complete crushing of the section, which only takes place in the central part of the pipe. Finally, the area of the tool joints subjected to the action of the cutting edges of the shear rams tends to break with

reduced crushing and with completely unforeseeable fracture lines. Some metal debris may therefore remain entrapped, blocking the ram devices and consequently preventing the closing of the well.

5 The objective of the present invention is therefore to provide a safety valve for extraction wells of hydrocarbons which is capable of solving the above-mentioned drawbacks of the known art, allowing the well to be closed after a possible failure of the BOPs.

10 More specifically, an objective of the present invention is to provide a safety valve for extraction wells of hydrocarbons which allows the tubular material possibly present in the safety valve, to be cut and the well closed with hydraulic sealing, allowing the
15 subsequent application of suitable intervention plans for controlling the well if the BOPs have proved to be ineffective.

 A further objective of the present invention is to provide a safety valve for extraction wells of
20 hydrocarbons which is capable of exerting the shearing action of the tubular material with a higher capacity than conventional BOPs, considering the worst stress conditions created in correspondence with the well head not currently envisaged by said BOPs. In particular,
25 the safety valve according to the invention is capable of cutting/shearing a wide range of tubular materials in its interior.

 Another objective of the present invention is to provide a safety valve for extraction wells of
30 hydrocarbons which is capable of exerting the cutting action and closing of the well with hydraulic sealing with a greater reliability with respect to BOPs.

These objectives according to the present invention are achieved by providing a safety valve for extraction wells of hydrocarbons as specified in claim 1.

Further characteristics of the invention are indicated in the dependent claims, which are an integral part of the present description.

In accordance with a first aspect of an embodiment, there is provided a safety valve for extraction wells, configured to be installed on an oil well head and for enclosing a portion of a tubular material inserted inside the well, said tubular material being internally hollow and configured to contain and transport fluids and other substances extracted from the well, the safety valve being provided with a central hole through which the tubular material passes and comprising:

- a blocking system, configured to firmly keep the tubular material to be cut fixed with respect to the safety valve;
- a cutting and closing group configured to cut and close the well under certain operative conditions; and
- a sealing mechanism, configured to actuate an hydraulic sealing of the well, after the cutting, wherein the cutting and closing group consists of a hole saw housed in a respective chamber of said cutting and closing group, said hole saw being rotated by a motorized actuation means and being configured to move in a controlled mode along a substantially orthogonal direction with respect to the development

direction of the well,
the cutting and closing group is provided with a
movable protection element which at least partially
surrounds the hole saw and which is configured to move
5 along the same movement direction as the hole saw for
arriving into the well and going in contact against the
sealing mechanism, so as to effect the hydraulic
sealing of the central hole of the safety valve and
consequently of the well.

10

In accordance with a second aspect of an
embodiment, there is provided a method for the closing
of a well which comprises the following steps:

- fixing a safety valve onto the well head, so that
15 a portion of a tubular material inserted inside the
well is enclosed inside a central hole of the safety
valve and a cutting and closing group of said safety
valve is positioned in correspondence with the tubular
material;
- 20 - actuating the rotation of a hole saw belonging to
said cutting and closing group and the controlled
advancing of said hole saw along a direction
substantially orthogonal to the development direction
of the well, so as to effect the progressive cutting of
25 said tubular material;
- controlled advancing of a movable protection
element belonging to said cutting and closing group and
that surrounds at least partially the hole saw, said
movable protection element being configured to move
30 along the same movement direction as said hole saw for
arriving into the well, so as to effect the occlusion
of the central hole of the safety valve; and

- activating a sealing mechanism of the safety valve, said sealing mechanism being seal-engaged against the movable protection element to effect the watertight closing of the central hole of the safety valve and therefore the well.

The safety valve according to the invention is provided with its own control unit and independent feeding. After the shearing operation, said safety valve is capable of closing the well, producing hydraulic sealing.

The actuation of the safety valve is of the reversible type for allowing the restoration of the well if this is possible. The actuation of the safety valve, which always occurs after the actuation of the BOPs and should their closing action and safeguarding of the well fail, can be operated either during a so-called "kick" phase (influx into the well of gas coming from geological formations), or possibly during a blow-out of the well. After installation, the safety valve can also be left on the well head during the production phase, when the BOP has been removed, remaining below the production cross, thus reducing environmental risks in the case of possible damage of the cross itself.

The safety valve according to the invention is capable of functioning by cutting tubular materials having larger dimensions than the pipe bodies and under critical operating conditions, for example with the tubular material in the BOP and under compression due to the pressure thrust of the well, or with the tubular material arranged randomly inside the safety valve.

The characteristics and advantages of a safety

valve for extraction wells of hydrocarbons according to the present invention will appear more evident from the following illustrative and non-limiting description, referring to the enclosed schematic drawings, in which:

5 figure 1 is a schematic view of the safety valve according to the invention, positioned on an underwater well head, and the relative actuation systems;

figure 2 is a sectional view of a preferred embodiment example of the safety valve according to the
10 invention;

figure 3 is a sectional view of the safety valve of figure 2, provided with the relative pressure compensation device;

figure 4 is a sectional view of the blockage system
15 of the safety valve of figure 2;

figures 5 and 6 are sectional views of the cutting and closing group of the safety valve of figure 2;

figure 7 is a sectional view of the sealing mechanism of the safety valve of figure 2;

20 figure 8 is a sectional view of the protection element of the safety valve of figure 2;

figure 9 is a sectional view of the pressure compensation device of the safety valve of figure 2;

figures 10A-10H respectively show the various
25 phases of the actuation procedure of the safety valve of figure 2 to obtain the closing of the well; and

figures 11A-11E respectively show the various phases of the re-opening procedure of the well using the safety valve of figure 2.

30 With reference in particular to figure 1, this shows a generic floating drilling rig 100 set up for the drilling of an underwater well. The safety valve

according to the invention, indicated as a whole with the reference number 10, is installed on the head 11 of the well so as to allow, during the drilling phases, the installation of blow-out preventers or BOPs, indicated as a whole with the reference number 200. At the end of the drilling, unlike the BOPs 200 which are removed, the safety valve 10 can remain installed for the whole operational duration of the well.

In particular, the safety valve 10 is configured to be installed on the well head 11 and to enclose a portion of a tubular material 12 inserted inside the well. The tubular material 12 can consist, for example, of a so-called "production tubing" or "pipe string" oriented in the same axial direction as the well. The tubular material 12 is internally hollow and is designed for containing and transporting fluids and other substances extracted from the well, among which, for example, hydrocarbons (petroleum or natural gas), water, sludge, rock debris and/or land debris.

The safety valve 10 is operated by a remote power and control system 300 which can be installed either at a drill construction site (in the case of land drillings), or on the sea bottom (in the case of off-shore drillings), at a predefined distance from the well head 11. The technical characteristics of the safety valve 10, as will be better explained hereunder, are such as to not require maintenance during the operating life of the safety valve 10 itself. The remote power and control system 300, however, can be removed to effect either programmed or occasional maintenance. In the case of off-shore drillings, the electric and hydraulic connections 400 between the

remote power and control system 300 and the safety valve 10 can be operated by means of an underwater ROV ("remotely operated vehicle") 500, using suitable connectors called "ROV-mateable connectors".

5 With reference to figures 2 and 3, these show a preferred embodiment example of the safety valve 10 according to the invention. The safety valve 10 is composed of the following main components:

- a blocking system 14 and 16;
- 10 - a cutting and closing group 18;
- a sealing mechanism 20;
- a protection element 22; and
- a pressure compensation device 24.

The blocking system 14 and 16 is configured for
15 keeping the tubular material 12 to be cut firmly fixed with respect to the safety valve 10.

In particular, the blocking system 14 and 16 consists of at least one upper blocking clamp 14, positioned above the cutting and closing group 18, and
20 at least one lower blocking clamp 16, positioned below the cutting and closing group 18. The upper 14 and lower 16 blocking clamps therefore have the function of keeping the tubular material 12 fixed with respect to the safety valve 10 during the cutting action of the
25 tubular material 12 on the part of the cutting and closing group 18. Two upper blocking clamps 14 and two lower blocking clamps 16 consisting of respective blocking elements 38 activated by opposing hydraulic pistons 40, are preferably envisaged. It should be
30 pointed out that, in the present description, the terms "upper" and "lower" should be considered as defining the position of specific components of the safety valve

10 with reference to the development direction (deep into the ground) of the well.

The cutting and closing group 18 is configured for shearing the tubular material 12 under certain operative conditions of the well. The cutting and closing group 18 advantageously consists of a hole saw 26 rotated by a motorized actuation means 28, typically consisting of a hydraulic motor or also an electric motor.

10 On the basis of preferred embodiments of the safety valve 10 according to the invention, the hole saw 26 is configured for effecting the cutting of tubular materials having diameters and thicknesses defined as follows:

- 15 - casings having an external diameter preferably ranging from 1" to 20", with a wall thickness preferably up to about 20 mm,
- drill pipes having an external diameter preferably ranging from 1" to 10", with a wall thickness preferably up to about 20 mm,
- 20 - tool joints having an external diameter preferably ranging from 1" to 10", with a wall thickness preferably up to about 40 mm,
- protective collars having an external diameter preferably ranging from 1" to 24", with a wall thickness preferably up to 20 mm.

The hole saw 26 is configured for moving in a controlled mode along a substantially orthogonal direction with respect to the development direction of the tubular material 12. The control function of the linear movement of the hole saw 26 is exerted by a hydraulic piston 30 housed inside a respective cylinder

32 operatively connected to the cutting and closing group 18. The hydraulic motor 28, which rotates the hole saw 26 by means of a transmission shaft 34 inserted inside the stem 54 of the hydraulic piston 30, is also housed inside the cylinder 32.

A movable element 36 having a substantially cylindrical form, which at least partially surrounds the hole saw 26 and which is capable of advancing along the same direction as said hole saw 26 to interact with the tubular material 12, is slidably inserted inside the cutting and closing group 18.

As specified in more detail hereunder, the movable element 36 is configured for being abutted against the sealing portion 64 of a sliding closing collar 62 of the sealing mechanism 20, so as to effect the watertight closing of the central hole of the safety valve 10 and consequently of the well.

With reference to figure 4, this shows a single blocking clamp 14 of the blocking system of the safety valve 10 according to the invention. Each blocking clamp 14 or 16 consists of a blocking element 38 capable of engaging the tubular material 12 by interference. The blocking element 38 can be moved along a direction perpendicular to the axial direction of the tubular material 12 and is pushed by a hydraulically driven piston 40. A mechanism 42, preferably a screw mechanism, is assembled behind the piston 40, i.e. in an opposite position with respect to the position of the blocking element 38, which allows the blocking of said piston 40 in the position reached also in the case of a loss in the hydraulic pressure.

The screw mechanism 42 can be actuated in the

release phase, through the action of the pressure of a fluid which activates the piston 40. A position sensor 44, which allows the stroke of the blocking element 38 to be exactly controlled so as to center the portion of tubular material 12 enclosed inside the safety valve 10, is assembled in the rear part of the blocking clamp 14 or 16, i.e. behind the screw mechanism 42.

The seals 48 and 76 of the stem 56 of the piston 40 and of the blocking element 38 are protected by the well fluids by means of an elastic bellows 46. This elastic bellows 46 allows small movements of the piston 40. Said movements, set at regular time intervals, are necessary for lubricating the seals 48 and 76, avoiding the galling on the cylinder, as the latter must remain inactive for an extremely long period of time, and also for effecting the functional tests of the safety valve 10 according to the invention. When the blocking clamp 14 or 16 is to be actuated, the force of the piston 40 shears the elements that are holding the elastic bellows 46 on the stem 56, which continues its stroke necessary for causing the blockage of the tubular material 12.

With reference to figures 5 and 6, these show a cutting and closing group 18 of the safety valve 10 according to the invention. The cutting and closing group 18 comprises a hole saw 26 which rotates inside the movable element 36. Said movable element 36 therefore functions as a protection element for the hole saw 26. The rotation of the hole saw 26 takes place on bushings or bearings 50 protected by the cutting residues through an oil seal 52. Both the bearings 50 and the oil seal 52 are situated on the

movable cylindrical element 36. This assembly configuration of the cutting and closing group 18 ensures that the hole saw 26 is only subjected to torsion, whereas other possible loads are supported by
5 the movable cylindrical element 36 and do not cause flexion of the transmission shaft 34.

The rotation movement of the hole saw 26 is supplied by the hydraulic motor 28 by means of the transmission shaft 34 which rotates inside the stem 54
10 of the hydraulic piston 30. The hydraulic piston 30 which slides in the cylinder 32 pushes the stem 54, which in turn imparts the linear advance movement to both the hole saw 26, and to the movable cylindrical element 36. The hydraulic motor 28 is preferably
15 integral with the hydraulic piston 30 and is fed by a series of flexible sleeves 58 which follow the hydraulic motor 28 itself during the translation movement of hydraulic piston 30. A linear sensor 60 continuously provides the position of the hydraulic
20 piston 30 inside the respective cylinder 32.

After completing the cutting of the tubular material 12, the movable element 36 advances as far as a stroke-end, so that a closing portion thereof, having a high thickness, reaches the centre of the hole of the
25 safety valve 10. The thickness of the closing portion of the movable element 36 is such as to resist the vertical thrust which is exerted inside the central hole of the safety valve 10 and which is due to the kick pressure.

30 With reference to figure 7, this shows the sealing mechanism 20 of the safety valve 10 according to the invention. The sealing mechanism 20 is conceived for

effecting the closing of the well with hydraulic sealing. The sealing mechanism 20 is configured for enveloping the tubular material 12 inside the central hole of the safety valve 10 and is preferably
5 positioned below the cutting and closing group 18. After the tubular material 12 has been cut and the movable cylindrical element 36 brought inside the central hole of the safety valve 10, the hydraulic sealing is obtained by means of the sliding closing
10 collar 62 of the sealing mechanism 20. The sliding closing collar 62 is pushed upwards against the movable cylindrical element 36, forcing the sealing portion 64, formed on the upper edge of said sliding closing collar 62, against the cylindrical surface of the cylindrical
15 element 36. The force necessary for actuating the sliding closing collar 62 is provided by the hydraulic pressure of a fluid contained in a lower thrust chamber 66 located inside the sealing mechanism 20.

Once the closing position has been reached, the
20 sliding collar 62 is blocked by means of one or more blocking pins 68, so as to keep said sliding collar 62 in the closed position against the cylindrical element 36 also in the absence of hydraulic pressure. The blocking pins 68 are pushed into corresponding grooves
25 of the sliding closing collar 62 by means of one or more corresponding springs 70, and, when the movement of the same sliding closing collar 62 is required, the springs 70 are withdrawn by the thrust of a pressurized fluid contained in a respective chamber 72.

30 With reference to figures 8 and 9, these respectively show the protection element 22 and the pressure compensation device 24 of the safety valve 10

according to the invention. The safety valve 10, also after the drilling phase and completion of the well, must remain installed on the well head 11 below the production cross for the whole of its operating life.

5 All the mechanical parts that are inside the safety valve 10, above all the seals of both the stem 54 of the hydraulic piston 30, and the transmission shaft 34 which transmits the rotation movement to the hole saw 26, must therefore remain protected firstly from the
10 drilling sludge and secondly from the action of the completion fluid during the whole production life of the well.

For the above reasons, the safety valve 10 is provided with a protection element 22 consisting of a
15 protection jacket or sleeve made of a metallic material having a reduced thickness. The protection jacket 22 is mounted around the tubular material 12 and coaxially with respect to it. The protection jacket 22 is provided with sealing rings 74 for keeping the central
20 hole of the safety valve 10 separate from the chamber where the hole saw 26 is housed. This chamber is filled with an inert fluid kept at the same pressure as the well by means of the pressure compensation device 24. When the well is to be closed, the hole saw 26 also
25 cuts the metallic protection jacket 22.

With reference to figures 10A-10H, the operating sequence of the phases performed by the safety valve 10 for effecting the closing procedure of the well is as follows. A first phase (figure 10A) provides for the
30 actuation of the pistons 40 of the upper 14 and lower 16 blocking clamps. The upper 14 and lower 16 blocking clamps which can be actuated independently, position

the portion of tubular material 12 to be cut in the centre of the hole of the safety valve 10 and subsequently tighten said portion of tubular material 12 so as to support the axial load that weighs on the tubular material 12 itself.

The hydraulic motor 28 is subsequently actuated (figure 10B) in order to rotate the hole saw 26, until reaching the nominal rotation regime. The rotation regime of the hole saw 26 is controlled by measuring the flow-rate of the fluid which feeds the hydraulic motor 28 or by means of an appropriate rotary sensor positioned in correspondence with the hydraulic motor 28.

Once the hydraulic motor 28 has reached an optimal rotation regime, the hydraulic piston 30 is actuated in order to obtain the controlled linear movement of the hole saw 26 (figure 10C). The control is effected on the basis of the measurement of the position with the linear sensor 60 and by regulating the supply flow-rate of the actuation fluid to the cylinder 32. The controlled advancement of the hole saw 26 causes the cutting of the protection element 22 and subsequent progressive cutting of the tubular material 12 (figure 10D).

The stroke of the hydraulic piston 30 continues until the hole saw 26 and the corresponding movable protection element 36 reach the opposite part of the tubular material 12 with respect to that on which the cutting and closing group 18 is positioned (figure 10E). In this position, the closing portion of the movable protection element 36 is in correspondence with the central hole of the safety valve 10.

Once the hole saw 26 and the corresponding movable protection element 36 have reached the respective stroke-end positions, the withdrawal of the blocking pins 68 from the sliding closing collar 62, is effected
5 (figure 10F). The withdrawal of the blocking pins 68 is obtained by means of a dedicated hydraulic line which sends pressurized fluid into the chamber 72. The fluid counteracts the action of the springs 70 and therefore moves the respective blocking pins 68 away from the
10 sliding closing collar 62.

The introduction of pressurized fluid into the lower thrust chamber 66 causes the consequent upward movement of the sliding closing collar 62 (figure 10G), until it forces the sealing portion 64 onto the movable
15 protection element 36, closing the well. The sealing portion 64 of the sliding closing collar 62 can be conveniently pushed inside a corresponding recess formed in the movable protection element 36, so as to block any possible axial movements of said movable
20 protection element 36.

Finally, pressure is removed from the hydraulic actuation line of the blocking pins 68, which, pushed by the respective springs 70, re-enter the corresponding grooves of the sliding closing collar 62
25 and block the sliding closing collar 62 itself in the closing position (figure 10H).

With reference to figures 11A-11E, the operating sequence of the steps performed by the safety valve 10 for operating the re-opening procedure of the well is
30 as follows. A first step consists in actuating the pistons 40 of both the upper blocking clamps 14 and of the lower blocking clamps 16 to release the segments of

the drill pipe positioned above and below the cut portion of tubular material 12. The lower segment of tubular material falls into the well, whereas the upper segment of tubular material can be removed from above.

5 The blocking pins 68 of the sliding closing collar 62 are subsequently moved back by means of the respective hydraulic actuation line (figure 11A). By regulating the flow of fluid inside an upper thrust chamber 78, a consequent downward movement of the
10 closing collar 62 is thus caused (figure 11B).

At this point, pressure can be removed from the hydraulic actuation line of the blocking pins 68 which, pushed by the respective springs 70, re-enter the corresponding grooves of the sliding closing collar 62
15 and block the sliding closing collar 62 itself in the rest position (figure 11E).

At this point, the hydraulic piston 30 can be activated for moving back the hole saw 26 in a controlled mode (figure 11C). The control is always
20 actuated on the basis of the measurement of the position revealed by the linear sensor 60 and by regulating the supply flow-rate of the actuation fluid to the cylinder 32.

The stroke of the hydraulic piston 30 continues
25 until the hole saw 26 and the respective movable protection element 36 have been brought back to their seats (figure 11D).

It can thus be seen that the safety valve for extraction wells of hydrocarbons according to the
30 present invention achieves the objectives previously indicated, obtaining, in particular, the following advantages:

- 5 - cutting action of the tubular material based on the removal of shavings, in a manner therefore more versatile with respect to the known devices, considering the variety of geometries to be cut: from tool joints (small diameter, large thickness) to casings (large diameter, small thickness);
- 10 - creation of a well-defined cutting surface, so as not to leave metal debris that prevent the subsequent passage of the closing element: the metal debris are, in fact, collected by the hole saw;
- 15 - capacity of operating the cutting of the tubular elements also under critical conditions;
- protection of the seals of the piston systems from well fluids, thus avoiding maintenance of the seals and leaving the safety valve installed for the whole operating life of the well.

20 The safety valve for extraction wells of hydrocarbons according to the present invention thus conceived can in any case undergo numerous modifications and variants, all included in the same inventive concept; furthermore, all the details can be substituted by technically equivalent elements. In
25 practice, the materials used, as also the forms and dimensions, can vary according to technical requirements.

 The protection scope of the invention is therefore defined by the enclosed claims.

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CLAIMS

1. A safety valve for extraction wells, configured to be installed on an oil well head and for enclosing a portion of a tubular material inserted inside the well, said tubular material being internally hollow and configured to contain and transport fluids and other substances extracted from the well, the safety valve being provided with a central hole through which the tubular material passes and comprising:
- 10 - a blocking system, configured to firmly keep the tubular material to be cut fixed with respect to the safety valve;
 - a cutting and closing group configured to cut and close the well under certain operative conditions;
 - 15 and
 - a sealing mechanism, configured to actuate an hydraulic sealing of the well, after the cutting, wherein the cutting and closing group consists of a hole saw housed in a respective chamber of said cutting and closing group, said hole saw being rotated by a
 - 20 motorized actuation means and being configured to move in a controlled mode along a substantially orthogonal direction with respect to the development direction of the well,

the cutting and closing group is provided with a
movable protection element which at least partially
surrounds the hole saw and which is configured to move
5 along the same movement direction as the hole saw for
arriving into the well and going in contact against the
sealing mechanism, so as to effect the hydraulic
sealing of the central hole of the safety valve and
consequently of the well.

10 2. The safety valve according to claim 1, wherein the
blocking system consists of at least one upper blocking
clamp, arranged above the cutting and closing group,
and at least one lower blocking clamp, arranged below
the cutting and closing group.

3. The safety valve according to claim 2, wherein each blocking clamp consists of a blocking element capable of engaging the tubular material by interference, said blocking element being movable along a direction
5 perpendicular to the axial direction of the well and being pushed by a hydraulically driven piston.

4. The safety valve according to claim 3, wherein each blocking clamp comprises a mechanism to block the piston in the position reached also in the case of a
10 loss in the hydraulic pressure.

5. The safety valve according to claim 3 or 4, wherein each blocking clamp comprises a position sensor which exactly controls the stroke of the blocking element so as to center the portion of tubular material enclosed
15 inside the safety valve.

6. The safety valve according to any claims 3 to 5, wherein each blocking clamp comprises an elastic bellows protecting the seals of the stem of the piston and the blocking element from the well fluids.

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7. The safety valve according to claim 1, wherein the cutting and closing group comprises a hydraulic piston housed inside a respective cylinder, said hydraulic piston being actuated for imparting a controlled linear
5 movement to both the hole saw and the movable protection element.

8. The safety valve according to claim 7, wherein the motorized actuation means comprises a transmission shaft inserted inside the stem of the hydraulic piston,
10 said transmission shaft rotating the hole saw.

9. The safety valve according to claim 7 or 8, wherein the motorized actuation means consists of a hydraulic motor integral with the hydraulic piston and fed by a series of flexible sleeves which follow said hydraulic
15 motor during the translation movement of said hydraulic piston, a linear sensor continuously providing the position of said hydraulic piston inside the respective cylinder.

10. The safety valve according to any claims 1 to 9,
20 wherein the sealing mechanism comprises a sliding closing collar configured to envelope the tubular material, said sliding closing collar being provided with a sealing portion suitable for forced contact with the movable protection element and being actuated by
25 the hydraulic pressure of a fluid contained in at least one thrust chamber obtained inside the sealing

mechanism.

11. The safety valve according to claim 10, wherein the sealing mechanism comprises one or more blocking pins suitable for blocking the sliding collar in one or more
5 predefined positions, said one or more blocking pins being pushed into corresponding grooves of the sliding closing collar by means of one or more corresponding springs retractable by means of the thrust of a pressurized fluid contained in a respective chamber
10 obtained inside the sealing mechanism.

12. The safety valve according to any previous claims, wherein it comprises a protection element consisting of a sleeve mounted around the central hole of the safety valve and provided with sealing rings for keeping the
15 central hole of the safety valve separate from the chamber where the hole saw is housed.

13. The safety valve according to claim 12, wherein it comprises a pressure-compensating device configured to fill the chamber where the hole saw is housed with an
20 inert fluid kept at the same pressure as the well.

14. The safety valve according to any previous claims, wherein it comprises a remote power and control system installed at a predefined distance from the well, said remote power and control system being operatively
25 connected to the safety valve by means of electric and hydraulic connections comprising a remotely operated underwater vehicle.

15. A method for the closing of a well which comprises the following steps:

- fixing a safety valve onto the well head, so that a portion of a tubular material inserted inside the well is enclosed inside a central hole of the safety valve and a cutting and closing group of said safety valve is positioned in correspondence with the tubular material;
- actuating the rotation of a hole saw belonging to said cutting and closing group and the controlled advancing of said hole saw along a direction substantially orthogonal to the development direction of the well, so as to effect the progressive cutting of said tubular material;
- controlled advancing of a movable protection element belonging to said cutting and closing group and that surrounds at least partially the hole saw, said movable protection element being configured to move along the same movement direction as said hole saw for arriving into the well, so as to effect the occlusion of the central hole of the safety valve; and
- activating a sealing mechanism of the safety valve, said sealing mechanism being seal-engaged against the movable protection element to effect the watertight closing of the central hole of the safety valve and therefore the well.

16. The method according to claim 15, wherein it is reversible, thus allowing the re-opening of the well.

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