United States Patent [19]

Soulié et al.

[11] **3,764,176**

[45] **Oct. 9, 1973**

[54] **TOOL FOR LOWERING OR RAISING SAFETY DEVICES IN OIL WELLS**

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[22] Filed: **Apr. 15, 1971**

[21] Appl. No.: **134,183**

[30] **Foreign Application Priority Data**

Apr. 17, 1970 France 7013941

[52] **U.S. Cl.**..... **294/86.25**, 166/153, 175/247, 294/86.1

[51] **Int. Cl.**.. **E21b 31/02**, E21b 33/10, E21c 19/00

[58] **Field of Search**..... 166/117.7, 153, 156; 175/247; 294/86.15, 86.17, 86.22, 86.25

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Assistant Examiner—W. Scott Carson
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[57] **ABSTRACT**

A tool for lowering or raising a safety device in an oil well comprises a hollow cylindrical body, a plunger which reciprocates axially in said body in response to fluid pressure pulses, means for converting the axial movement of said plunger to rotary movement of a rotatable member, and nut and screw means for converting the rotary movement of said rotating member to axial movement by a screw which actuates pincer means.

3 Claims, 11 Drawing Figures

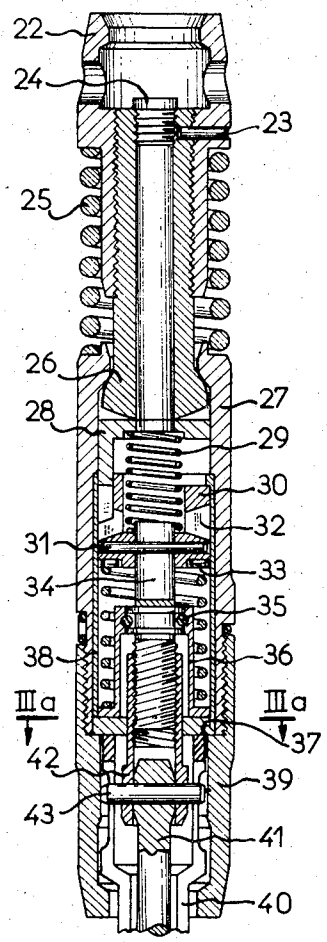

Fig: 3a.

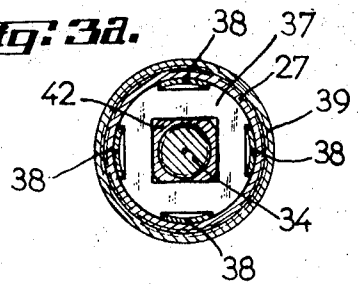

Fig: 1.

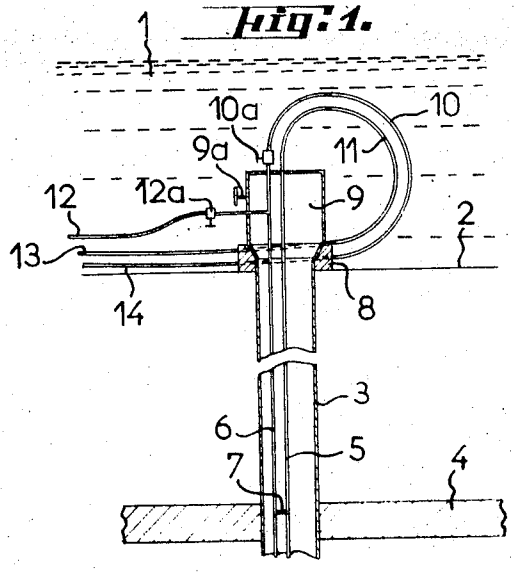

Fig: 3.

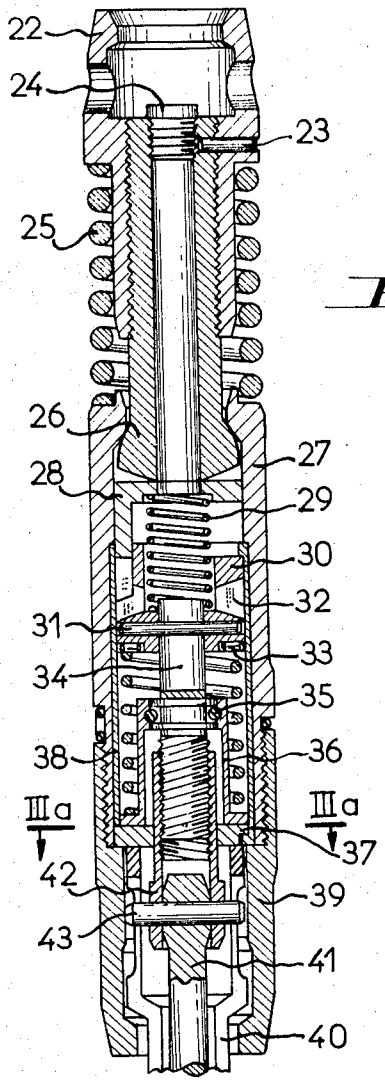

Fig: 4.

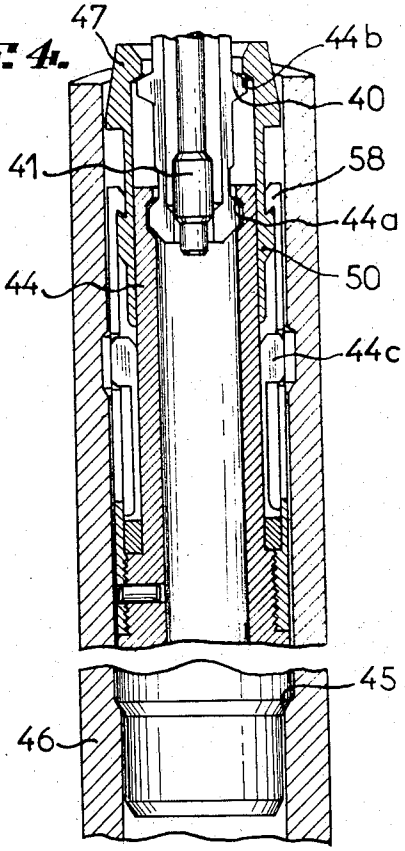

Fig: 2.

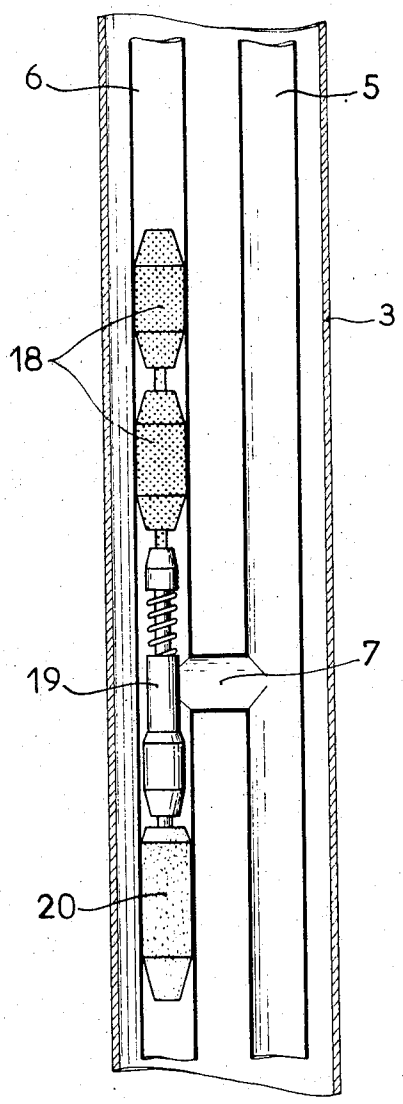

Fig: 5.

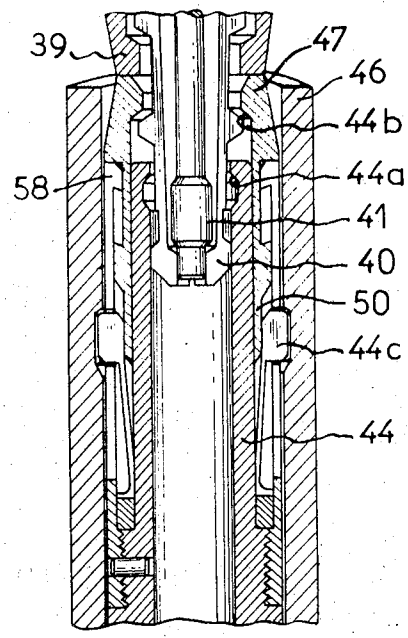

Fig: 6.

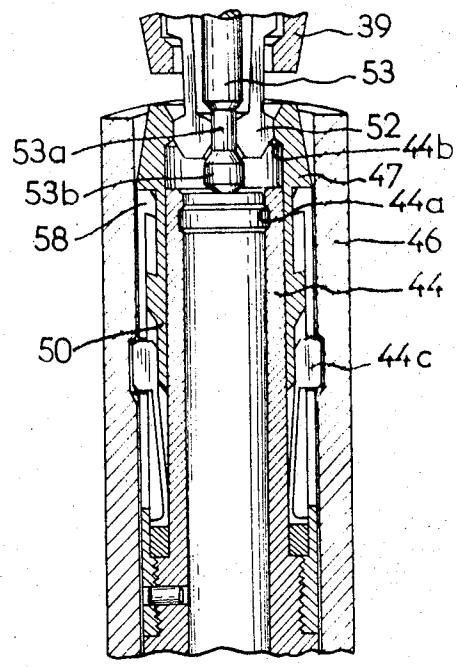

Fig: 7.

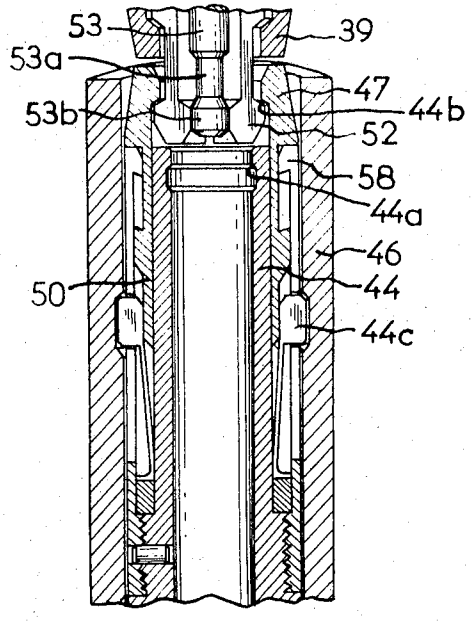

Fig: 8.

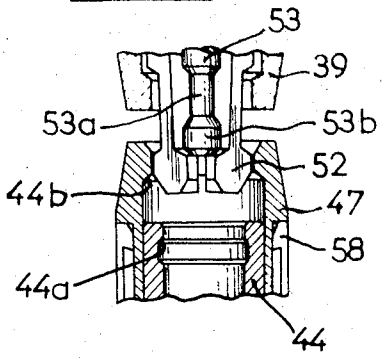

Fig: 9.

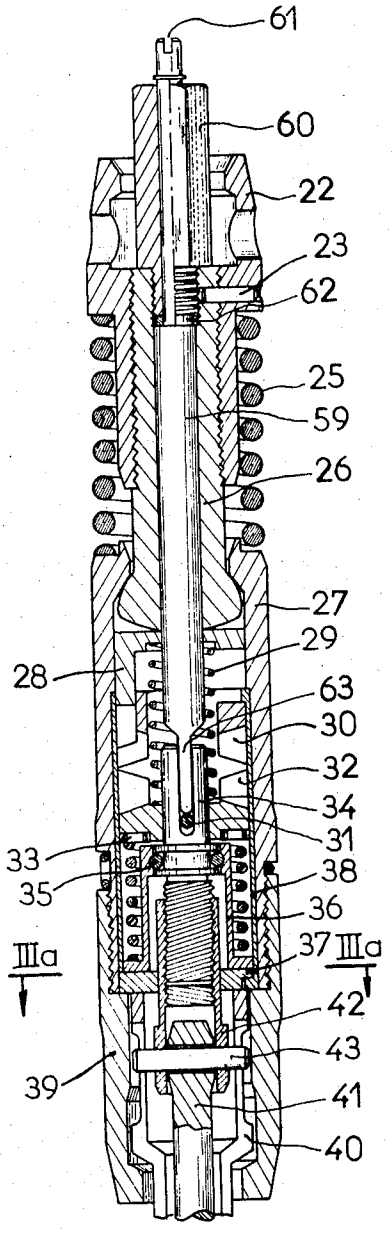
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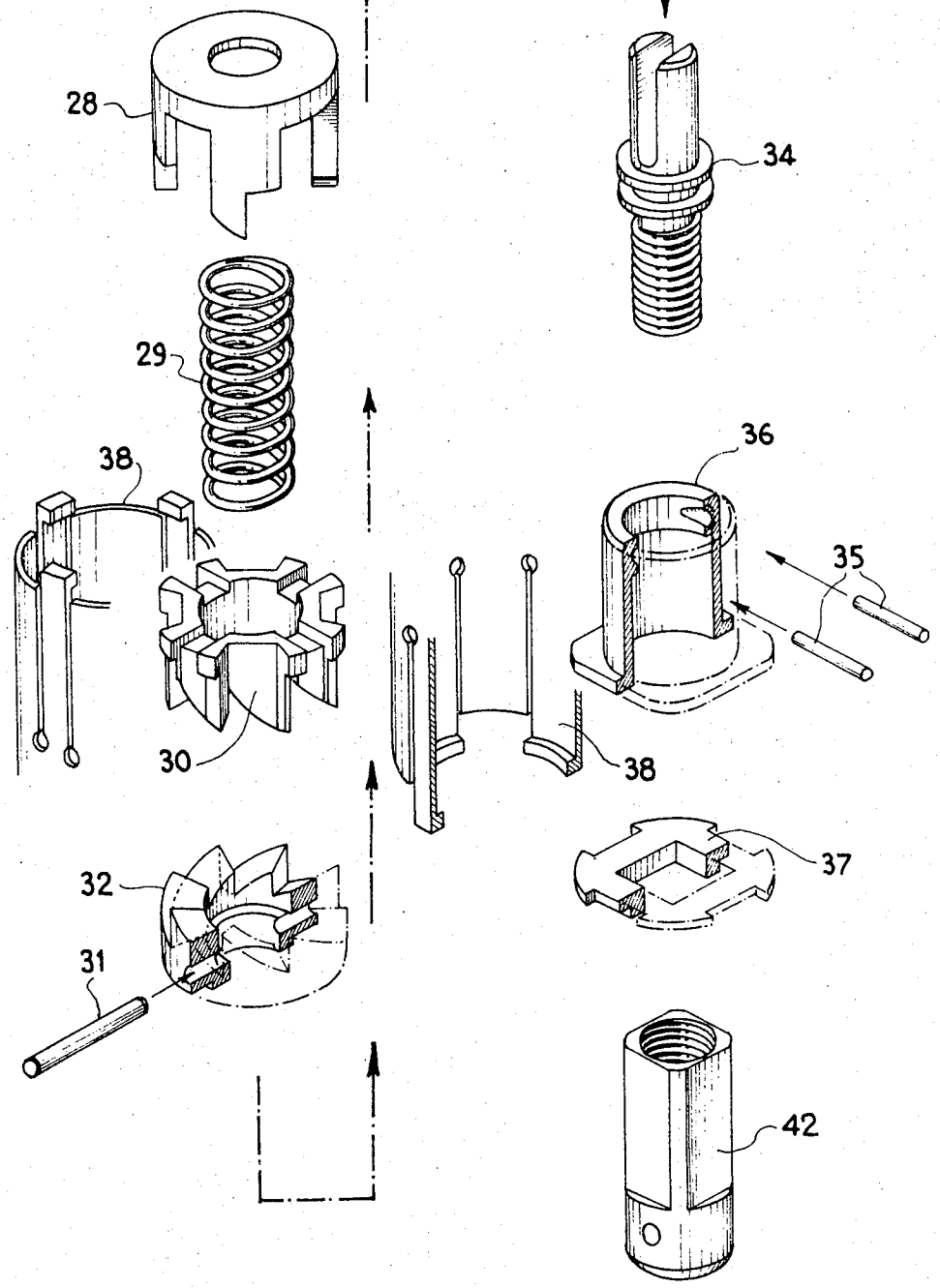
FIG. 10



TOOL FOR LOWERING OR RAISING SAFETY DEVICES IN OIL WELLS

The present invention concerns a tool for lowering or raising a safety device in an oil well, the said device being placed inside a tubing which passes down inside the well to the oil-bearing layer.

Existing tools for lowering and raising such devices include those operated by cables, in which the safety device is separated from the installing tool, or hooked on to it and removed from its working position inside the tubing, by means of given tensions or accelerations exerted on these cables.

Units for underwater wells also include those in which lowering and raising are done by means of a tool forced along an operating tubing by fluid pressure. This operating tubing is accompanied by a return tubing, parallel to it, and in which the fluid can circulate, in one direction for descent, and in the opposite direction for re-ascent. The two tubings are linked in the region of the safety devices by a circulation coupling.

The lowering or raising tool according to the present invention, which is pushed by a set of propelling devices moved by pressure, consists of a hollow cylindrical body containing a mechanism involving a driving part and a driven part, the driving part being acted upon by a plunger which can slide axially in the upper part of the tool as the result of impulses imparted by fluid pressure against the force of a spring, in such a way as to bring about a shift in the driven part, linked to the upper end of a piston, the lower end of which is outside the tool, and which operates the clips to attach the safety device.

According to the invention, this tool is characterized mainly by the fact that the said mechanism also includes a rotating component (32), held lengthwise in the casing (27) by a stop (35), so that it can rotate inside the casing without moving lengthwise, and a system (30, 32), to convert the axial movement of the driving part (30) into a rotary movement of the rotating component (32), which is attached rigidly to one of the two components of a screw (34) and nut (42) connection, the other component of which, guided lengthwise in the body (at 37), so that it can slide but not rotate, forms the driven part of the said mechanism.

It will be easier to understand the invention from reading the following description, illustrated by the accompanying figures.

FIG. 1 represents the installation layout of the tubings with which the lowering or raising tool according to the invention is used.

FIG. 2 represents a detailed diagram of the tubings, near the circulation connection linking the two tubings.

FIG. 3 represents a detailed illustration of the driving part of the lowering or raising tool.

FIG. 3*a* shows a transverse cross-sectional view along the line IIIa—IIIa on FIG. 3.

FIG. 4 shows the hooking section of the tool.

FIG. 5 shows the same part, in the position.

FIG. 6 shows the active part of the raising tool, in the arrival position.

FIG. 7 shows the same raising tool in the hooking position.

FIG. 8 shows this same tool in the release position, in the event of the safety device remaining jammed.

FIG. 9 shows a cross-sectional view of the lowering or raising tool and the setting mechanism.

FIG. 10 is an exploded perspective view of a ratchet mechanism used in the tool.

FIG. 1 shows an underwater well, beneath sea-level (1). The sea-bed 2 has been drilled and lined with a casing 3, transversing an oil-bearing layer 4. Two tubings 5 and 6 are inserted in the casing. They are parallel to each other, and are connected in the region of the oil-bearing layer by a circulation coupling 7. The casing is suspended from a suspension head 8, which carries a Christmas tree 9. The tubings 5 and 6 continue through the top of this Christmas tree (10 and 11), to form a circle with a fairly large radius. They then continue (13 and 14), along the sea-bed, and are linked to the land. Valves 9*a*, 10*a*, and 12*a* (which is placed on the production line 12), allow the oil to be extracted along the line 12, when the valve 12*a* is open, and the valve 10*a* shut, or operations to lower or raise safety devices to be performed. To this effect the tubing 6 is open at the bottom, being fitted with a filter, for instance, while the lower end of the tubing 5 is closed.

The lowering and raising tools thus move inside the tubing 14, 10, 6, while the tubing 5, 11, 13 is used for the circulation of oil during lowering of the tool and for reverse circulation during raising. The safety devices fit into the places machined for them in the installation, to control the cross-sectional area of the tubing 6.

FIG. 2 shows a tool assembly, as it reaches the region of the circulation coupling 7. The tubing 6 is subjected to fluid pressure, by means of a pump not shown here. This fluid pushes the two propelling devices 18 downwards. These devices provide a more or less hermetic seal between themselves and the wall of the tubing, and they push in front of them the lowering and raising tool 19, connected to the safety device 20 which is to be installed in the well.

This safety device may be a solid plug, or a calibrated valve, to stop the flow of fluid from the oil well in the event of incidents at the head of the well, or a two-way valve which will close, for instance, at a given back-pressure, and also at a given direct pressure.

The cirulation connection 7 allows the fluid forced out by the propelling devices to re-ascend by the tubing 5, the bottom of which is closed. Conversely, the establishment of fluid circulation along the tubing 5 allows the tools in the well to be raised: the propelling devices 18 pull the lowering and raising tool and, if necessary, the safety devices.

FIG. 3 shows a cross-sectional view of the lowering or raising tool.

The component 22 is used to link the tool and the propelling devices. It consists of two parts, screwed together so as to allow a spring 25 to be placed in position. The two parts are held together rigidly by a pin 23.

Inside this component is a plug 24, the purpose of which will be explained in connection with FIG. 9. The component 22 ends in a rounded piston-head 26, allowing it to move out of alignment with the casing 27 of the main tool, when moving round bends in the tubing.

The hollow body 27 rests on the round-ended piston, and on the spring 25. The casing 27 is screwed on to an extension 39, making assembly easier. Inside the casing 27, a component 28 with engagement pawls is pressed against the end of the piston by a spring 29. The pawls of the component 28 are engaged in a ratchet 30, which cannot turn, and which faces a ratchet 32, able to turn and fixed by a pin 31 to a shaft 34, also able to turn. Bearings 33 make rotation easier. The shaft 34 is pre-

vented from moving lengthwise by a seat **36** and two pins **35**, which press against two stops on the shaft **34**. The bottom end of this shaft is threaded, and can be screwed into a nut with the same thread **42**, which is prevented from turning by a plate **37**, so that it moves lengthwise when the shaft **34** is turned. The nut has a non-circular cross-section, and moves through a matching opening in the plate **37**. The nut is attached rigidly to a rod **41** by a pin **43** at its base. Two pincers **40**, the purpose of which will be explained below, are placed round the rod **41**.

FIG. **4** shows the lower part of the tool, including the rod **41** and the pincers **40**. These pincers are held in their locking position by a wider section on the rod **41**. They then fit into two recesses **44***a* and **44***b* in the casing of the safety device **44**. The base of this safety device is shown in position in its seating **45**, prepared for it in the tubing before installation of this tubing **46**. The locking ratchets **44***a* are still flat against the safety device.

FIG. **5**, like FIG. **4**, shows the lower part of the tool. As a result of the action of the tool, the rod **41** rises and the pincers **40** close. They have left the recesses **44***a* and **44***b*, sliding donnwards, while the extension **39** of the casing **27** causes the ratchets, **44***c*, attached to the casing **44** of the safety device, to move apart, as the upper casing **47** slides downwards.

By changing the direction of circulation of the fluid, the tool can then be disengaged and raised.

FIG. **6** shows the lower part of a tool equipped for raising a safety device. This part of the tool differs from the part shown in FIG. **5** in two ways. The pincers **52** have only one shoulder, and the piston **53** includes a narrower section **53***a* followed by a wider section **53***b*.

The tool **51** is lowered along the tubing **54**, with the shoulders of the pincers **52** level with the narrower section **53***a* on the piston **53**. The tool component **39** presses on the casing **47** of the safety device.

Pressure impulses make the ratchet **32** turn (FIG. **3**) as a result of the to-and-fro movement of the components **26** and **28**, and the non-rotating ratchet wheel **30**. The result of this is to draw the piston **53** upwards (FIG. **6**).

FIG. **7** shows the tool when it has gripped its load. The pincers **52** are held apart by the wider section of the piston **53**. Raising can then begin. Reverse circulation is set in motion through the second tubing. The head **47** of the safety device begins by following the raising tool, sliding along the casing **57** of the device. This releases the blocking ratchets **56**. The separate movement of the head is halted by the ratchets **58**, which draw up the whole safety device. Circulation pressure is continued, so that the whole assembly moves upwards.

FIG. **8** shows the release operation of the raising tool in the event of the safety device being jammed.

If the resistance offered by the jammed device is too high, pressure impulses are given in order to raise the piston **53** further. The pincers **52** are released and can close, releasing the load. Another impulse, involving direct circulation, relocks the blocking ratchets **56** (not shown here). The tool can then be raised and adjusted for another test, in which the series of propelling devices **18** has been modified (FIG. **2**).

FIG. **9** shows the method of assembly for adjustment of the tool. The plug (FIG. **3**) is unscrewed, and a shank **59** ending in a flat section **63** is inserted into the central channel of the round-headed piston **26**. The flat section fits into a mortice provided for it in the rotating component. The shank **59** is gripped in a guide **60**, which replaces the cap **24**.

There is a slot **61** at the top of the shank, and a joint **62** enables the shank to turn easily inside the guide **60**.

The shank **59** is turned with a spanner, making the component **34** and the ratchet wheel **32** turn. The component **42**, and the piston **41** fixed to it by the pin **43**, are thus shifted lengthwise. The tool is adjusted so that the wider section of the piston **41** holds the pincers **40** apart, where the tool is being used to lower a safety device, or closed where it is being used to raise a device, and so that one turn of the component **34** will release or engage this wider section. The tool is then ready for use, and the number of pressure impulses needed to release or engage it is known. The component **60** is next removed, then the shank **59**, and finally the cap **24** is screwed back on.

The tool is used as follows to instal a safety device (well-bottom valve known as a storm-choke, for instance, to be fitted into the position provided at the lower end of the tubing, known as the landing nipples).

The storm-choke is fitted to the front of the tool, which is then adjusted as described above, and connected to the propelling devices. The whole assembly is inserted into the tubing **14** (FIG. **1**). The valve **10**a is opened and the valve **12***a* shut. A pump is connected to the tubing **14**, and oil is rejected, so that the tool assembly is driven along the tubing, through the section **10** and into the section **6**, while the fluid forced out returns along the tubing **13**. When the storm-choke reaches the landing nipple, a pressure impulse is felt, since the circulation coupling **7** is situated so that the propelling devices remain above it when the storm-choke is in position.

The propelling devices are designed in such a way as to involve a large pressure loss, but allow a small flow of oil to pass. The assembly is now stationary. Pressure variations are produced, with the result (FIG. **3**), that the component **26** is pushed downwards, along with the component **28** and the non-rotating ratchet-wheel **30**. This ratchet causes the ratchet-wheel **32**, to which the shaft **34** is fixed by the pin **31**, to turn. The shaft **34** shifts the nut component **42** lengthwise, drawing the piston **41** upwards. The number of impulses provided for during adjustment is applied, plus three or four as a safety measure. The pincers **40** are released from their recesses, releasing the storm-choke (FIG. **5**), and then an additional impulse pushes the upper section **47** of the storm-choke downwards, forcing the blocking ratchets **44***c* into their recesses. Reverse circulation is then started up along the tubing **13** and the propelling devices operate in the opposite direction, withdrawing the tool, which is recovered at **14**.

Raising of a sfaety device is carried out similarly. The piston **41** is replaced by another piston **53** (FIG. **6**), operated in the same way but slightly different in shape.

What is claimed is:

1. A tool for lowering and raising a safety device in an oil well, said tool comprising:

a hollow cylindrical body (**27**),

a driving member (**28**) actuated by a piston (**26**) and mounted to slide axially in said body in response to pulses imparted thereto by fluid pressure,

a spring mounted in said body to resist movement of said driving member in response to said pulses and

return said driving member to an initial position after each pulse,

a rotating member (**31**) mounted in said body,

an intermediate mechanism (**19, 30, 32**) for converting axial movement of said driving member to rotary movement of said rotating member,

a driven member (**41**) mounted for axial movement in said body,

means comprising a screw component (**34**) and an interfitting nut component (**42**) for converting the rotary movement of said rotating member to axial movement by said driven member, said rotating member being connected to one of said components and said driven member being connected to the other of said components, and

pincer means (**40**) connected to be actuated by axial movement of said driven component to engage said safety device.

2. A tool as claimed in claim **1** in which said intermediate mechanism comprises a first non-rotating ratchet member (**30**) in which said driving member (**28**) slides to impart rotational movement to a second rotatable ratchet member (**32**) which turns said rotating member when struck by said first ratchet member, said rotating member being connected to turn said screw component.

3. Tool as claimed in claim **1** comprising two axially spaced propelling devices attached to said driving member in axial alignment therewith.

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