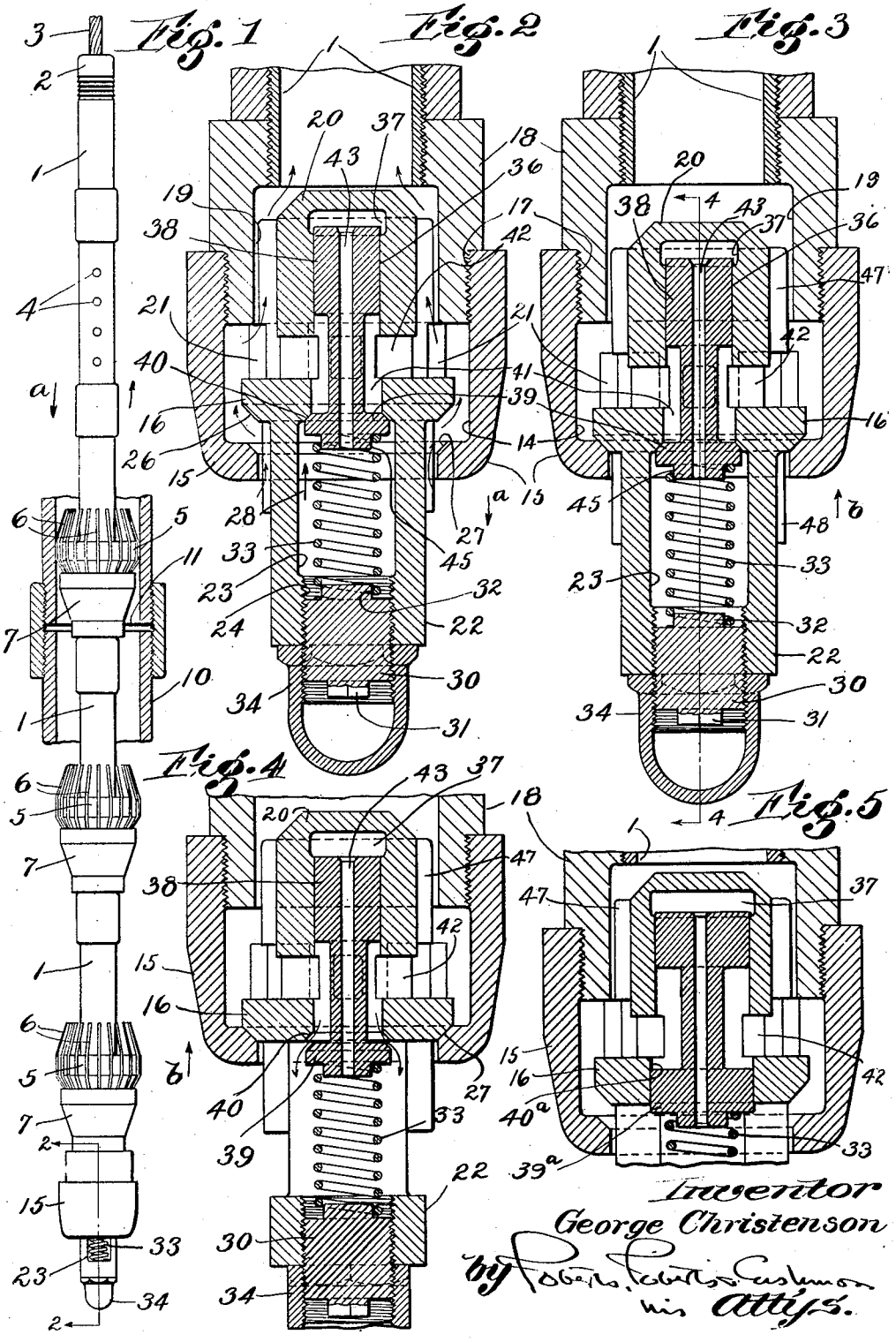
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SWAB VALVE

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SWAB VALVE.

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To all whom it may concern:

Be it known that I, GEORGE CHRISTENSON, a citizen of the United States of America, and resident of North Plainfield, in the county of Somerset and State of New Jersey, have invented new and useful Improvements in Swab Valves, of which the following is a specification.

This invention relates to heavy-duty plungers, bailing devices or swabs, so called, particularly useful for driving fluids against great pressures or, specifically, for lifting a column of fluid from a deep well.

I am aware of the use in oil well practice, for example, of lifting plungers, bails or swabs comprising essentially a weighted tube of smaller diameter than the lining or casing of the well to be operated upon, equipped with packings of one kind or another adapted to make a hydraulic piston contact between the periphery of the tube and the lining or casing of the well, and having therein a check valve permitting the weighted tube to be lowered by the adjunctive hoisting apparatus of the well into the fluid contents of the casing. When a well does not flow, the simplest way to recover the oil is to lower such a swab or bail to a distance estimated to be sufficiently beneath the upper level of the oil standing in the well and then to haul up the swab, which brings the oil with it.

In the operation of such devices it is not only difficult to maintain an oil-tight contact between the piston element of the swab and the casing of the well, which is often a rough tube, having burrs and sharp edges at its joints, with considerable variations in internal diameter, but it is also impossible to estimate from day to day the height of the column of oil in the well. The hoisting gear is rarely capable of lifting a whole column of oil, which may be 2000 or more feet long. When a swab or bail has been sent too deep into the oil, the enormous pressure developed on its piston element quite generally interlocks the piston element and the casing of the well, or results in the destruction of the piston element before the charge can be lifted; which, when the piston packings are rugged enough, produces so much resistance to lifting that the hoisting cable, drums or motor are incapable of the necessary effort. Under these circumstances, it is now practice to drop the swab to the bottom of the well and break it up with an explosive charge to permit recovery of the cable only.

It will be understood that there is a certain depth of immersion, or height and weight of the column of oil, which represents the most desirable quantity to lift out of a deep well by the swabbing or bailing operation. The nearer this quantity is to be the practicable maximum capable of being lifted, the better will be the efficiency of the operation.

Objects of this invention are to provide devices for use with a bailing or swabbing plunger adapted to measure the height of the column of oil detained by the swab and lifted by its hoisting cable; to provide a construction of plunger adapted to be used repeatedly with relatively infrequent renewals of renewable parts; to make the operation of bailing or swabbing certain and efficient, and to provide for the above and other purposes a valve device adapted to operate under conditions of high pressure automatically to entrap on one side of a piston or plunger with which it is or may be combined a certain quantity of fluid only, as measured by the hydrostatic pressure required to lift a column of the said fluid of a predetermined height.

The invention will now be explained in connection with certain illustrated instances of devices containing it, as shown in the accompanying drawings, in which:—

Fig. 1 is an elevation of a plunger, swab or bail equipped with the new device;

Fig. 2 is a section of an automatic valve on the plane 2—2 of Fig. 1 showing the main valve open;

Fig. 3 is a corresponding section showing the valve closed, for example during the lifting of a charge by the device of Fig. 1;

Fig. 4 is a section on plane 4—4 of Fig. 3 showing the main valve closed and the auxiliary valve open, for example during operation of the device of Fig. 1 at hydrostatic pressures above a predetermined limit; and

Fig. 5 is a section similar to Fig. 3 showing a modified form of auxiliary valve.

Referring now to Fig. 1 a suitable swab may comprise, as familiar to those skilled in the art, a suitable heavy metallic tubular stem 1 having a cable anchorage 2 for the wire cable 3, provided with a sufficient num-

ber of openings 4 to permit a fluid surrounding the stem 1 freely to enter the interior of the tube, and a sufficient plurality of packing cups 5, shown as three, to retain a heavy liquid column above the cups 5 despite irregularities of the casing 10 in which the device works. The cups 5 may be of any suitable construction, but are preferably provided with an exterior spring wire caging as shown at 6 to guard the edge of the cup 5 from such damage as would otherwise be caused by joints 11 in the casing 10, and other roughnesses and obstructions in the casing 10. The cups 5 may be mounted on the stem 1 in any desired way; as shown, by a heavy metal annular socket or cup 7 suitably fastened to the stem 1. The bottom of the stem 1 is equipped with a valve casing 15 containing a check valve 16 adapted to open upwardly on motion of the structure shown in Fig. 1 downwardly in the direction of arrow *a* against a gaseous or liquid resistance, and to close on motion upwardly against a similar resistance.

Preferably the casing 15 comprises a chamber formed as a cylindrical cavity 14, and is internally threaded at 17 to receive the reduced lower threaded end of an attachment collar 18 having a recess 19 providing an ample flow passage around an upward cylindrical extension 20 of the valve 16, which may have guide wings 47 for sliding contact in recess 19, and which is also provided with the usual crenellated upward extension or series of stop lugs 21 adapted, when the valve 16 is off its seat, to limit the upward motion of the valve 16 by contact with the collar 18.

The valve 16 may be provided with any appropriate closure face 26, and the casing 16 may be provided with any appropriate form of valve seat 27 providing suitable free spaces 28 when the valve 16 is open.

An opening through the stem 1 or past the packings 5, according to this invention, is arranged to be closed upon the occurrence of a predetermined downward pressure, or any lesser pressure, on the device as a whole. The opening referred to and the means for its obstruction or closure may be in any suitable part of the swab, but are preferably provided as adjunctive parts of the casing 15, and in relation to the check valve 16.

Valve 16, for example, may be provided with a depending extension 22, having exterior guide wings 48, preferably cylindrically chambered within, having lateral openings at 23 of liberal size, and interiorly threaded at 24 to receive an adjustable threaded plug 30 having a squared head 31 and an upwardly projecting positioning lug 32 for the lower end of a strong spiral spring 33. Plug 30 is locked in adjusted position by a locking cap-nut 34 or otherwise.

The upward extension 20 of the valve 16 is cylindrically bored at 36 and recessed at 37 to receive a cylindrical plunger 38 of a differential auxiliary valve 39 adapted under stress of spring 33 to close upon a seat 40 closing an opening 41 in the valve 16, which opening 41 communicates through ports 42 with the passages around the valve 16. The clearance space 37 communicates with the space under the valve 16 through a central bore 43 in the differential valve 38, 39, which valve is further provided with a seating lug 45 for the upper end of the spring 33. The bore 43 operates as a vent to enable the differential valve to operate under the influence of pressures on its parts 16 and 38 without hindrance by fluid in the chamber 37.

It will be obvious that the spring 33 holds the valve 39 upon its seat 40 in the valve 16 against pressures acting downwardly on the area represented by the differences in size between the valve 39 and the plunger 38. The valve 39 is slightly the larger, as shown. The spring 33 therefore opposes downwardly acting pressures tending to open the valve 39 and effective in relation to the area comprising the difference between the area of 38 and the area of 39 only. For example, if the difference in area is 0.001 sq. in., the valve 39 will close at pressures of 3000 pounds to the square inch or less when the spring 33 exerts a force of 3 pounds, and at other pressures proportional to the stress of spring 33 as it may be adjusted.

The differential valve 38, 39 may be varied in construction. For example, as shown in Fig. 5, the lower portion 39ª may be constructed as a cylindrical piston interfitting when closed with a cylindrical seat 40ª, with advantage in the accuracy with which the structure 38, 39ª opens and closes at a particular pressure in any adjustment of spring 33.

In operation, the whole device of Fig. 1, appropriately weighted if not already sufficiently heavy, is allowed to sink in the well to any predetermined depth in excess of the proper depth below the upper level of the oil or water to be swabbed out. This is permitted by the opening, unopposed, of valve 16, as shown in Fig. 2, during motion in direction *a*. The upper level of the column of fluid is generally unknown, and is never capable of being determined with any accuracy by devices likely to be on hand at an oil well. If the swab is now hauled up, moving in the direction of arrow *b*, Fig. 3, motion will result in closing valve 16, Fig. 3, whereupon the hydrostatic pressure resulting from the depth of the column of liquid above the swab is immediately exerted within the valve casing 15.

If the pressure so developed is in excess of the pressure which, acting on the area measured by the difference of area between the plunger 38 and valve 49, will overcome the adjusted resistance of spring 33, then

the differential auxiliary valve 39 will open, Fig. 4, and remain open during upward travel of the swab at a rate permitted by the resistance of the fluid passages through stem 1, ports 42, and the annular space around valve 39, without any greater strain on the cable 3 and cups 5 than the predetermined weight of the column of liquid intended to be lifted out of the well. When the swab is sufficiently withdrawn, decreasing weight and pressure of the column of liquid then above the swab permits the valve 39 or 39ª automatically to be seated by spring 33, Fig. 3, at the predetermined value of this weight as measured by the pressure effective on the differential excess of area of valve 39 or 39ª over plunger 38. Thereafter, the swab is a closed piston, and continued hauling lifts all of the liquid entrapped above the cups 5.

If desired the adjustment plug 30 may be graduated, to read directly in numbers of barrels or gallons or in pressures, but in practice this is not essential, the spring 33 being set up in response to experience to permit a convenient maximum effort only of the hoisting apparatus to be exerted.

It is obvious that the automatic valve described may be used with any desired type of tubular stem and any kind or kinds of packing cup, swab or plunger desired, with great advantage, and that when so used, the lifting stroke of the swab will deliver a maximum measured quantity of liquid only.

I claim:

1. Valve mechanism for use in deep-well swabs comprising a casing adapted for attachment to such swabs, said casing having an opening therethrough, a check-valve adapted to close said opening, said check-valve having an opening therethrough and a chambered extension, a differential auxiliary valve in said extension co-operating with said opening in said check-valve, and adjustable means for maintaining said auxiliary valve in open position upon the occurrence of pressures tending to close said check-valve and exceeding a predetermined pressure.

2. Valve mechanism comprising a casing and a check-valve for closing an opening in said casing; an auxiliary valve carried by the movable element of said check-valve and adapted to open and close a passage through the check-valve when the check-valve is seated, said auxiliary valve having therein oppositely effective pressure-actuated parts one of which is of greater effect than the other, in combination with a spring opposing the combined effect of said pressure-actuated parts.

3. Valve mechanism comprising a casing and a check-valve for closing an opening in said casing; an auxiliary valve carried by the movable element of said check-valve and adapted to open and close a passage through the check-valve when the check-valve is seated, said auxiliary valve having therein oppositely effective pressure-actuated parts one of which is of greater effect than the other, in combination with a spring and means for adjusting said spring mounted on said check-valve for opposing the combined effect of said pressure-actuated parts.

Signed by me at New York, N. Y., this 28th day of December 1923.

GEORGE CHRISTENSON.