

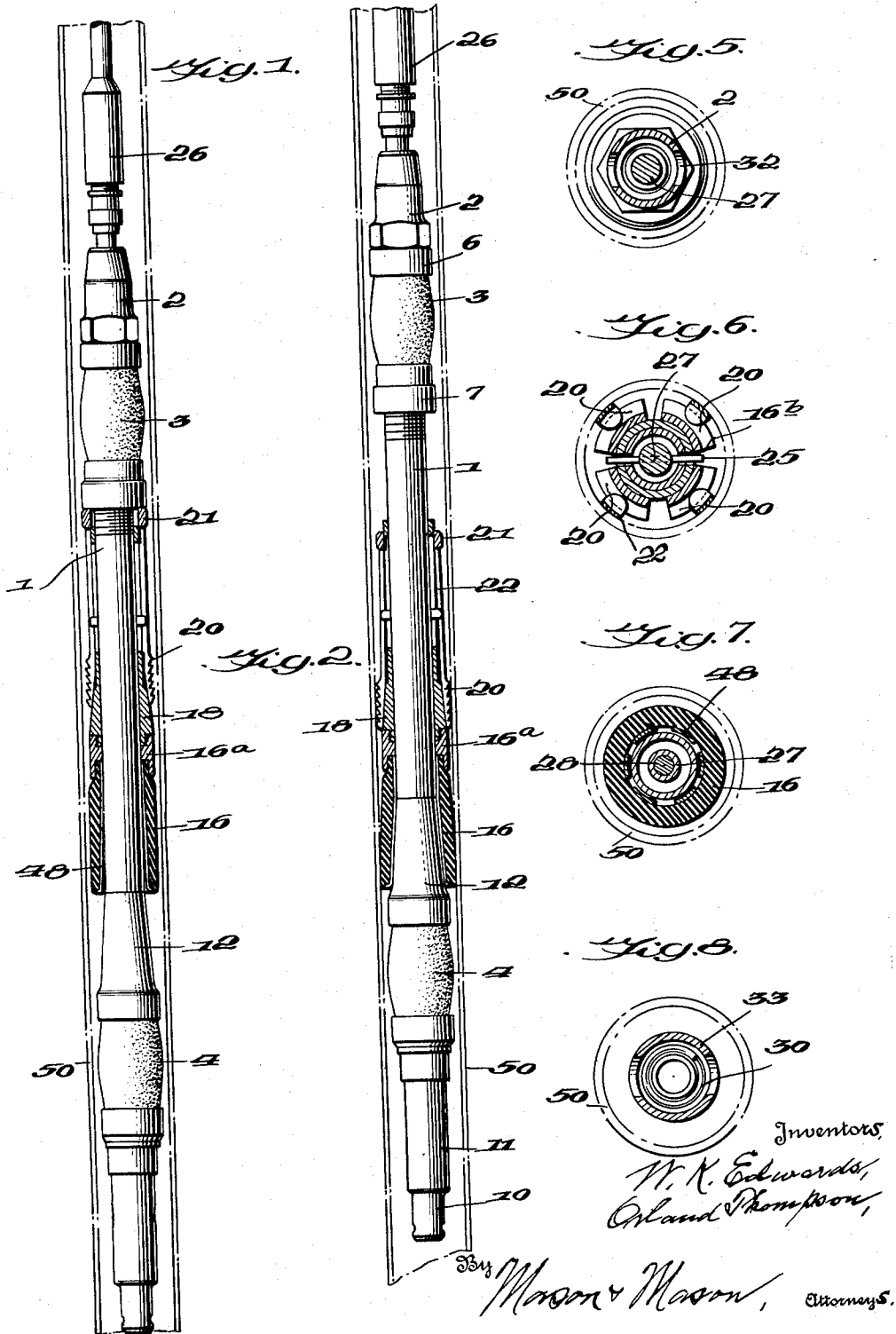
June 27, 1939.

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Filed Jan. 22, 1938

2 Sheets-Sheet 1



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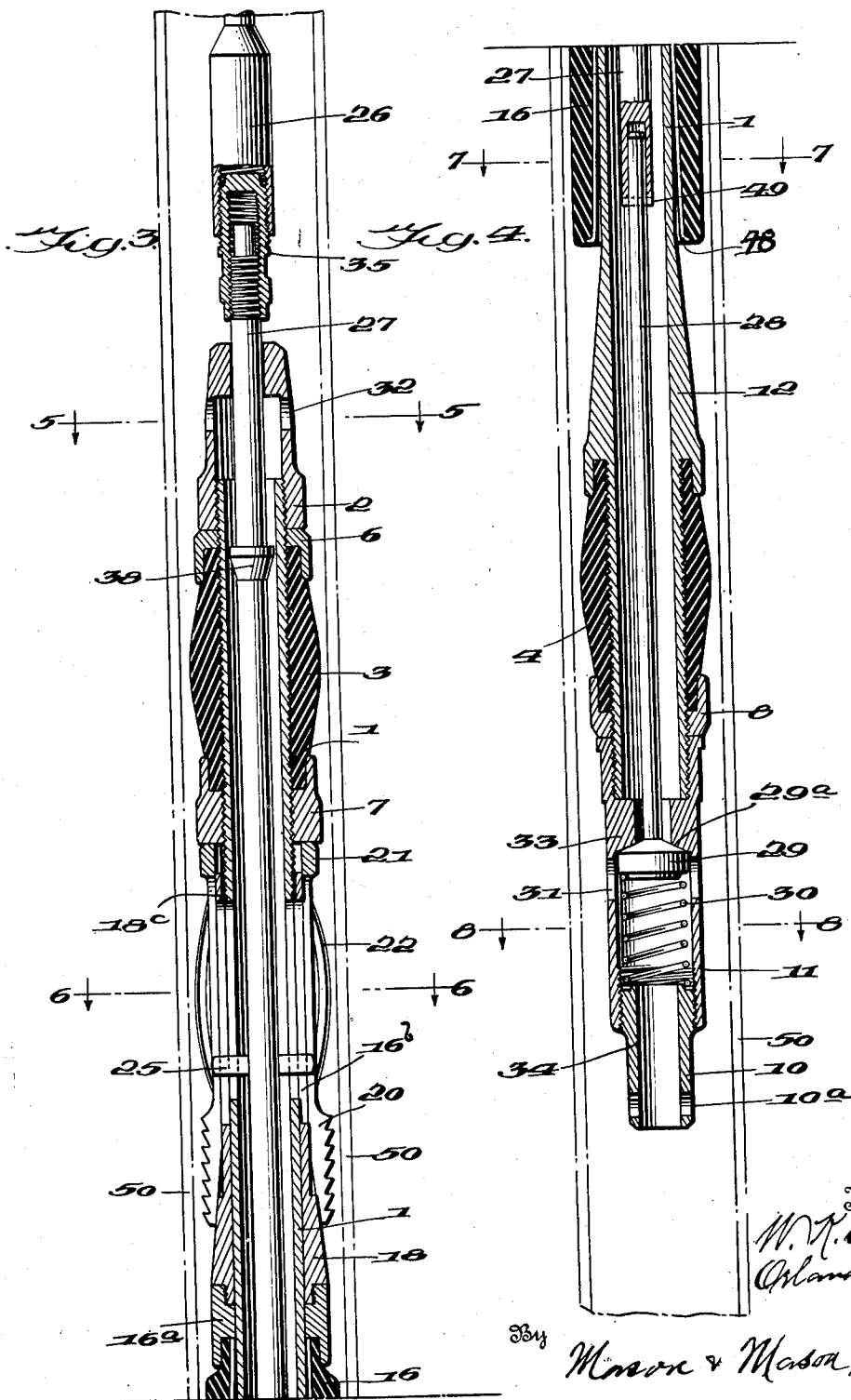
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UNITED STATES PATENT OFFICE

2,163,976

FLOW PREVENTER FOR OIL WELLS

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Application January 22, 1938, Serial No. 186,456

10 Claims. (Cl. 166—13)

This invention relates to devices of that type which are pumped down into an oil well for preventing the flow of oil upwardly through the well tubing while certain repairs or replacements of the tubing are being made, or for any other reason it is found necessary to withdraw the well tubing from an oil well, without permitting the oil to escape from the well.

Such devices are known in the oil well art as "pump down" plugs or flow preventers, and the present invention has to do with certain important improvements in such devices.

The withdrawal from the well of the tubing, for repairs or otherwise, renders it necessary to temporarily stop the flow of oil from below while such repairs or replacements of the tubing sections are being made, and while devices of this general character have been heretofore constructed, so far as applicants are aware, they have not operated with that certainty which is necessary to insure the complete cutting off of the oil from the well, either when the tubing is withdrawn or there is a leakage through the tubing. The present invention is devised for the purpose of insuring more certainty of the stoppage of the flow by the pump-down plug, and moreover, to enable the well operator to remove the plug when desired.

A further and very important object of the present improvements, however, resides in a means for flushing the well through the pump-down plug or flow preventer, as sometimes after the plug has been pumped or forced to the bottom of the tubing it has been found necessary to pump or circulate fluid through it, in order to free the tubing which may be obstructed or sandlocked. With a view to accomplishing this purpose applicants provide under the present invention a hollow mandrel in the flow preventer which contains a valve stem having thereon a valve which is forced to its seat in the lower portion of the plug by a spring. The tension of this spring may be so regulated that while it will resist the opening of the valve under the pressures which force the plug down into the well, the spring will yield when a higher pressure is applied to the fluid for the purpose of permitting a circulation of the fluid through the valve and plug, when desired.

The foregoing, and other important and valuable objects and advantages of the invention will be more fully understood from the following detailed description, when considered in connection with the accompanying drawings, in which

a pump down plug embodying the invention is illustrated.

In the drawings:

Figure 1 shows the invention, partly in vertical section and partly in elevation, with the expanding cone for the plug withdrawn,

Figure 2 is a view similar to Figure 1, but showing the parts in a different position; that is, with the rubber packer and slips expanded for holding the plug in position in the well;

Figures 3 and 4 illustrate the device in two separate parts, with the mandrel and packer parts in section, and the valve and valve stem parts in elevation;

Figure 5 is a section on the line 5—5 of Figure 3;

Figure 6 is a section on the line 6—6 of Figure 3;

Figure 7 is a section on the line 7—7 of Figure 4, and

Figure 8 is a section on the line 8—8, Figure 4. The mandrel 1, shown in elevation in Figures 1 and 2, and in section in Figures 3 and 4, is hollow and the upper portion thereof is externally threaded and is surrounded by a rubber 3 which is held in position between rings 6 and 7, threaded to the mandrel, while a cap 2 is threaded to the extreme upper end portion of the mandrel and provided with apertures 32 for conveying circulating liquid to the interior of the mandrel.

The lower portion of the mandrel is provided externally with threads and receives a lower rubber 4, whose lower end is secured in a ring 8, threaded to the mandrel, the upper portion of the rubber 4 being herein shown as secured within an annular recess in a tapering enlargement 12 of the mandrel. A packer sleeve 16 of rubber or other soft material, surrounds the mandrel and is provided with a longitudinal bore fitting over the enlarged tapering portion 12 of the mandrel and extending upwardly therefrom a substantial distance. The upper end of the rubber packer 16 is connected to a ring 16a, which surrounds the mandrel and slides thereon. A tapered sleeve 18 surrounding the mandrel is connected at its lower end portion with the ring 16a, and extending upwardly from the tapered portion of the sleeve a cylindrical part thereof is provided at opposite sides with diametrical slots 16b, the extreme upper extension of the cylindrical portion of the sleeve 18 terminating in a ring 18c, the sleeve, its cylindrical extension and terminal ring being free to slide for a limited distance upon the exterior of the mandrel, for a reason which will be hereinafter explained.

Surrounding the sleeve 18 are a plurality of slips 20 which are herein shown as integrally formed with a collar 21, the slips being separated from each other by slots, as shown, and leaf springs 22 extend from the collar 21 and have their outer end portions bearing against the slips to normally hold the latter contracted and out of gripping engagement with the interior of the well tubing, which latter is indicated by the numeral 50. The slips 20 are, as usual, formed with annular teeth as shown in order that they may when properly spread, grippingly engage the interior of the tubing so as to prevent the flow preventer from being blown outwardly by the pressure within the well, after the pressure of the pumping fluid from above has been diminished, or stopped. The interior walls of the slips are tapered as shown, from a large bore at the lower end to a small bore at the upper portion, as will be clear from the drawings, such tapering interior surface of the slips causing, through engagement with the tapered exterior surface of the sleeve 18, when the latter moves upwardly relatively to the slips, due to the pressure from below, a spreading movement of the slips outwardly whereby they are made to engage the interior of the well tubing to thereby arrest outward movement of the flow preventer as an entirety. When the pressure from the well below is less than the pressure from above, due to the pumping of the fluid downwardly, the slips will be out of wedging engagement with the surface of the sleeve 18, and the springs 22 will effect a contraction of the slips, thereby leaving the flow preventer free for movement in a downward direction. This occurs while the pump is operating to force the fluid against the flow preventer to cause it to move downwardly in the well to that point where it is desired to shut off the well flow from the tubing.

When the parts are as shown in Figure 1 of the drawings, the mandrel with its tapered portion 12 is withdrawn a slight distance below the packer sleeve 16 and the tapering sleeve 18 is in lowered position, out of wedging engagement with the slips 20 so that both the packer sleeve and slips are withdrawn inwardly, and out of contact with the interior of the well tubing. This is the position that the parts assume when the plug or flow arrester is being pumped down into the well by the hydrostatic pressure effected by the pump. In the drawings we have shown the parts of the pump down plug in Figure 2 as in that position which they assume when the hydrostatic pressure from above is diminished or entirely suspended, whereby the pressure of the oil from below will predominate, forcing the plug upwardly so that the enlargement 12 will spread the packer 16 against the wall of the well and at the same time the tapered sleeve will spread the slips 20 outwardly against, and in gripping engagement with, the well tubing so that the plug is prevented from moving outwardly and the packing 16 effects a tight joint between the well and plug to prevent outward escape of the oil.

As a means for effecting a circulation of the fluid through the pump down plug we have, under this invention, provided a hollow mandrel, and sliding interiorly thereof, as shown in Figures 3 and 4, a valve stem is provided. This valve stem is made in two parts, 27 and 28, the part 27 being at its lower end provided with a bore which receives the upper end portion of the section 28, as shown in Figure 4. A pin 49 extends transversely through an aperture in the

lower part 28 of the valve stem, and acts as a limiting means against relative movement of the two portions of the stem, in a direction towards each other. The telescopic, sliding connection between the two members of the valve stem, however, permits relative movement of these parts outwardly. The lower portion of the member 28 of the stem is provided with a valve 29 which seats upon a valve seat 29a formed in a section 33 of the mandrel, which is threaded to the lower end portion of the mandrel, and provided below the valve with ports 31 for the exit of water of circulation. The telescopic, sliding connection or slip joint between the two members of the valve stem is for the purpose of permitting the valve to be forced outward against the tension of the spring to permit the fluid to pass through the plug without affecting or moving the upper portion 27 of the valve stem, whose downward movement is limited through engagement of a key 25 with the ends of the slots through which said key passes.

A thimble 34 is externally threaded to engage an internal thread in the lower portion of the member 33, said thimble being provided with a central bore and having apertures 10a in the lower portion thereof. A spiral spring 30 is located in the member 33 and confined between the lower face of the valve and the thimble 34. The latter serves as a means for adjusting the tension of the spring 30, and hence, for determining by such tension the hydrostatic pressure which the valve will resist before opening to permit circulation of the fluid.

The upper portion 27 of the valve stem is provided with an enlargement or shoulder 38, and at a suitable distance therebelow, with a key 25, extending transversely through a slot in the stem. This key passes through diametrical guide slots in the mandrel 1, the upward extension of the sleeve 18, and the slips 20.

The upper end portion of the stem part 27 is externally threaded to receive an internal and externally threaded cap 35. A sleeve 26 is shown as in threaded engagement with the external thread of this cap. This sleeve is the size of the average pumping rod and is for the purpose of fishing the plug, when necessary to remove it, the diameter of the sleeve conforming to the tubing slips, or fishing tool, that is in common use. The sleeve 26 may be and preferably is lined with Babbitt or some soft metal, and being threaded to the cap 35, it may be broken loose from the plug by upward pull on the line, in case the plug should be so stuck in the well that it would be impossible to pull the same, in which event, as will be obvious, the internal threads of soft or Babbitt metal in the sleeve 26 would strip.

Preferably, and as herein shown, the packer 16 is lined interiorly with a plurality of strips 48, which act as a reinforcing liner for the packer, and delay the wearing out of the packer through contact with the tapering portion 12 of the mandrel, after repeated use of the plug.

It will be observed that during the operation of the oil pressure from the well the swab rubber 4 acts as a piston and effectively permits the pressure to not only spread the slips against the tubing to arrest movement of the flow preventer, but additionally, will effect the spreading of the packer sleeve 16 when the oil pressure from the well predominates over the pressure from the pump above. The pressure from below, accordingly, upon the swab rubber 4 effects an upward movement of the mandrel, thereby causing the

tapering portion 12 to spread the packer 16 and thus effecting an absolutely liquid-tight joint, preventing any flow of oil beyond the flow preventer. Also, it is apparent that when the plug 5 is being forced downward into the well the upper swab rubber 3 is that element of the plug upon which the pump pressure acts to force the plug downward into the well, preliminary to the release of pressure from above, under which circumstances the well pressure predominates.

When it is desired to circulate fluid through the plug, the pressure from the pump is simply increased to that point where it will overcome the resistance of the spring 30, thus forcing open the valve 29 and permitting the liquid to circulate. Unless the pressure from above is sufficient to open the valve during the normal operation of the plug down into the well, the valve remains closed, thus permitting the plug to be moved 20 downwardly to that point where it is desired to cut off the flow of the oil. It is common practice in well tubing to have a pin welded through the bottom of the tubing to prevent various tools from going out into the well, and this pin will 25 arrest the plug of the present invention when it reaches the bottom of the well, if it is ever forced down that far.

When it is desired to remove the plug from the well, fishing means, such as the sleeve 26, are 30 threaded to the cap 35, or upper portion of the valve stem, which latter is pulled upward. Preliminary to this operation it is usual with this device to first jar it down slightly, thus giving the slips a chance to release from gripping en- 35 gagement with the interior of the tubing, then upon an upward pull being applied to the valve stem, the key 25 will move upwardly in the slots in the mandrel, slip expander sleeve, and slips, and will lift the slips and packer up to the bottom 40 face of the sleeve 7 attached to the swab rubber, this action freeing the plug from engagement with the well tubing. A further movement of the valve stem upward will cause engagement between the shoulder or enlargement 38 and the 45 upper interior terminal wall of the cap 2 which affords a positive engagement between the valve stem shoulder 38 and the plug, thus enabling the latter to be removed from the well. As some resistance may be encountered in this operation, it 50 will be seen that the positive engagement between the stem and cap, which latter is an extension of the mandrel, will relieve the key 25 of the load created by the friction in lifting the plug out of the tubing, placing the entire strain upon the 55 valve stem shoulder and mandrel cap. During this operation it will be apparent that the telescopic connection between the parts 27, 28 of the stem, being shorter than the upward distance traveled by the stem before the shoulder 38 con- 60 tacts with the cap, will cause a separation of the stem parts. When the parts are re-inserted, however, a reverse movement of the stem will permit reengagement of the two stem parts by reason of the fact that the shoulder 38 will act 65 as a guide, thus insuring the movement of the lower end of the part 27 over the upper end of the part 28 to restore these elements to their normal condition. The downward pressure of water on the valve 29 does not move that valve a 70 sufficient distance to cause separation between the two parts of the stem.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

75 1. In a device of the class described, the com-

bination of a hollow mandrel having a tapered portion, a plurality of slips surrounding said mandrel, a wedge member slidable on the mandrel and engaging a wedging surface interiorly of the slips, pistons at the opposite ends of the mandrel, 5 a packer sleeve on said mandrel having a bore to engage the tapered portion thereof, whereby upward pressure on the mandrel will cause the slips to engage a well casing and will also effect a spreading of the packer sleeve against the tubing, 10 and a downwardly facing valve seat in said mandrel, a valve on said seat, a spring for holding said valve normally seated, said valve arranged to open under hydrostatic pressure to permit a circulation of fluid through the device.

2. In a device of the class described, the combination of a hollow mandrel, means carried by said mandrel and movable longitudinally thereon for effecting engagement between the mandrel and the well tubing, said means being operated by 20 pressure of the oil from the well, and a spring seated valve within said hollow mandrel provided with an upwardly extending stem formed of two slidingly connected parts permitting free movement of the lower part with the valve under 25 hydraulic pressure from within the mandrel to permit circulation of fluid therethrough.

3. In a flow preventer, a hollow mandrel provided interiorly with a valve seat, a valve stem and valve within said mandrel, the valve being 30 normally seated by a spring, means operable by pressure from the well to effect a locking of the mandrel to the well tubing, means operated by the same pressure for effecting a tight joint between the flow preventer and well, said spring 35 being of sufficient strength to hold the valve closed during the application of that amount of pressure necessary to force the flow preventer down into the well but arranged to yield and permit the valve to open under excess fluid pressure from above to cause circulation of said fluid 40 through the flow preventer.

4. In a flow preventer, a hollow mandrel, pistons on the mandrel arranged near opposite end portions thereof, a tapering member on said mandrel, a packing sleeve on said mandrel, slips carried by the mandrel, a wedging element for 45 spreading said slips operable when the mandrel is moved upward by pressure within the well, a valve seat in said mandrel, a valve stem and valve in said mandrel, and a spring for seating said valve, said spring being of strength sufficient to prevent the valve from being unseated by pressure from above until a predetermined pressure 50 has been exceeded, thus permitting circulation of the fluid downwardly and through the flow preventer.

5. In a flow preventer, a hollow mandrel, packing means and slips surrounding said mandrel, means sliding upon said mandrel for effecting out- 60 ward movement of the packing and slips due to pressure from the well, a two-part valve stem the members of which are in telescopic engagement located in said mandrel, a valve carried by the lower section of said stem, a spring for normally 65 holding said valve to its seat, and a shoulder on the upper portion of said stem arranged for engagement with an abutment carried by a portion of the mandrel to permit relative engagement between said portion of the valve stem and man- 70 drel in withdrawing the flow preventer from the well.

6. In a flow preventer, a hollow mandrel provided with a valve seat, a two-part valve stem in said mandrel having telescopic connection with 75

each other to permit relative movement of said parts to each other, a spring pressed valve carried by one of said valve stem parts and arranged to be held on said valve seat by its spring, the other
 5 portion of said valve stem provided with a transversely extending key, and with a shoulder above said key, said key arranged for movement through slots in said mandrel, and said shoulder being arranged for engagement with an abutment
 10 carried by the mandrel for withdrawing the flow preventer from a well.

7. In a flow preventer, a hollow mandrel provided with a valve seat and an externally tapered portion, a plurality of slips surrounding said
 15 mandrel, a tapering sleeve slidable on the mandrel and engaging a wedging surface interiorly of said slips, pistons on the opposite ends of said mandrel, a packer sleeve on said mandrel having a bore to engage the tapered portion thereof,
 20 whereby upward pressure on the mandrel will cause the slips to engage a well casing and movement of the mandrel thereafter under pressure against the lower piston will effect a spreading of the packer sleeve in engagement with the well
 25 casing, a valve stem in said mandrel provided with a shoulder and having a transversely extending member which slides in slotted portions in said mandrel wedge member and slips and arranged upon upward movement of the stem to
 30 lift the slips and packer upwardly and thereafter through engagement of the shoulder on the stem with an abutment in said mandrel to effect withdrawal of the flow preventer from the well.

8. In a flow preventer, the combination of a
 35 hollow mandrel provided with an enlarged conical portion, expansible slips surrounding said mandrel, a packer surrounding the conical portion of said mandrel, means for spreading said slips upon upward movement of the mandrel, pistons located
 40 on opposite ends of the mandrel, a valve stem

having a valve thereon within said mandrel, a spring normally holding said valve against a seat therein, and ports arranged for the entrance of fluid near one end of the mandrel and for the exit of said fluid near the opposite end of said
 5 mandrel.

9. In a flow preventer, a hollow mandrel provided with means for circulating fluid there-
 10 through, means for arresting upward movement of said mandrel actuated by pressure from the well, pistons located near opposite ends of the mandrel, a stem in said mandrel, a combined stop and guide on said stem for engagement with an
 15 abutment on the mandrel at the upper terminal of movement of the stem when withdrawing the latter from the well, and a sleeve having soft metal internal threads for threaded engagement with said valve stem to provide a rupturable connection between said stem and sleeve upon the
 20 application of an upward force to withdraw the flow preventer from a well.

10. In a flow preventer, a hollow mandrel provided at its ends with means permitting the entrance and exit of circulating fluid therethrough, a packer and slips surrounding said mandrel, 25 means sliding upon said mandrel for effecting outward movement of the packing and slips due to pressure from the well, a two-part valve stem in said mandrel the members of which are in telescopic connection, a valve carried by the lower
 30 section of said stem, a string for normally holding said valve against a valve seat in said mandrel, and a projection on the upper portion of said stem arranged for engagement with an abutment within the mandrel to permit withdrawal of the mandrel from the well when an upward pull is exerted
 35 upon the upper portion of the valve stem.

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