July 21, 1964 G. A. THOMAS 3,141,506

DEVICE FOR USE IN PRESSURIZING WELL TUBING AND THE LIKE AND FOR RELEASING SUCH PRESSURE

Filed May 22, 1962

FIG. 1

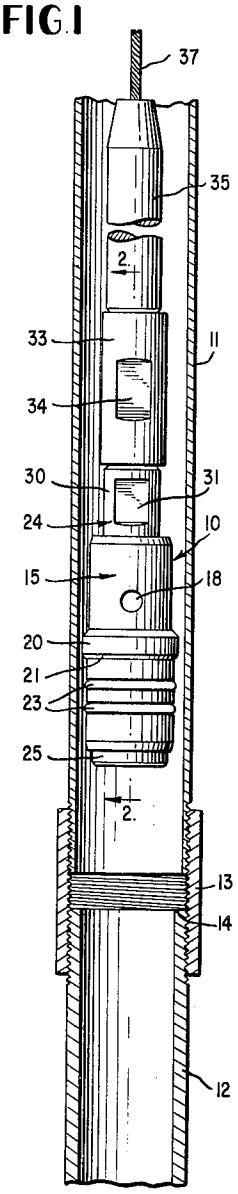


FIG. 2

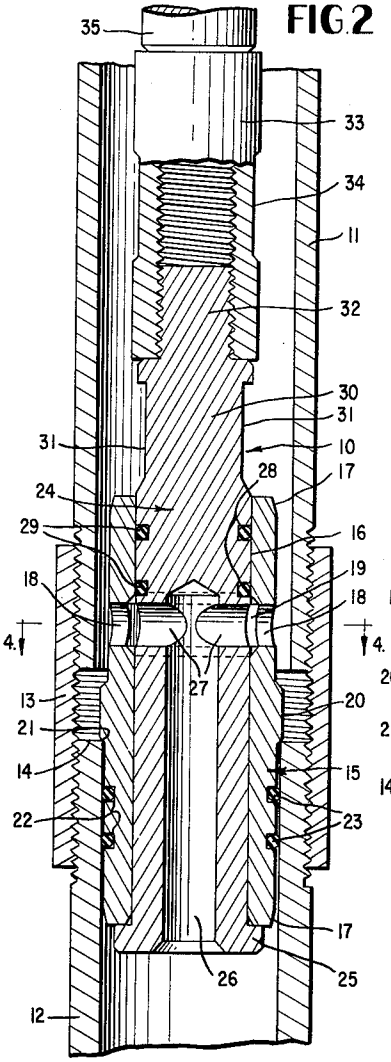


FIG. 3

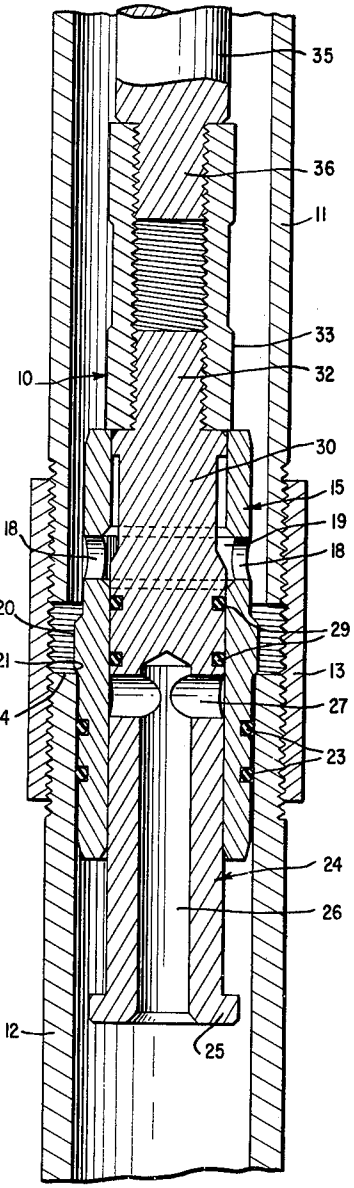
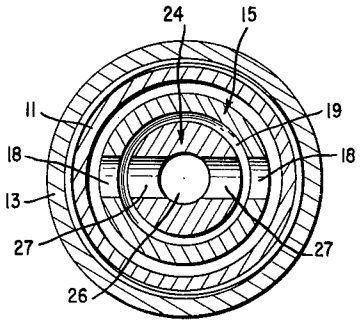


FIG. 4



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3,141,506

DEVICE FOR USE IN PRESSURIZING WELL TUBING AND THE LIKE AND FOR RELEASING SUCH PRESSURE

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This invention relates broadly to wells, and more particularly to a tool or implement for plugging well casing or tubing deep down in a well bore hole to facilitate pressurizing the casing or tubing by means of fluid and for other like purposes.

An important object of the invention is to provide a device of the above-mentioned character which is highly economical in construction, simplified, compact, reliable and efficient in operation and readily recoverable from a great distance below the surface of the earth.

A further object is to provide a device for plugging or closing off well casing or tubing at any desired point along the same and having the characteristics of a bypass valve in one adjusted position thereof and serving as a casing or tubing plug in a second adjusted position thereof.

Another object is to provide a device of the mentioned character which is very rugged and durable, requiring no adjustment and little or no maintenance and which is adapted for a wide variety of uses in the well industry, as will be well known to those skilled in the art.

Other objects and advantages of the invention will be apparent during the course of the following detailed description.

In the accompanying drawings forming a part of this application and in which like numerals are employed to designate like parts throughout the same,

FIGURE 1 is a side elevation of a tool for plugging well casing or tubing according to the invention, partly broken away, and showing a section of well casing or tubing within which the tool is being placed, the well casing being shown in cross section,

FIGURE 2 is an enlarged fragmentary central vertical longitudinal section through the tool and well casing showing one adjusted position of the tool to allow free circulation of fluid through the casing,

FIGURE 3 is a similar sectional view showing a second adjusted position of the tool for blocking the flow of fluid through the casing as when pressure testing the latter or operating certain instrumentalities connected therewith which require fluid pressure within the casing, and

FIGURE 4 is a transverse horizontal section taken on line 4—4 of FIGURE 2.

In the drawings, wherein for the purpose of illustration is shown a preferred embodiment of the invention, the numeral **10** designates the device or tool of the invention in its entirety and shown as it is being lowered into a casing string **11**, FIGURE 1, a section of well tubing or the like far below the surface of the earth. At any desired point along the casing string **11**, near the bottom thereof or at some intermediate point, a nipple **12** may be connected therein by a suitable screw-threaded coupling sleeve **13**. The upper end of the nipple **12** forms an annular horizontal shoulder **14** of somewhat smaller internal diameter than the inside diameter of the well casing or tubing proper. The well bore hole of any desired depth has been omitted from the drawings for the purpose of simplicity.

The tool **10** comprises an outer open ended relatively short generally cylindrical plug sleeve **15** having an axial

cylindrical smooth through bore **16**. The ends of the plug sleeve **15** may be beveled as shown at **17**. Relatively near the upper end of the plug sleeve **15** and below such end, the plug sleeve has a pair of diametrically opposed radial ports **18** formed through the side wall thereof. An internal annular groove **19** is formed in the bore of the plug sleeve **15** adjacent the ports **18** so that the latter may communicate around the circumference of the plug sleeve. The plug sleeve is further provided externally and approximately at its longitudinal center with an enlarged integral annular shoulder **20** having a lower tapered seating surface **21** adapted to engage and rest upon the annular shoulder **14** of the nipple **12**, FIGURE 2. Below the annular shoulder **20**, and above the lower end of the plug sleeve, the same is further provided with external annular grooves **22** receiving O-ring seals **23** or the like adapted to engage snugly within the cylindrical bore of the nipple **12** to plug the same in a fluid tight manner.

The tool **10** further comprises an inner valve and plunger element **24**, generally cylindrically shaped and adapted to engage telescopically and slidably within and through the plug sleeve **15**, as shown. At its lower end, the element **24** has an integral enlarged annular head **25** disposed exteriorly of the plug sleeve **15** and having a smaller diameter than the latter and adapted to abut the lower end of the plug sleeve in one adjusted position as shown in FIGURE 2. The valve and plunger element **24** is provided in its lower end with a central axial passage **26** leading upwardly for a substantial distance above the bottom of the element **24** and terminating therein. The element **24** also has radial ports **27** intersecting and communicating with the top of the passage **26** and opening through diametrically opposite sides of the element **24** and adapted to register with the ports **18** and groove **19**, FIGURE 2, when the head **25** abuts the lower end of plug sleeve **15**.

The valve and plunger element **24** is further provided externally, above the ports **27**, with annular grooves **28**, receiving O-ring seals **29**, for snug fluid tight sealing engagement with the through bore **16** of plug sleeve **15**. The element **24** has an integral longitudinal extension **30** extending axially of the plug sleeve **15** when the parts are positioned as in FIGURE 2. The extension **30** may have wrench-engaging flats **31** formed thereon as shown. A reduced screw-threaded stem **32** on the extension **30** is detachably coupled with a tubular internally screw-threaded coupling part **33** also having wrench-engaging flats **34** thereon to facilitate tightening or loosening of the coupling parts. A ferrule **35** has threaded engagement at **36** with the coupling part **33**, and the ferrule **35** is suitably firmly anchored to a supporting wire or cable **37** of any required length to support the tool **10** a great distance below the surface of the earth. The cable supporting and coupling structure may be conventional and need not be further described herein.

The entire tool **10** as shown and described is very slender and can be constructed so that its maximum outside diameter is only about 2¼ inches, enabling the tool to be extended through well tubing having an inside diameter of about 2½ inches. The size of the tool and its components is a variable to meet the needs of various applications within the scope of the invention.

In use, the tool **10** supported on the wire or cable **37** is lowered into a casing string or well tubing having the nipple connected therein at any desired elevation in the well. The parts of the tool are initially positioned as shown in FIGURE 1 with the lower end of the plug sleeve **15** resting upon and supported by the head **25**. The ports **27** and **18** are in open communication. When the tool **10** is arranged above the seating shoulder **14**, as in FIGURE 1, fluid may flow freely downwardly in the tube

or casing 11 and around the tool 10 and this fluid may pass through the bottom of the casing or tubing and circulate upwardly in the well bore hole, not shown.

When the tool 10 is lowered to the position shown in FIGURE 2 and the seating surface 21 engages the shoulder 14, the lower end portion of the plug sleeve 15 enters and seals the bore of the nipple 12, and the O-ring seals 23 prevent the passage of fluid from above through the nipple 12. However, as long as the ports 18 and 27 remain in communication, FIGURE 2, the fluid from above may enter the ports 18 and groove 19 and pass through the ports 27 and the passage 26 and circulation of fluid may continue downwardly through the tool to the open bottom of the casing string or tubing and then upwardly through the well bore hole externally of the tubing.

Continued lowering of the wire 37 after engagement of the seating surface 21 with shoulder 14 allows the valve and plunger element 24 to shift downwardly by gravity and with the aid of inertia to the position shown in FIGURE 3, wherein the head 25 is spaced below the plug sleeve 15 and the lower end of coupling 33 is engaging the top of the plug sleeve. In this position, the ports 27 are shifted below and out of registry with the groove 19 and ports 20 and the seals 29 seal the bore of the plug sleeve below the ports 18. Consequently, the fluid in the tubing or casing string is now plugged off and prevented by the tool from entering the nipple 12, and a double seal is provided within the bore of the nipple 12 by the seals 23 and within the bore of the plug sleeve 15 by the seals 29. Fluid pressure may then be built up in the tubing above the tool 10 and this pressure may be allowed to increase to the extent desired by controlling the hydrostatic head of the column of fluid which collects in the tubing above the tool. This hydrostatic pressure is utilized for various purposes such as for pressure testing the casing string or well tubing, or for operating various pressure-responsive units which may be connected with the casing or tubing. For example, the hydrostatic pressure developed above the tool may be utilized for operating the formation protecting means disclosed in my copending application S.N. 172,019, filed Feb. 8, 1962, for Method of and Apparatus for Completing Oil Wells and the Like. The hydrostatic pressure may also be utilized for various other purposes well known to those skilled in the art.

When it is desired to re-establish normal circulation of fluid through the tubing and bore hole, it is merely necessary to elevate the plunger and valve element 24 to the position shown in FIGURE 2 to again place the ports 18 and 27 in communication, and the fluid from above the tool may again circulate freely through the ports 18 and 27 and through the outlet passage 26 to the nipple 12. This quickly equalizes the fluid pressure in the tubing above and below the tool 10 rendering it very easy to elevate the entire tool from the casing or tubing along with the wire or cable 37. If there is any tendency for the plug sleeve 15 to stick in the bore of the nipple 12, the head 25 may be utilized to tap the bottom of the plug sleeve and this will quickly loosen the latter. This feature whereby the movement of the parts to the position shown in FIGURE 2 quickly equalizes the fluid pressure above and below the tool 10 to facilitate its easy withdrawal from the casing or tubing is an important novel feature of the invention. If this feature were not present for relieving the heavy hydrostatic pressure caused by the column of fluid above the tool in FIGURE 3, it would be difficult or impossible to remove the tool from the casing after the pressure is built up to a high degree.

The tool is therefore essentially a positive acting shut-off valve or plug for the well casing or tubing which may be readily operated and controlled from a distant point at ground level, far above the locale of the tool proper. At such location of the tool far down in a well, it is not practical or possible to operate conventional valve structures involving screw-threaded parts, levers or the like. By means of the invention, the entire tool is controlled,

operated, inserted and withdrawn by means of the wire 37 and the coaction of the plug sleeve 15 with the nipple 12 and the two simple relatively movable elements 15 and 24 of the tool. If a mere plugging ball or like object were to be utilized for plugging the nipple 12, it would be impossible to extract the same from the tubing due to the hydrostatic head developed above the same as stated, and the invention fully overcomes this difficulty and provides a convenient and economical tool which can be reused indefinitely for a variety of purposes.

It is to be understood that the form of the invention herewith shown and described is to be taken as a preferred example of the same, and that various changes in the shape, size and arrangement of parts may be resorted to, without departing from the spirit of the invention or scope of the subjoined claims.

I claim:

1. Apparatus for regulating the circulation of fluid in a well casing or the like and for pressurizing and depressurizing said casing, said casing having a nipple of lesser diameter than the bore of said casing and providing an annular shoulder within the casing, said apparatus comprising an open-ended sleeve having a through bore and an external enlargement intermediate its ends and being insertable through the bore of the casing toward and into said nipple, a first fluid seal means on the exterior of said sleeve engageable snugly and sealingly within the bore of said nipple with said enlargement then abutting and resting upon said shoulder of the nipple, said sleeve having side opening fluid passage means above said shoulder and enlargement communicating with the bores of the sleeve and said casing, a reciprocatory valve element within the bore of said sleeve and having an axial opening formed through its lower end and extending throughout a major portion of its length and terminating within the valve element, said valve element having radial side opening means formed therein near the top of the axial opening and intersecting the same and adapted for radial registration with the side opening fluid passage means of said sleeve when the valve element is in an elevated position within said sleeve, an enlarged external head on the lower end of said valve element abutting the lower end of the sleeve when the valve element is in said elevated position and said side opening and fluid passage means are in registry, a second fluid seal means on the exterior of the valve element above said side opening means and sealingly engaging the bore of the sleeve when the valve element is in said elevated position and said head is engaging the lower end of the sleeve, a shoulder on the valve element above said second seal means and spaced from the top of said sleeve during registry of said side opening and fluid passage means and adapted to abut the upper end of said sleeve to positively limit downward movement of the valve element within the sleeve, the second seal means sealing the bore of said sleeve below the fluid passage means of the sleeve when said shoulder and valve element is engaging the upper end of the sleeve and said head of the valve element is spaced below the lower end of the sleeve, said side opening means of the valve element then being covered by the bore of the sleeve below said fluid passage means thereof, and a flexible element secured to the top of the valve element and carrying said apparatus bodily and allowing it to be lowered into and raised from the bore of said casing, reciprocation of the valve element within the bore of the sleeve causing repeated engagement of said head with the lower end of the sleeve serving to dislodge the sleeve from the bore of said nipple.

2. A reuseable valve device for regulating the circulation of fluid through a well casing or the like and for pressurizing said casing and relieving fluid pressure therein comprising in combination a sleeve having a through bore and radial openings near one end communicating with the through bore, an external fluid seal on said sleeve near its other end and spaced from said radial openings, an external shoulder on said sleeve intermediate said

openings and seal, a reciprocatory valve element extending telescopically through said sleeve and having external enlargements formed thereon above and below said sleeve, said enlargements being spaced apart axially a distance exceeding the length of said sleeve, a flexible element secured to the top of the valve element to raise and lower it relative to said sleeve and with said sleeve, said valve element having an axial fluid passage opening through its lower end and radial fluid passages opening through its side wall intermediate its ends and communicating with said axial passage and adapted to register with said sleeve side openings when the lowermost enlargement of the valve element is contacting the lower end of said sleeve, and an external fluid seal on said valve element above said radial passages of the valve element and adapted to seal the bore of said sleeve above and below the radial openings of said sleeve.

3. The invention as defined by claim 2, and wherein said first and second-named seals comprise at least one O-ring seal on the exterior of said sleeve and valve element, said sleeve and valve element having external grooves receiving said O-ring seals.

4. A fluid control apparatus for use in well casings and the like comprising a cylindrical sleeve having a through bore of constant diameter and radial fluid passages opening from said through bore near and below the top of the sleeve and an annular enlargement below said radial passages, O-ring seals on the exterior of said sleeve below said enlargement, a plug valve element extending through the bore of said sleeve slidably and being longer than said sleeve and having external enlargements above and below said sleeve and spaced apart axially a distance greater than the length of said sleeve, a flexible actuating element secured to the top of the valve element to manipulate it relative to and with said sleeve, O-ring seals on the exterior of the valve element intermediate said enlargements and adapted to seal the bore of the sleeve above and below said radial fluid passages thereof, said valve element having an axial fluid passage opening through its lower end and terminating within the body of the valve element near the seals of the valve element, said valve element having radial fluid passages leading from said axial passage below the seals of the valve element and adapted to register with the radial passages of the sleeve when the lowermost enlargement of the valve element is in abutting relation to the lower end of the sleeve, said radial passages of the valve element being covered by the bore of the sleeve below the radial passages of the sleeve when the uppermost enlargement of the valve element is in abutting relation to the upper end of the sleeve.

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