

Aug. 8, 1944.

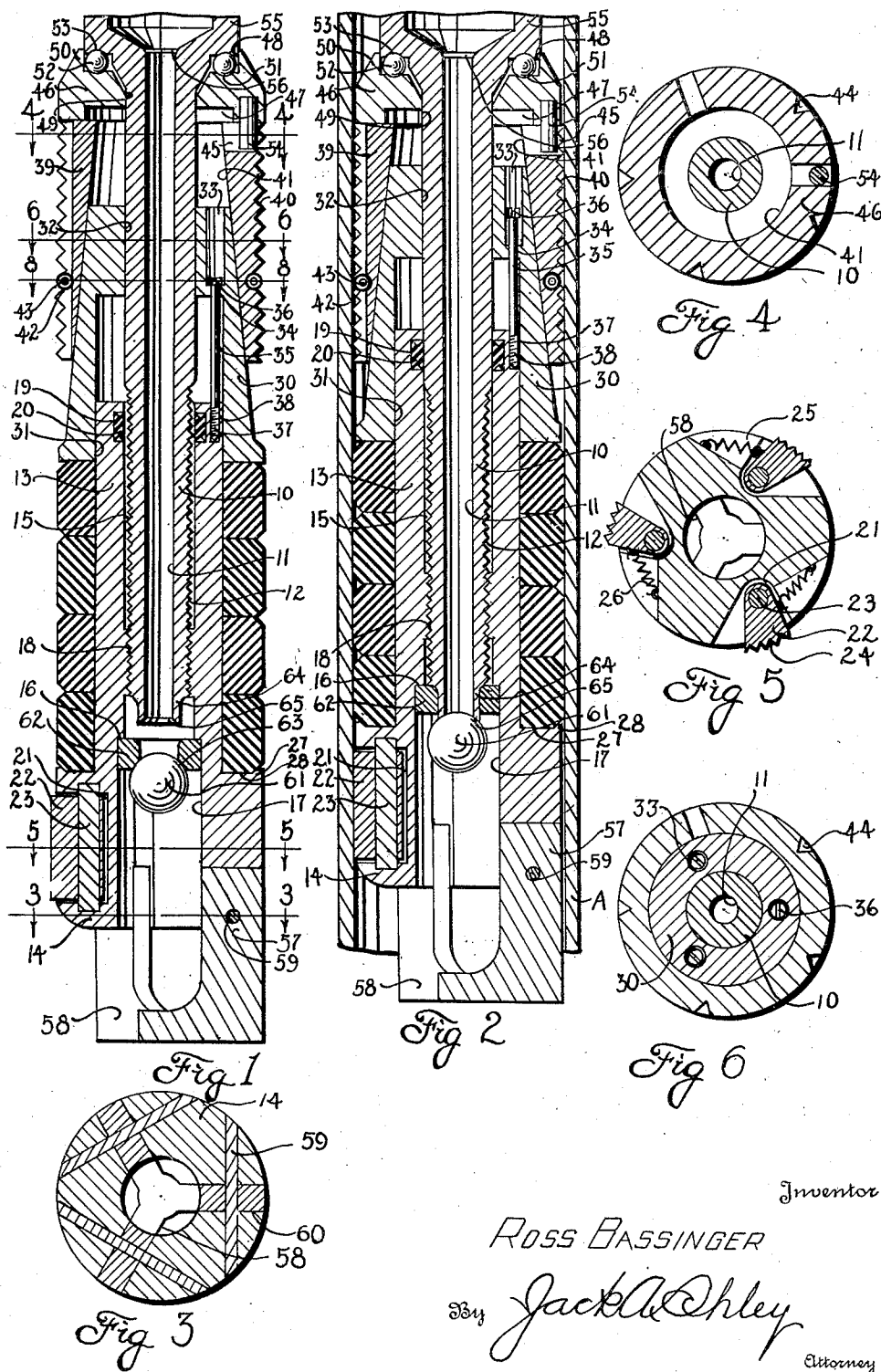
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2,355,199

WELL PLUG

Filed May 6, 1940

2 Sheets-Sheet 1



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Aug. 8, 1944.

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WELL PLUG

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2 Sheets-Sheet 2

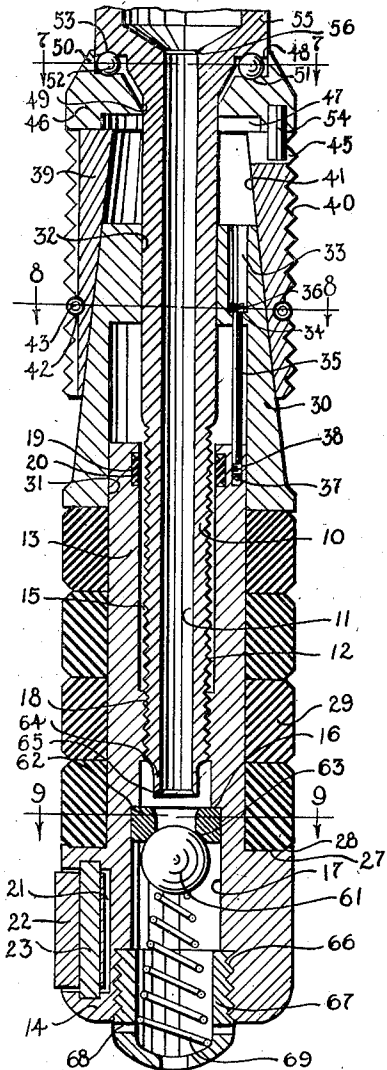


Fig 11

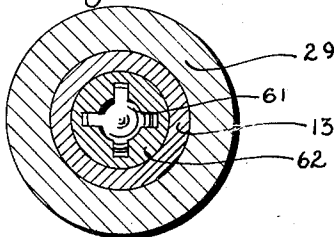


Fig 9

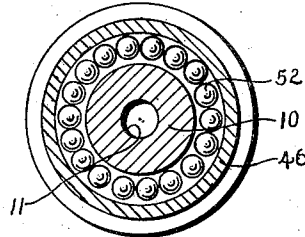


Fig 7

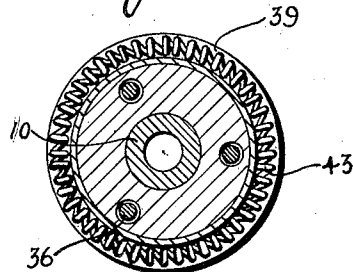


Fig 8

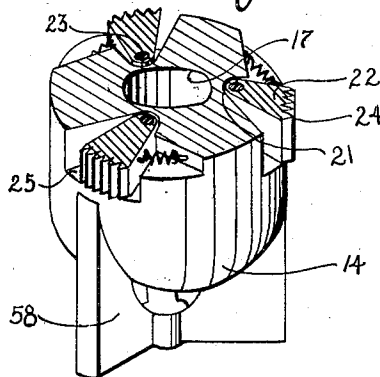


Fig 10

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UNITED STATES PATENT OFFICE

2,355,199

WELL PLUG

Ross Bassinger, Houston, Tex.

Application May 6, 1940, Serial No. 333,584

7 Claims. (Cl. 166—12)

This invention relates to new and useful improvements in well plugs.

One object of this invention is to provide an improved well plug which may be quickly and readily set in a well bore; and which is arranged to prevent the accidental or premature setting thereof.

An important object of the invention is to provide an improved well plug which is so arranged that any fluid pressure acting upwardly against the plug, after the latter has been set in the well bore, will tend to further distort the packing means and increase the set of the slip means, whereby the plug will not be loosened in the well bore or caused to leak by the pressure fluid.

A further object of the invention is to provide an improved well plug which is formed in its entirety of readily drillable material, and wherein means is provided for holding the various elements against rotation during the drilling operation so that, when desired, the plug may be drilled out and circulated out of the well bore by means of the drilling fluid.

A still further object of the invention is to provide an improved well plug adapted to be lowered into the well bore upon a tubing string, and to be set by the rotation of said tubing, and which may be used as a cement retainer, a flow packer, and a bridge plug.

Still another object of the invention is to provide an improved well plug which is constructed of a minimum number of parts, whereby the manufacture of the plug is rendered less difficult and expensive, and the operation of the plug is simplified and made more efficient and positive.

A further object of the invention is to provide an improved well plug having a frangible slip member arranged to be readily broken into sections when engaged by a drill in drilling up the plug.

Still another object of the invention is to provide an improved shoe for a well plug arranged to anchor the plug in the well bore when cemented.

Another object of the invention is to provide an improved well plug, wherein the means for holding the plug against rotation is disposed at the lower extremity thereof, so as to hold the elements above said means against rotation while they are being drilled up.

A construction designed to carry out the invention will be hereinafter described, together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings, in

which an example of the invention is shown, and wherein:

Figure 1 is a longitudinal sectional view of a well plug constructed in accordance with the invention, showing the plug as it is lowered into the well bore,

Figure 2 is a view similar to Figure 1, showing the well plug set in the well bore,

Figure 3 is a horizontal, cross-sectional view taken on the line 3—3 of Figure 1,

Figure 4 is a horizontal, cross-sectional view taken on the line 4—4 of Figure 1,

Figure 5 is a horizontal, cross-sectional view taken on the line 5—5 of Figure 1,

Figure 6 is a horizontal, cross-sectional view taken on the line 6—6 of Figure 1,

Figure 7 is a horizontal, cross-sectional view taken on the line 7—7 of Figure 11,

Figure 8 is a horizontal, cross-sectional view taken on the line 8—8 of both Figures 1 and 11,

Figure 9 is a horizontal, cross-sectional view taken on the line 9—9 of Figure 11,

Figure 10 is an isometric view of the lower portion of the plug, showing the construction of the wall-engaging dogs and the anchoring member, and

Figure 11 is a longitudinal, sectional view of a well plug, constructed in accordance with a modification of the invention.

In the drawings, the numeral 10 designates an elongate tubular mandrel or actuating element which has an axial bore 11 extending there-through. The lower portion of the mandrel is slightly reduced and provided with external screw threads 12. The mandrel telescopes the sleeve or shank 13 of an annular shoe 14, the shank and sleeve forming a support. The sleeve 13 is provided with an axial bore 15 which terminates at its lower end at an annular shoulder 16 formed at the upper end of an enlarged axial bore 17 in the shoe. A short distance above the shoulder 16 the bore 15 of the sleeve is formed with an annular boss or nut 18 which is internally screw-threaded to receive the screw threads 12 of the mandrel, so that when the mandrel is rotated, it will be moved longitudinally in the bore of the sleeve. In order to pack off the sleeve and mandrel, an annular recess 19 is provided in the upper end of the bore 15 of the sleeve, and receives an annular, pressure-sealing, packing ring 20 which has an internal diameter of such size as to permit the screw threads 12 to pass freely therethrough, but to snugly engage around the smooth outer surface of the mandrel as shown in Figure 2.

The shoe 14 is provided with a plurality of elongate, radial, vertical recesses 21 in which suitable back-off dogs 22 are mounted. The dogs are secured by pins 23 which extend longitudinally of the recesses, said dogs being adapted to swing into engagement with the inside wall of the casing A upon clockwise rotation of the plug. Each of the dogs 22 carries vertical gripping teeth 24 upon its outer end, said teeth being so designed as to resist right-hand rotation of the sleeve. A horizontal groove 25 extends backwardly from each of the recesses, and a short coil spring 26 is positioned in each of the grooves. One end of each of the springs 26 is secured to the shoe 14 within one of the grooves 25, while the other end of each spring is secured to one of the dogs. Since the springs are under tension, they act to urge the dogs and the teeth constantly into engagement with the wall of the casing. It is pointed out that the teeth 24 are designed to allow vertical movement of the dogs, while resisting and substantially preventing lateral or rotative movement of the latter. Obviously, counterclockwise or left-hand rotation of the sleeve will cause the dogs to swing inwardly out of engagement with the casing A.

The upper portion of the shoe 14 forms an outwardly-directed annular shoulder 27 above the back-off dogs, and an upwardly-directed annular flange 28 is provided on the outer edge thereof. A plurality of suitable resilient packing rings 29 rest upon the shoulder within the flange and surround the shank 13. A slip-actuating or setting member 30 rests upon the upper end of the uppermost packing ring, which is spaced downwardly from the upper end of the shank 13. The member 30 is substantially frusto-conical in contour, and is provided at its lower portion with an enlarged, axial, circular counterbore 31. The bore is of sufficient diameter to receive the upper end of the shank and extends upwardly some distance into the member. A bore 32 extends upwardly from the counterbore throughout the remainder of the member, and is of sufficient diameter to receive the mandrel 10.

A plurality of circular longitudinal bores 33 extend downwardly from the upper end of the member to the counterbore 31 thereof and are spaced radially about the bore 32. Each of the bores 33 is provided with an axial counterbore 34. A bolt 35 is disposed in each of the bores 33 so as to have the enlarged head 36 of the bolt disposed in the counterbores 34, while the lower screw-threaded end 37 of the bolt extends into the counterbore 31. A plurality of longitudinal, internally screw-threaded, circular recesses 38 are provided about the upper end of the sleeve, and are adapted to receive the lower screw-threaded ends 37 of the bolts 35. Thus, the engagement of the bolt-heads 36 within the recesses 33 limits the upward travel of the slip-actuating member 30 with respect to the shank 13 and the mandrel 10, but allows the shank 13 to travel upwardly within the counterbore 31 as shown in Figure 2.

A split slip or pipe-gripping member 39 rests upon the member 30, and is provided with the usual external casing-engaging teeth 40. The teeth 40 are adapted to engage the inside wall of the casing A, and prevent the upward or downward movement of the well plug with respect thereto. The slip member is formed with an axial inverted frusto-conical bowl 41 which is complementary to, and adapted to be engaged by, the conical-shaped member 30. In the unset position

shown in Figure 1, the upper end of the member 30 extends into the bowl 41.

An annular groove 42, substantially circular in cross-section, is formed in the outside wall of the slip member, and encircles the latter in a horizontal plane at a point spaced above the lower end thereof. A coil garter spring 43 is positioned within the groove 42 and surrounds the slip member so as to compress the latter. As will be noted in the drawings, the outside diameter of the slip member is slightly less than the outside diameter of the other elements of the plug, so that as the plug is lowered into the well bore, there will be no possibility of the slip member contacting the inside wall of the casing and accidentally setting the plug. Also, the garter spring 43, together with the inherent resiliency of the slip member, will serve to hold the member in a contracted position, so that the possibility of accidentally setting the plug by allowing the slip member to engage the casing wall is eliminated.

As is shown in Figures 4 and 6, a number of longitudinal grooves 44 are provided upon the face of the slip member 39. When the plug is set in the well bore, as will be hereinafter described, the engagement of the member 30 with the slip member 39 will exert an expanding force upon the slip member. Under these conditions, the grooves 44 will allow the member 39 to break up into longitudinal sections which may be readily milled and circulated out of the well bore. A radial recess or groove 45 is formed in the upper end of the member and extends from the inside wall of the bowl to the teeth.

A bearing block 46, having an enlarged circular recess 47 formed in its bottom, rests upon the upper end of the slip member 39, and is disposed beneath an annular shoulder 48 formed upon the upper portion of the mandrel 10. The block 46 is provided with an axial bore 49 for receiving the mandrel. An upstanding marginal flange 50 is provided on the upper end of the block, and is contiguous to the periphery of the shoulder 48. An annular race 51 is formed in the upper end of the bearing block between the flange 50 and the upper portion of the bore 49. A plurality of bearing balls 52 are disposed in the race 51, and have their upper sides engaging in a race 53 formed in the lower side of the shoulder 48. In addition, a pin 54 extends downwardly from the lower side of the bearing block, and engages in the groove 45. The pin 54 serves to hold the bearing block against any appreciable rotative movement with respect to the slip member 39.

The mandrel has its upper end 55 formed integral with the lower end of the sleeve of a clutch device, such as is shown in my co-pending application filed February 5, 1940, Serial No. 317,232, now Patent No. 2,317,021, granted April 20, 1943, and which it is not considered necessary to illustrate herein; however, any tool suitable for the purpose may be connected to the upper end of the mandrel. An annular seat 56 is provided at the upper end of the bore 11 of the mandrel for receiving a valve ball (not shown) when the device is used as a bridge plug or for any other purpose; however, said seat may be omitted if desired.

An anchoring member 57, consisting of three rectangular plates or blades 58, joined along one common vertical edge and equiangularly displaced from one another, is secured by means of pins 59 within three radial slots 60 formed in the shoe 14 and equiangularly displaced from one another. Each of the pins 59 passes horizontally through the shoe and one of the blades 58 (Figure 3), so that the member 57 is securely

held in position. The lower portion of the anchoring member projects some distance below the lower end of the shoe for reasons to be set forth hereinafter. As is shown in Figures 1 and 2, the bore 17 continues downwardly some distance into the anchoring member and terminates at a point short of the lower end of the member. Thus, communication through said bore with the space below the shoe is maintained.

A suitable valve ball 61 is positioned within the bore 17. An annular spider 62, having an axial ball seat 63 has a snug sliding fit in the bore 17 below the shoulder 16, which arrests said spider at the upper end of its movement. The frictional engagement of the spider with the bore 17 is sufficient to hold the spider in position, but allows the spider to be forced downwardly in said bore. The seat 63 is of sufficient diameter to accommodate the lower end 64 of the mandrel, which is reduced so as to telescope said seat. It is pointed out that the valve ball 61 will rest in the anchoring member 57 when the plug is assembled, but when the plug is lowered into the well bore the ball will be forced upwardly against the spider 62 by the fluid present within said bore. The mandrel has an annular beveled valve seat 65 formed on its lower end for the valve ball 61 to seat against. When the device is in its set position, the ball will engage the valve seat 65 to prevent fluid from flowing upwardly through the mandrel.

The setting of the plug is simply and easily carried out. The plug is suspended from a string of tubing (not shown), and lowered into the well bore; the well fluid present therein will flow upwardly around the ball 61 and through the spider 62. The bolts 35 will hold the slip-actuating member 30 down upon the shank 13. The well fluid flowing upwardly, past the member 30, might tend to raise the member and cause it to expand the slip member 39 into a setting position. Also, the frictional drag of the packing rings 29 against the casing wall, or the encountering of trash and foreign material in the well bore, would sometimes be sufficient to set the slip member and the plug prematurely. The bolts 35 securely hold the member against upward movement and thereby eliminate these possibilities.

When the desired point is reached in the well bore, the plug is rotated (by means of the tubing string) in a clockwise direction, thereby allowing the springs 26 to pull the dogs 22 into engagement with the inside wall of the well casing A. In this position, the dogs prevent further rotation of the shoe 14 and shank 13, and force the mandrel to screw downwardly within the screw-threaded boss 18 of said shank. As the mandrel continues to rotate, and screw downwardly within the bore of the shank, it forces the shank, along with the packing rings 29 and the slip-actuating member 30, to move upwardly against the slip member 39. The slip member is forced against the bearing block 46 which bears against the bearing balls 52, said balls in turn engaging in the race 53 against the shoulder 48. Since the slip member cannot move further upwardly, the conical contour of the member 30 will force the slip member to expand against the garter spring 43 so that the teeth 40 engage the inside wall of the casing A. Continued rotation or upward movement of the mandrel will set the slip member securely. When the slip member is firmly set, the continued upward movement of the shank 13 and shoe 14, through the rotation of the mandrel, will force the packing rings 29 to distort into a

packed-off position, as is shown in Figure 2. At the same time, the upper unthreaded portion of the mandrel 10 will move into contact with the packing ring 20, thereby positively sealing off all avenues of escape up the well bore with the exception of the bore 11 of the mandrel. Thus the plug is set positively and very snugly in the well bore.

There are many instances in the petroleum industry in which this well plug may be used to advantage. One of the most advantageous uses of the plug is as a cement retainer. In this instance, the plug is set in the well bore as hereinbefore set forth. It is pointed out that as the plug is lowered into the well, the ball 61 will ride against the spider 62, due to the upward flow of the well fluid past the plug, but will not shut off the flow of the well fluid upwardly through the bore 11 of the mandrel 10 because of the open construction of said spider. After the plug has been set, the cement may be pumped down the bore of the tubing, through the bore 11 of the mandrel, into the well hole. As is shown in Figure 2, in the set position of the plug, the lower reduced end 64 of the mandrel will extend through the opening of the spider so that the ball 61 seats upon the ball seat 65 formed thereupon. The frictional engagement of the spider within the bore 17 allows the former to be forced downwardly by the mandrel as the plug is set. The ball will seat upon the seat 65 and will act as a back-pressure valve during and after the cement pumping operation. As will be noted, the presence of fluid pressure beneath the plug may in no way cause the plug to loose or slip. Any upward motion of the plug will cause the member 30 to wedge more securely beneath the slip member 39, thus setting the slip member more securely. It is also pointed out that any desirable degree of setting of the plug may be obtained by placing tension upon the mandrel through the tubing string. Obviously, upward movement of the mandrel will set the slip member more securely, and distort the packing rings 29 to a more tightly packed-off position. If desired, a valve ball (not shown) may be dropped down the bore of the tubing so as to seat upon the ball seat 56, thereby shutting off communication with the bore 11 of the mandrel 10. Any suitable type of washdown and disconnecting means may be positioned above the plug.

When it becomes desirable to drill out the plug and circulate the cuttings out of the well bore, the operation is readily accomplished, due to the fact that the entire plug may be formed of drillable material. It will be noted that the dogs 22 are situated in the lower end of the plug so that the upper portion of the plug will be held against rotation as it is drilled out. Also, the anchoring member 57 is firmly embedded in cement at the completion of the cementing operation. The engagement of the blades 58 in the cement will hold the entire plug against rotation, even after the dogs have been drilled out.

It is important that all the various elements of the plug be held against rotation during the drilling out operation. If any one element was not held against rotation, it might rotate with the cutting mill used and thereby require an excessively long period of drilling. For this reason, this plug has been constructed in such a manner that all of the elements are held against rotative movement after the plug has been set in a well bore. It will be noted that the bolts

35, which secure the member 30 to the shank 13, will hold said member against rotation, and that the slip member 39 is also held against rotation by means of its frictional engagement with the member 30 and the inside wall of the casing. The engagement of the pin 54 within the groove 45, of the slip member, holds the bearing block 46 against rotative movement so that the entire outside assembly of the plug is held against rotation by the dogs 22 and the anchoring member 57. In this manner, a cement retainer is provided which is readily and positively set in the well bore, and which may easily be drilled or milled out when so desired.

A modification of the invention is shown in Figure 11. This form of the invention is very similar to the form described hereinbefore, with the exception that the extreme lower end of the bore 17 of the shank 13 is enlarged and carries internal screw threads 66. The anchoring member 57 is omitted, and is replaced by a bull-nose plug 67 which is externally screw-threaded to engage in the screw threads 66. Openings 68 are provided in the nose of the plug to establish circulation through the bore 17, and a conically-shaped helical spring 69 is confined between the plug and the valve ball 61. Thus the spring 69 tends to urge the ball constantly upward into engagement with the spider 62, before the well plug is set, and the valve seat 65, after the plug is set. In all other respects as to structure and operation, the modified form of the invention is substantially the same as the first form hereinbefore described.

Other important uses of the well plug, described hereinbefore, are as a bridge plug and as a production or flow packer. If it is desired to use the plug as a bridge plug, the plug is set in the usual manner and a suitable valve element dropped down the bore of the tubing string so as to rest upon the ball seat 56. In this manner, flow is shut off both upwardly and downwardly through the bore 11 of the mandrel, which, as pointed out hereinbefore, is the only passage open for communication through the plug. It will be noted that the slip teeth 40 are designed to hold the plug against both upward and downward movement, whereby the plug is firmly anchored against pressure acting thereupon from above or below. Also, pressure acting from above the plug cannot dislodge the slip-actuating member 30 from behind the slip member 39, due to the full floating construction of the member 30. The member 30 is not rigidly connected to any other part of the plug, and is therefore free to remain in position behind the slip member, even though the other elements of the plug may shift their position slightly. Pressure acting from below the plug would, manifestly, tend only to set the member 30 more tightly behind the slip member.

If the operator desires to use the plug as a production or flow packer, the valve ball 61 is omitted from the completely assembled plug, and the latter is set in the usual manner. The absence of the valve ball will allow fluids to flow upwardly through the bore 11 of the mandrel and the bore of the tubing string. At the same time, the space between the tubing and casing above the plug is sealed off, so that any fluids present therein are prevented from entering the tubing string. If desired, the spider 62, and certain other elements unnecessary to the operation of the plug as a production packer, may be omitted from the completed assembly of the plug.

The modified form shown in Figure 11 is particularly adapted for use as a bridge plug or a flow packer, however the form shown in Figures 1 to 10, inclusive, may be likewise used, but neither form is limited to such use.

The well plug described hereinbefore possesses various other apparent and advantageous uses and applications, all of which constitute a part of this invention.

Various changes, alterations and modifications may be made in the size, shape and arrangement of the herein described elements within the scope of the appended claims.

What I claim and desire to secure by Letters Patent is:

1. A well packing device including, a support, an anchor attached to said support and having depending anchoring blades, means carried by the support for holding the device against rotation, a packer carried by the support, means carried by the support for expanding the packer and securing the device in a well casing, and means engaging and movable longitudinally of the support for actuating the expanding and securing means.

2. A well packing device, including, a support, an anchor attached to said support, means carried by the support for holding the device against rotation, a packer carried by the support, means carried by the support for expanding the packer and securing the device in a well casing, and means engaging and movable longitudinally of the support for actuating the expanding and securing means, said expanding and securing means including means for holding the packer against upward movement, whereby premature actuation of the expanding and securing means is prevented.

3. A well packing device including, a mandrel, a shoe, a sleeve secured to said shoe and attached to said mandrel, a packer carried by the sleeve, dogs carried by the shoe for holding the device against rotation, a spider mounted in the sleeve, a valve ball disposed below the spider, a valve seat formed on the lower end of the mandrel and adapted to be engaged by the valve ball, means for securing the device in position, and means for expanding said securing means.

4. A well packing device including, an actuating element having a longitudinal bore, a support movably carried by the actuating element, an anchor attached to the support and having depending anchoring blades, said actuating element and support having co-acting means for moving said support longitudinally of the element when the means is actuated by said element, packing means mounted externally upon the support, casing-engaging means carried by said support, a setting member having connection with the support and movable relative thereto expansible pipe-gripping means slidably disposed upon and adapted to be expanded into pipe-gripping position by the setting member, whereby the movement of the support longitudinally of the actuating element causes expansion of the pipe-gripping means and distortion of the packing means.

5. A well packing device including, an actuating element having a longitudinal bore, a support movably carried by the actuating element, an anchor attached to the support and having depending anchoring blades, said actuating element and support having co-acting means for moving said support longitudinally of the element when the means is actuated by said element, packing means mounted externally upon

the support, casing-engaging means carried by said support, pipe-gripping means disposed above the packing means and support, and means associated with the pipe-gripping means movable relative to said support for expanding said pipe-gripping means and distorting said packing means into sealing position when the support is moved longitudinally of the actuating element.

6. A well packing device including, an actuating element having a longitudinal bore, a support movably carried by the actuating element and having an axial bore communicating with the bore of said element, valve means including a valve and a seat member in the bore of the support, the seat member having an opening for bypassing fluid upwardly through the bores of said support and elements when the valve is seated and the device is being lowered through a well casing, the element and support having co-acting means for moving said support longitudinally of said element when the means is actuated by the element, packing means mounted externally upon the support, an anchor attached to the sup-

port and having depending anchoring blades, casing-engaging means carried by said support, pipe-engaging means disposed above the packing and support, and means associated with the pipe-gripping means and movable relative to the support for expanding said pipe-gripping means and distorting the packing means into sealing position when said support is moved longitudinally of the actuating element.

7. A well packing device including, a support, an anchor attached to the support and having depending anchoring blades, means carried by said support for holding the device against rotation, a packer mounted on the support, means carried by said support for expanding the packer and securing the device in a well casing, means engaging and movable longitudinally of the support for actuating the expanding and securing means, and anti-friction means associated with the actuating means and said expanding and securing means for assisting in moving the latter means into active position.

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