

April 5, 1966

S. L. VILLALON, JR
RETRIEVABLE BRIDGE PLUG

3,244,233

Filed April 4, 1963

3 Sheets-Sheet 1

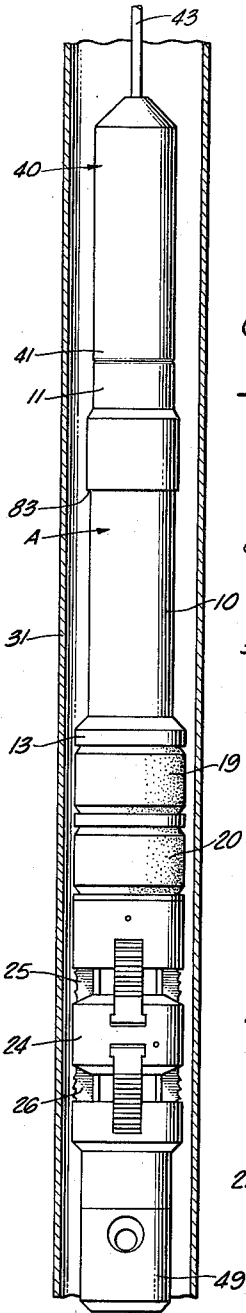


Fig. 1.

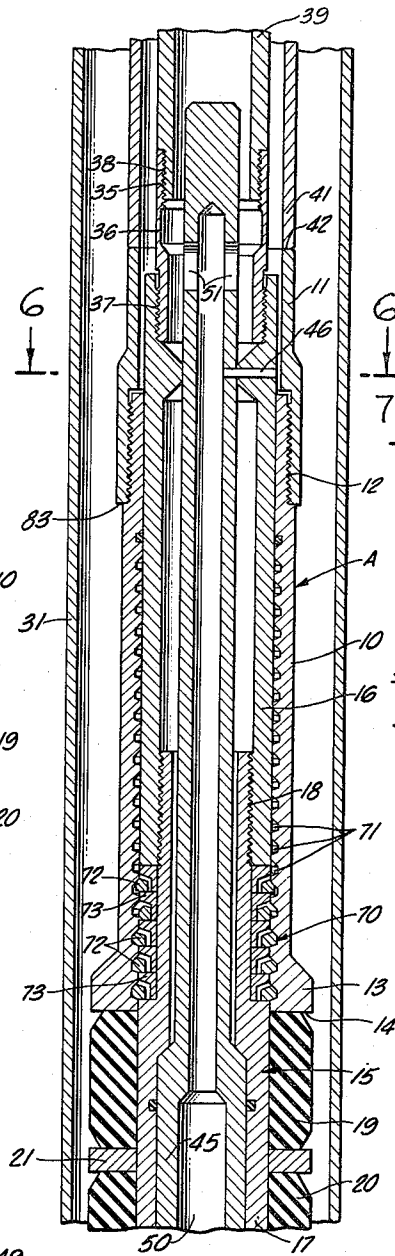


Fig. 2.

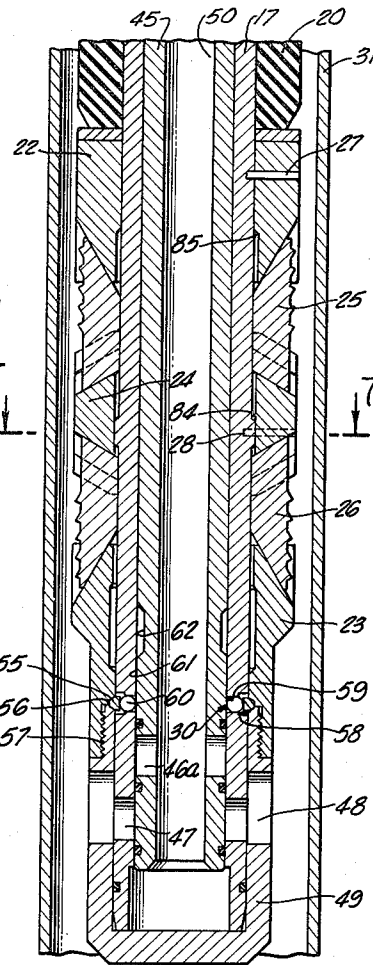


Fig. 3.

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3 Sheets-Sheet 2

Fig. 4.

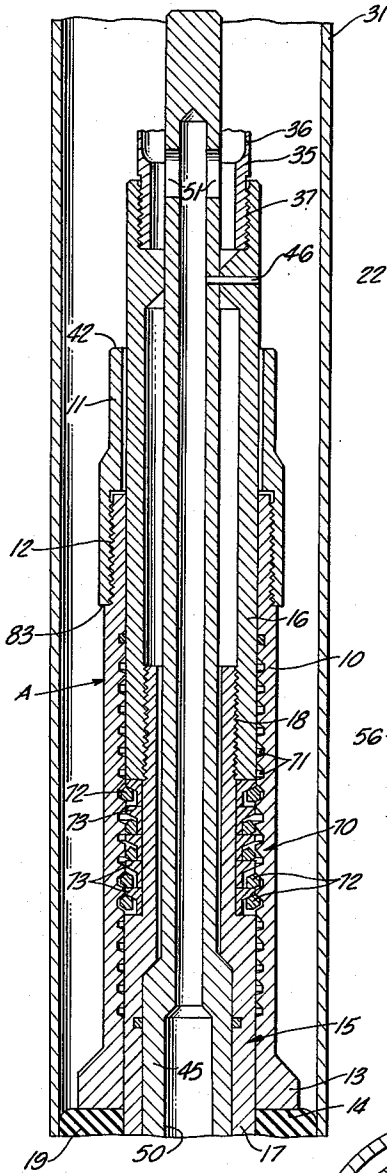


Fig. 5.

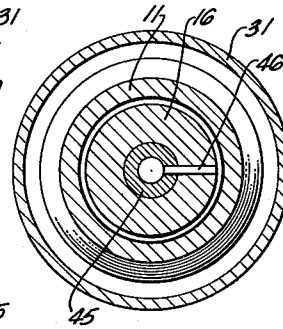
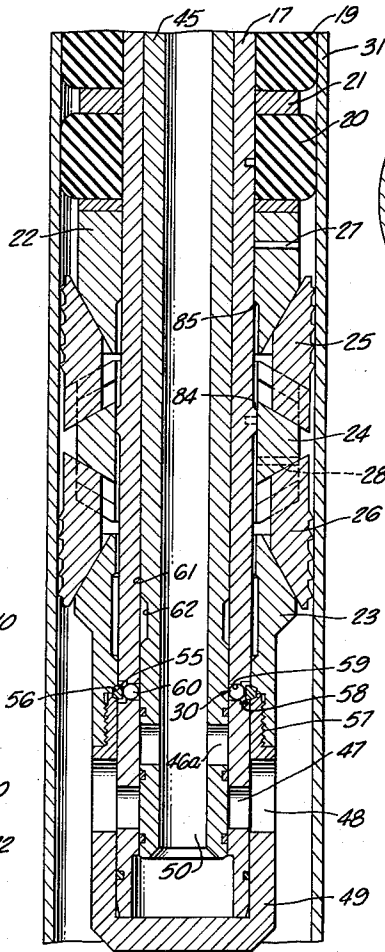


Fig. 6.

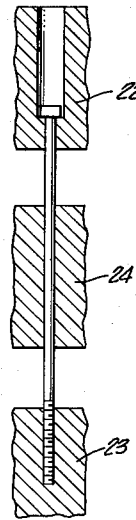
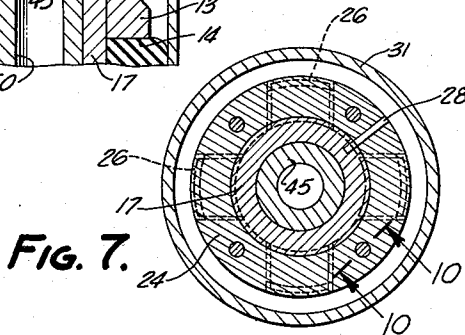


Fig. 10.



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1

3,244,233

RETRIEVABLE BRIDGE PLUG

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5 Claims. (Cl. 166-123)

This invention relates to bridge plugs of the type used in a casing string in a well and is particularly directed to an improved form of retrievable bridge plug which may be run into the well casing on a wire line or on a tubing string and set in position.

The setting tool and wire line are withdrawn from the casing string, leaving the bridge plug set in the desired position for subsequent well treating or cementing operations. The bridge plug may later be removed from the well casing by means of an overshot. After being re-dressed and recocked, the retrievable bridge plug may be set again in the same or other casing string.

The principal object of the present invention is to provide a retrievable bridge plug assembly having novel means for attaining all of the above-named attributes.

Another object is to provide such a device which is relatively simple in construction, easy to operate, and not apt to get out of order.

Another object is to provide a device of this type having inner and outer mandrels movable as a unit to set a packer and slip assembly within the casing and movable separately by means of the overshot to release the packer and slips to accomplish removal of the device from the well casing.

Other and more detailed objects and advantages will appear hereinafter.

In the drawings:

FIGURE 1 is a schematic diagram, showing a bridge plug assembly carried on the lower end of the setting tool and in position within a well casing.

FIGURE 2 is a sectional elevation, showing the upper portion of the bridge plug assembly constituting a preferred embodiment of this invention.

FIGURE 3 is a continuation of the lower end of FIGURE 2; FIGURES 2 and 3 show the position of the parts in the "running-in" position.

FIGURES 4 and 5 show the position of the parts after the device has been "set" in the well casing; FIGURE 4 shows the upper portion of the device, and FIGURE 5 is a continuation of the lower end of FIGURE 4.

FIGURE 6 is a transverse sectional view taken substantially on the lines 6-6 as shown in FIGURE 2.

FIGURE 7 is a transverse sectional view taken substantially on the lines 7-7 as shown in FIGURE 3.

FIGURE 8 shows the position of the parts after an overshot has been lowered into the casing to retrieve the device.

FIGURE 9 is a continuation of the lower end of FIGURE 8.

FIGURE 10 is a sectional detail taken substantially on lines 10-10 as shown on FIGURE 7.

Referring to the drawings, the retrievable bridge plug assembly A includes a tubular body 10, having at its upper end a tubular extension 11 connected by the threads 12. The lower end of the body includes a flange 13 provided with a downward-facing shoulder 14. An outer mandrel 15 has an upper mandrel section 16 and a lower mandrel section 17 connected by threads 18. The body 10 encircles the upper mandrel section 16, and the lower mandrel section 17 is encircled by a pair of deformable packer collars 19 and 20 separated by a metal ring 21. Slidably mounted upon the lower mandrel section 17 are an upper wedge collar 22, a lower wedge collar 23, and a slip retainer ring 24. An upper set of slips 25 is posi-

2

tioned between the upper wedge collar 22 and the slip retainer ring 24, and a lower set of slips 26 is positioned between the slip retainer ring 24 and the lower wedge collar 23. Shear pins 27 act to prevent relative movement of the upper wedge collar 22 and the lower mandrel section 17. Similarly, shear pins 28 act to prevent relative movement of the slip retainer ring 24 with respect to the lower mandrel section 17. A releasable locking device generally designated 30 acts to prevent relative movement of the lower wedge collar 23 with respect to the lower mandrel section 17.

From this description, it will be understood that downward movement of the body 10 relative to the outer mandrel 15 serves to shear the pins 27 and 28, causing the slips 25 and 26 to move outward to engage the inner surface of the casing 31 and causing the deformable packer collars 19 and 20 to expand into sealing relationship with the inner surface of the casing 31.

A frangible tension sleeve 35 having a thin annular section 36 is attached by threads 37 to the upper end of the upper mandrel section 16. Threads 38 on the tension sleeve 35 are provided for connection with the tension member 39 of a setting tool assembly 40. The compression member 41 of the setting tool assembly encircles the tension member 39 and the upper portion of the frangible tension sleeve 35, and the lower end of the compression member 41 rests on the end surface 42 of the body extension 11. The setting tool may be of any convenient or desirable type and is lowered into the well casing 31 as a unit with the retrievable bridge plug assembly A. The setting tool may be carried on the end of a wire line 43 or may be lowered on the end of a tubing string, not shown. The setting tool may be actuated in any conventional manner, such as, for example, by hydraulic means or by explosion of an internal powder charge. Various conventional setting tools are available. By way of example, the setting tool shown in Patent No. 2,640,547 or the setting tool shown in Patent No. 3,138,207, may be adapted to operate the bridge plug. In any event, the action of the setting tool 40 is to raise the tension part 39 relative to the compression part 41.

An inner mandrel 45 is mounted within the outer mandrel 15 for relative axial movement. Shear pins 46 normally prevent such movement. The lower end of the mandrel 45 is provided with lateral ports 46a in the wall thereof, which may be aligned with lateral ports 47 in the outer mandrel and lateral ports 48 in the lower cap 49, to form a bypass through the packer collars 19 and 20 by way of a central passage 50 and upper ports 51 in the inner mandrel 45.

The releasable locking device generally designated 30 includes a split snap ring 55, mounted in a recess 56 formed between the upper end of the lower cap 49 and a shoulder on the lower wedge collar 23. The cap 49 and the lower wedge collar 23 are connected by threads 57 and function as a single integral unit. A peripheral groove 58 is provided in the outer surface of the lower mandrel section 17, and the snap ring 55 extends into this annular groove. A plurality of radial openings 59 are provided in the wall of the lower mandrel section 17, and these openings 59 communicate with the annular groove 58. A series of balls 60 are provided, one being mounted within each of the radial openings 59. The proportions of the parts are such that the balls 60 each contact the outer surface 61 of the inner mandrel 45 and the inner surface of the snap ring 55. So long as the balls 60 engage the outer surface 61 of the inner mandrel 45, the snap ring 55 is held within the recess 56, and, hence, movement of the cap member 49 and lower wedge collar 23 relative to the mandrel 15 is prevented. Downward movement of the inner mandrel 45 relative to the

outer mandrel 15, however, brings the annular groove 62 on the inner mandrel 45 into registry with the balls 60, allowing them to move radially inward, thereby permitting the snap ring 55 to collapse radially inwardly to be wholly received within the annular groove 58. The lower wedge collar 23 and the cap member 49 are then free to move downward in respect to the lower slips 26. Axially extending tie bolts slide in the parts 22 and 24 and prevent disassembly of the wedge collar 23 and cap 49.

A ratchet device generally designated 70 is provided for allowing downward motion of the body 10 and its shouldered flange 13 with respect to the outer mandrel 15, but acting to prevent relative motion in the opposite direction. This ratchet device includes a series of circular grooves 71, provided on the inner surface so the body 10, together with a plurality of expansible metal rings 72 which are engageable in the grooves 71. A series of collars 73, one for each ring 72, is provided on the outer mandrel 15. The axial spacing of the end flanges on the collars 73 is different from the axial spacing of the grooves 71. The purpose of the ratchet device 70 is to lock the body and flange 13 against back-travel with respect to the mandrel 15 when the packer collars 19 and 20 are in a set position. Using five snap rings as shown, the maximum back-travel is limited to one-fifth of the axial distance between snap rings plus the vertical clearance on the inner collar 73.

In operation, the bridge plug assembly A is lowered into the well casing 31 on the lower end of a conventional setting tool 40. This setting tool 40 may be suspended on a wire line 43 or carried on a pipe string, not shown. FIGURES 2 and 3 show the parts of the bridge plug assembly A in "running-in" position. In this position, the shear pins 27 and 28 hold the slips 25 and 26 and the rubber packer collars 19 and 20 against expansion into contact with the well casing 31. The shear pins 46 prevent any relative movement between the outer mandrel 15 and the inner mandrel 45.

After running the bridge plug assembly to the desired depth, the setting tool 40 is actuated to lift the mandrels 15 and 45 with respect to the body 10, thereby seating the slips 25 and 26 within the casing and expanding the packer collars 19 and 20 into sealing engagement with the casing. Additional tension force supplied by the setting tool 40 to the frangible sleeve 35 separates the sleeve into two parts. The upper portion with the threads 38 remains with the setting tool 40, and the lower portion with the threads 37 remains fixed to the upper end of the upper mandrel section 16. The setting tool 40 may then be removed from the casing on the wire line 43, leaving the bridge plug assembly A in "set" position in the well casing. At this stage in the operations the shear pins 46 remain intact, while the shear pins 27 and 28 were fractured during the expansion of the slips 25 and 26 and packer collars 19 and 20. The ratchet device 20 functions to prevent downward movement of the mandrel 15 with respect to the body 10 and hence acts to hold the packer collars and slips in expanded position.

The bridge plug assembly A remains in "set" position in the well casing 31 until its use in the well is completed and its removal is desired. An annular overshot tool 80 is then lowered into the well casing 31 on a tubing string, and a crossbar 81 within the overshot tool rests on the upper end of the inner mandrel 45. The weight of the tubing string and overshot tool is utilized to fracture the shear pins 46 and to move the inner mandrel 45 with respect to the outer mandrel 15 until the inner mandrel 45 strikes the cap member 49 at the lower end of the assembly. This downward movement of the inner mandrel 45 with respect to the outer mandrel 15 serves to release the locking assembly 30, permitting the balls 60 to move inwardly into the annular recess 62. This action, in turn, allows the lower cap member 49 and lower wedge

collar 23 to move downward as a unit when the snap ring 55 retracts radially inward into the groove 58. Downward movement of the lower wedge collar 23 with respect to the outer mandrel 15 allows the slips 26 and the packer collars 19 and 20 to contract radially out of contact with the well casing 31. Release of the slips 26 from the casing 31 is assisted by application of weight to the inner mandrel 45 and lower cap 49, since this serves to pull the lower wedge collar 23 downward with respect to the slips 26. The split snap ring 82 is loosely mounted within the enlarged recess 86 in the overshot 80, and this ring 82 has a minimum diameter too large to pass through the bore 87. When the overshot 80 is initially lowered over the bridge plug assembly, the split ring 82 is enlarged by contact with the taper shoulder 88 and then snaps into position under the shoulder 83. Lifting of the overshot 80 to engage the snap ring 82 under the shoulder 83 on the body 10 brings the shoulder 84 on the lower mandrel section 17 into contact with the shoulder 85 on the upper wedge collar 22 and serves to pull a wedge collar 22 away from the slips 25, thus effecting release of the slips 25 from the casing 31. After full release of the slips and the rubber packer collars, the bridge plug assembly is ready to be retrieved from the well by means of the overshot 80. The bridge plug assembly may then be redressed and recocked for another run.

Having fully described my invention, it is to be understood that I am not to be limited to the details herein set forth but that my invention is of the full scope of the appended claims.

I claim:

1. In a retrievable bridge plug assembly adapted to be lowered into a well casing by means of a setting tool having a tension member and a compression member, the improvement comprising in combination: an outer tubular mandrel, frangible means for connecting said mandrel to the tension member, a tubular body slidably mounted upon and encircling a portion of said mandrel and having means at one end engageable by the compression member, a collar slidably mounted on said mandrel, releasable locking means connecting said collar to said mandrel, means including annular deformable packing rings encircling said mandrel and operatively interposed between said body and said collar whereby upward movement of said mandrel with respect to said body is effective to expand said packing means into engagement with the casing, ratchet means interposed between said body and said mandrel preventing upward movement of the body relative to the mandrel and means including an axially extending element engageable by an overshot to move said element axially in a direction to release said locking means.

2. In a retrievable bridge plug assembly adapted to be lowered into a well casing by means of a setting tool having a tension member and a compression member, the improvement comprising in combination: an outer tubular mandrel, frangible means for connecting said mandrel to the tension member, a tubular body slidably mounted upon said mandrel and encircling a portion of said mandrel and having means at one end engageable by the compression member, a collar movably mounted on said mandrel, releasable locking means connecting said collar to said mandrel, means including annular deformable packing rings encircling said mandrel and operatively interposed between said body and said collar whereby upward movement of said mandrel with respect to said body is effective to expand said packing means into engagement with the casing, ratchet means interposed between said body and said mandrel preventing upward movement of the body relative to the mandrel, an inner mandrel mounted for axial movement within said outer mandrel, said inner mandrel having means at its upper end engageable by an overshot to move the inner mandrel downward with respect to the outer mandrel, and means on the inner

mandrel operable to release said locking means upon downward movement of said inner mandrel.

3. In a retrievable bridge plug assembly adapted to be lowered into a well casing by means of a setting tool having a tension member and a compression member, the improvement comprising in combination: an outer tubular mandrel, frangible means for connecting said mandrel to the tension member, a tubular body slidably mounted upon said mandrel and encircling a portion of said mandrel and having means at one end engageable by the compression member, an upper wedge collar and a lower wedge collar mounted on said mandrel, releasable locking means connecting said lower wedge collar to said mandrel, slip means co-operable with said wedge collars and movable outward for engagement with the casing upon downward movement of the upper wedge collar with respect to said mandrel, annular deformable packing means encircling said mandrel and interposed between said body and said upper wedge collar whereby upward movement of said mandrel with respect to said body is effective to expand said slip means and said packing means into engagement with the casing, ratchet means interposed between said body and said mandrel preventing upward movement of the body relative to the mandrel, an inner mandrel mounted for axial movement within said outer mandrel, said inner mandrel having means at its upper end engageable by an overshot to move the inner mandrel downward with respect to the outer mandrel, and means on the inner mandrel operable to release said locking means upon downward movement of said inner mandrel.

4. In a retrievable bridge plug assembly adapted to be lowered into a well casing by means of a setting tool having a tension member and a compression member, the improvement comprising in combination: an outer tubular mandrel, frangible means for connecting said mandrel to the tension member, a tubular body slidably mounted upon said mandrel and encircling a portion of said mandrel and having means at one end engageable by the compression member, an upper wedge collar and a lower wedge collar mounted on said mandrel, releasable locking means connecting said lower wedge collar to said mandrel, slip means co-operable with said wedge collars and movable outward for engagement with the casing upon downward movement of the upper wedge collar with respect to said mandrel, annular deformable packing means encircling said mandrel and interposed between said body and said upper wedge collar whereby upward movement of said mandrel with respect to said body is effective to expand said slip means and said packing means into engagement with the casing, ratchet means interposed between said body and said mandrel preventing upward movement of the body relative to the mandrel, an inner mandrel mounted for axial movement within said outer mandrel, said locking means including a split snap ring extending into aligned recesses on said mandrel and said lower wedge collar, balls mounted in radial openings in the

mandrel contacting said split snap ring and said inner mandrel, said inner mandrel having means at its upper end engageable by an overshot to move the inner mandrel downward with respect to the outer mandrel, and a groove on the inner mandrel to permit radial inward movement of the balls and thereby allow the split snap ring to move into the recess on the outer mandrel, upon downward movement of the inner mandrel.

5. In a retrievable bridge plug assembly adapted to be lowered into a well casing by means of a setting tool having a tension member and a compression member, the improvement comprising in combination: an outer tubular mandrel, frangible means for connecting said mandrel to the tension member, a tubular body slidably mounted upon said mandrel and encircling a portion of said mandrel and having means at its upper end engageable by the compression member, an upper wedge collar and a lower wedge collar slidably mounted on said mandrel, releasable locking means connecting said lower wedge collar to said mandrel, slip means co-operable with said wedge collars and movable outward for engagement with the casing upon downward movement of the upper wedge collar with respect to said mandrel, annular deformable packing means encircling said mandrel and interposed between said body and said upper wedge collar whereby upward movement of said mandrel with respect to said body is effective to expand said slip means and said packing means into engagement with the casing, ratchet means interposed between said body and said mandrel preventing upward movement of the body relative to the mandrel, an inner tubular mandrel mounted for axial movement within said outer mandrel, frangible means connecting said mandrels for movement as a unit, said inner mandrel having means at its upper end engageable by an overshot to break said frangible means to move the inner mandrel downward with respect to the outer mandrel, means on the inner mandrel operable to release said locking means upon downward movement of said inner mandrel, and bypass ports on said mandrels brought into registry by said downward movement of said inner mandrel.

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