Oct. 30, 1962 J. A. MOOSMAN 3,061,012

WELL PACKERS

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Fig. 1

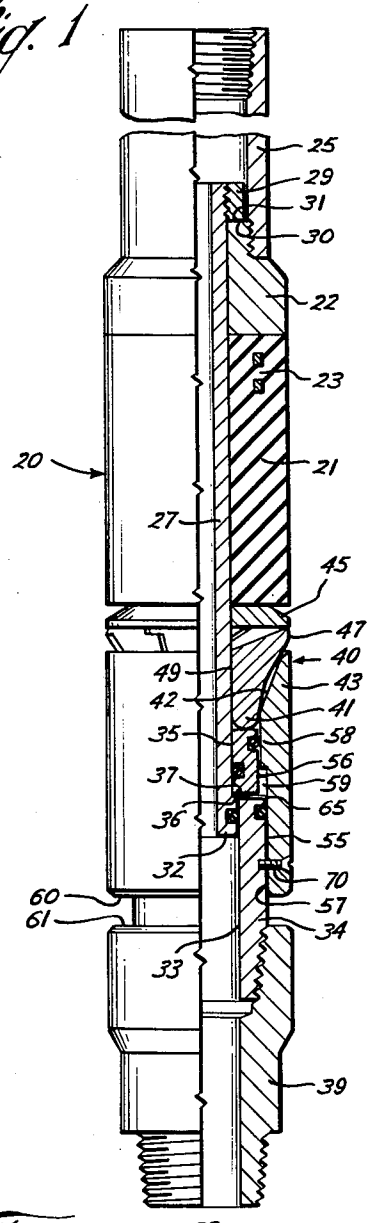


Fig. 3

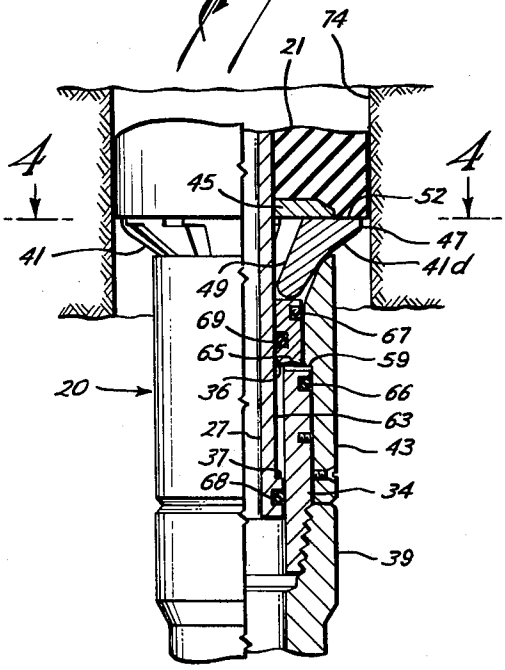


Fig. 2

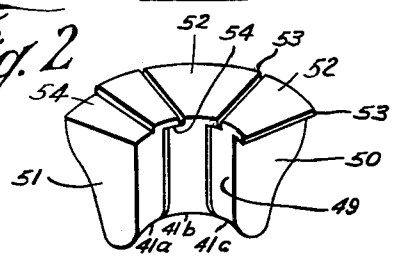
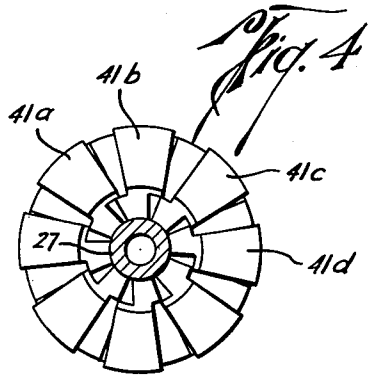


Fig. 4



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Fig. 5

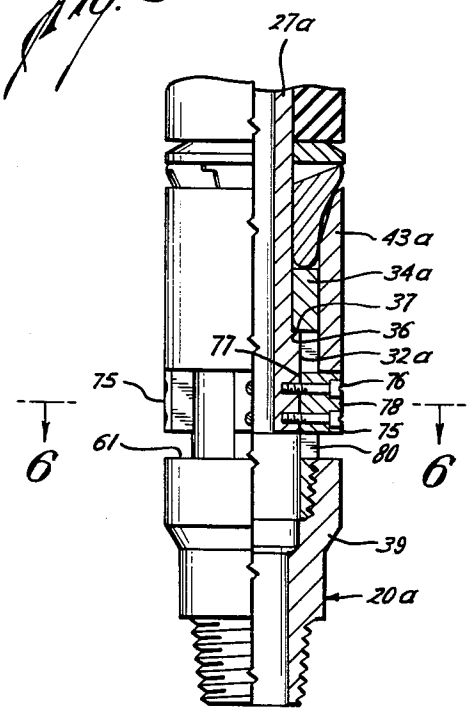


Fig. 7

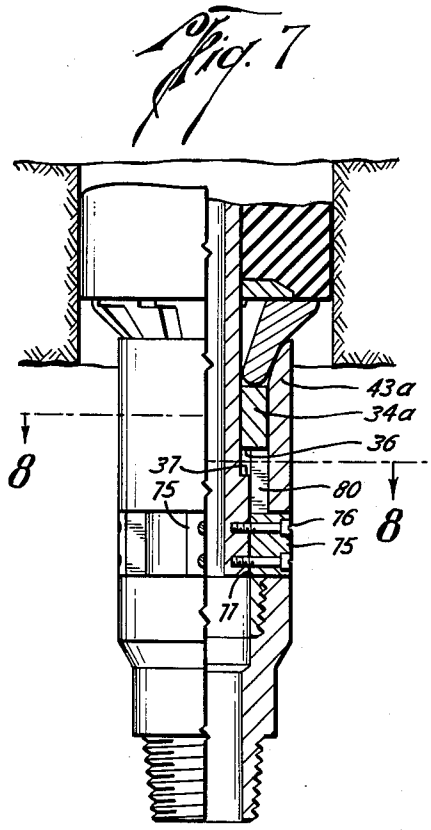


Fig. 6

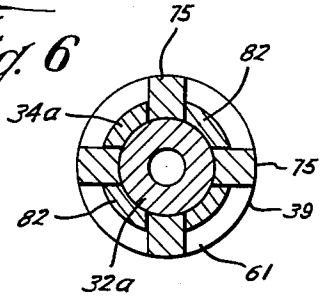
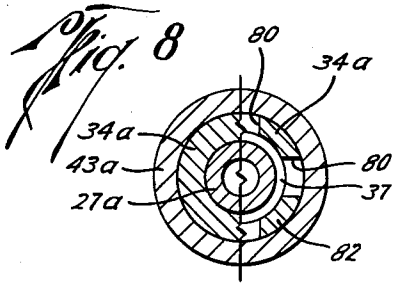


Fig. 8



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Fig. 9

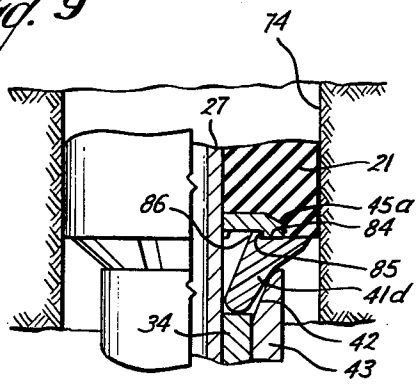


Fig. 10

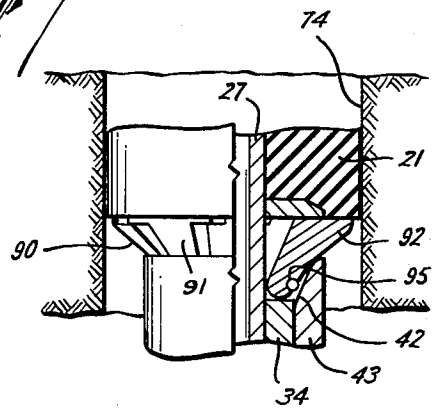


Fig. 11

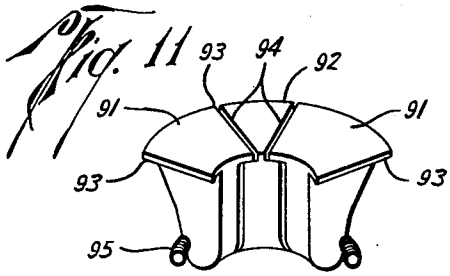
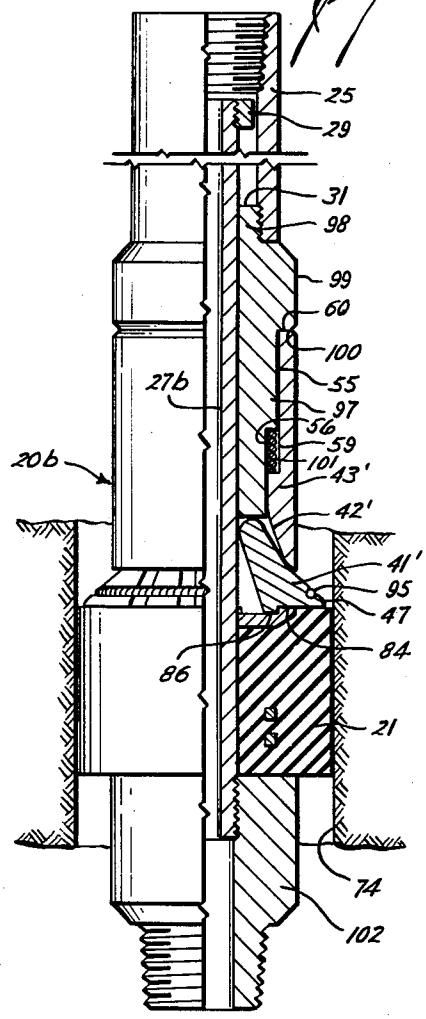


Fig. 12



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United States Patent Office 3,061,012 Patented Oct. 30, 1962

3,061,012

WELL PACKERS

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Filed Aug. 31, 1959, Ser. No. 837,051
20 Claims. (Cl. 166—201)

This invention relates to well packers and more particularly to packers having an elastic packing element arranged to be expanded into a sealing engagement with a well bore or conduit and having provision against lengthwise extrusion of the packing element.

In order that ample clearance may be provided about a well packer as it is moved through a well conduit or casing or through an uncased borehole, the well packer including the packing element carried by it commonly has an outside diameter appreciably smaller than the inside diameter of the casing, or the region or "seat" along the well bore with which the expanded packing element is to seal. The greater the degree of expansion required of the packing element, however, the greater is the tendency of the packing element to extrude or flow lengthwise of the packer in response to high pressure differentials, high temperatures, and axial thrusts imposed upon the packing element. Such extrusion is particularly pronounced in open hole formation testing where setting of the packer into sealed relation with the formation wall is accompanied by opening of the region on one side of the packer to essentially atmospheric pressure, thus combining the force of setting with a suddenly imposed hydrostatic pressure differential lengthwise across the packing element. Extrusion of the packing element, of course, impairs its sealing action and, at the same time, damages the packing element and raises the risk of sticking the packer in the well.

In past efforts to prevent extrusion of packing elements, use has been made of deformable rings composed, for example, of lead or mild steel, which are distended upon setting of the packer to outwardly extend the endwise support of the packing element as it is expanded. Upon retraction of the packing element, such deformable rings remain in their distended position thus reducing the annular clearance about the packer when the packer is moved along the well. In some instances, a ring of very hard rubber is positioned at one end of the packing element to inhibit extrusion while affording a degree of elastic restoration to the original diameter. The use of segmental rings has also been proposed, the ring segments being constructed to slide outwardly with expansion of the packing element to provide endwise support. Also proposed have been various shapes of metallic inserts embedded in endwise portions of the packing element, purporting to strengthen it against extrusion.

While certain of these anti-extrusion devices have been successful in many applications, the increasing pressures and temperatures encountered with deeper drilling of wells impose very severe requirements upon an anti-extrusion device. At the same time, the trend toward wells of smaller diameter makes more imperative the complete retraction of the anti-extrusion device when the packer is released.

It is therefore an object of the present invention to provide a new and improved well packer wherein extrusion of the packing element is effectively prevented.

It is another object of this invention to provide such a well packer wherein a substantial annular clearance about the packer is provided when the packing element is returned to its collapsed or retracted position.

A further object of this invention is to provide such

a packer with a device for resisting extrusion by sustaining largely compressive forces, rather than bending forces.

Still another object of this invention is to provide a new and improved well packer having an anti-extrusion device which is positively returned to its retracted position.

Yet a further object of this invention is to provide such a well packer which is readily and economically produced and maintained.

These and other objects are obtained, in accordance with the invention, by positioning a segmental retainer ring endwise of the packing element which expands to effect a seal between the packer and the surrounding well bore or casing. The segmental ring is received partially within an annular groove opening toward the packing element and defined by telescopic members supported with the packing element about a mandrel. The end portion of the ring segments opposite the packing element may thus be rocked between expanded and contracted positions by relative longitudinal movement of said telescopic members.

More particularly the ring segments may have a generally cylindrical inner surface concentric with the mandrel in the retracted position of the ring, an arcuate end portion pivotally received in the groove, a generally flat opposite end portion disposed in a radial plane when the segment is tilted to its expanded position, and an outer surface portion engaged by the outer telescopic member for support in the expanded position and positive displacement to the retracted position.

In one embodiment of the invention, relative longitudinal movement between the telescopic members is accomplished hydraulically. In another embodiment, a direct mechanical connection is employed. Resilient means are employed in yet another embodiment.

The invention will be better understood from the following detailed description taken in conjunction with the drawings in which:

FIG. 1 is an elevational view, partly in section, of a well packer constructed in accordance with the invention;

FIG. 2 is a view in perspective of a portion of the segmental retaining ring illustrated in FIG. 1;

FIG. 3 is a partial view in elevation of the well packer of FIG 1, shown in its expanded or set position in relation to a borehole wall;

FIG. 4 is a sectional view taken along the line 4—4 of FIG. 3 and illustrating the segmental retaining ring in its expanded position;

FIG. 5 is an elevational view, partly in section, of a well packer in accordance with another embodiment of the present invention;

FIG. 6 is a sectional view taken along the line 6—6 of FIG. 5;

FIG. 7 is a partial elevation view, partly in section, of the well packer of FIG. 5, shown in its expanded or set position in relation to a borehole wall;

FIG. 8 is a sectional view taken along the line 8—8 of FIG. 7;

FIG. 9 is a partial elevational view, partly in section, corresponding to FIGS. 3 and 7 and illustrating a modification of the segmental retainer ring and washer;

FIG. 10 is a view similar to FIG. 9 and showing another modification of the segmental retainer ring;

FIG. 11 is a view in perspective illustrating a portion of the segmental retainer ring of FIG. 10; and

FIG. 12 is an elevational view, partly in section, of a well packer in accordance with a further embodiment of the invention.

In FIG. 1 there is shown a wall packer 20 designed for setting in an open or uncased borehole although adaptable

for use also in cased wells. The well packer **20** is particularly suited for connection in a string of drill pipe or tubing, together with one or more formation testing tools, the packer serving to seal off and isolate a limited zone of the well for testing of fluids produced from the formations.

The well packer **20** more particularly comprises a packing element **21** formed as a sleeve of resilient elastic material such as a natural or synthetic rubber or plastic adapted to expand laterally with lengthwise compression so as to seal with a surrounding wall. The upper end of the packing element **21** is secured to an upper retainer ring **22** as by a molded connection at **23**, and the upper retainer ring **22** is in turn threadedly connected to annular travel head **25** by which the packer may be threadedly secured to a string of well pipe (not shown).

Providing internal support for the packing element **21** is a tubular mandrel **27** which may have an outside diameter snugly fitted within the inside diameter of the packing element **21** in the unstressed condition of the packing element. The mandrel **27**, in addition to supporting the packing element **21**, serves to connect the upper and lower ends of the packer and to provide a continuation of an axial flow course lengthwise through the packer. To maintain the packer in its assembled relation shown in FIG. 1, as when it is lowered into a well, for example, a stop nut **29** is threadedly connected to the upper end of the mandrel **27** to provide an annular downwardly facing shoulder **30** thereabout for engagement with an upwardly directed annular shoulder **31** defined by the upper end of retainer ring **22**. Thus, while the mandrel **27** has a sliding fit through the bore of upper retainer ring **22**, the stop nut **29** has a greater diameter to arrest downward movement of mandrel **27**. The top nut **29** is, however, free to travel upwardly from shoulder **31** within the bore of travel head **25**. At the lower end of mandrel is an annular raised portion **32** slidably received within the enlarged bore **33** of annular body member **34**. A reduced upper bore section **35** of body member **34** slidingly receives mandrel **27** and terminates in a downwardly facing annular shoulder **36** which rests on an upwardly facing annular shoulder **37** provided by raised portion **32** of the mandrel, when the packer is in its suspended or unset position. At the lower end of body member **34**, a threaded connection is made with a bottom sub **39** having a threaded pin at its lower end for connection with portions of a string of well pipe therebelow. Thus, the enlargements provided on either end of the mandrel **27** serve to retain the packer in assembled relation while unset or supported under tension.

When compression is applied lengthwise of the packer **20**, as will occur when the packer is being set to expand the packing element into sealed relation with the surrounding wall, it is necessary that provision be made for suitable retaining the packing element **21** at its lower end as well as at its upper end. While the improved retaining means in accordance with the present invention may suitably be employed at the upper end, as well as at both upper and lower ends, for illustrative purposes and particularly for applications in drill stem or formation testing, the improved retaining means is suitable employed at the lower end of the packing element. As shown in FIGS. 1–4 such retaining means **40** comprises a segmental retainer ring **41** which is received in an annular groove **42** defined between a sleeve member **43** and the mandrel **27** and bears upon the upper end of body member **34**. In addition to the segmental ring **41**, there may be provided a flat washer **45** slidably received on mandrel **27** and disposed intermediate the segmental ring **41** and the packing element **21** so as to be in direct engagement with each. In the retracted position shown in FIG. 1, the outermost tip **47** of the segmental ring **41** lies within the profile of the packing element **21** and sleeve member **43**, the unstressed packing element **21**, the washer **45** and the sleeve member **43** each desirably having the same outer diameter for ready movement through a well and maximum supporting strength in the set position of the packer.

The segmental retainer ring more particularly comprises a plurality of circumferentially arranged segments of generally cylindrical configuration flared upwardly and outwardly at their upper end and rounded at their lower end. Except for the small void spaces resulting from rounding of the segments immediately adjacent their lower end, the segments in their retracted position completely fill the annular groove **42** between the sleeve member **43** and mandrel **27**. In the retracted position, the annular groove **42** is of such depth that the length of the segment received in the groove exceeds the radial thickness of the segment, as measured from the inner cylindrical surface **49** of the segment to the outer tip **47**. The side and top surfaces **50**, **51** and **52** of each segment are preferably flat, although to provide overlap in the expanded position of the segmental ring the top surface **52** may be stepped inwardly from side surface **51** and extend outwardly from side surface **50** so as to provide complementary lips **53** and notches **54** to receive the same. The clockwise extent of the lips **53** and notches **54** may be substantially the same for snug interfitting in the retracted position while great enough to provide overlap in the expanded position whereby extrusion of rubber between adjacent segments is precluded.

As best seen in FIGS. 1 and 3, the plane of the top face **52** is set at an obtuse angle with respect to the axis of the cylindrical inner surface **49** such that the plane of the top surface is transverse to the axis (or horizontal) when the segments of ring **41** are rocked outwardly through an acute angle to their extended position. Where the acute angle, through which the segments rock, lies in the range from zero to 45 degrees and is preferably 30 degrees, the obtuse angle is correspondingly between 90 and 135 degrees and preferably 120 degrees. In the outwardly rocked or extended position, the segments will be seen in FIG. 3 to have flat surface engagement with the underside of washer **45** and to extend outwardly beyond washer **45** a substantial distance toward the surrounding wall, such as a distance half again the unstressed thickness of the packing element **21**. The washer **45** thus bridges the gap formed inwardly of the segments when they are rocked outwardly, while the segments effectively extend outwardly of the diameter of the washer effective to prevent lengthwise extrusion of the packing element.

To facilitate the outward rocking movement of the segments comprising the segmental ring **41**, the sleeve member **43** is telescopically supported for sliding movement over the enlarged exterior portion **55** and reduced exterior portion **56** of the body member **34**. Thus, the bore of the sleeve member **43** is correspondingly stepped, having a lower enlarged diameter portion **57** and a reduced diameter upper portion **58**, the difference in diameters serving to define an annular chamber **59** of variable length between the sleeve member and body member. However, the length of the annular chamber **59** is at least as great as the stand-off or spacing between the lower annular shoulder **60** at the lower end of the sleeve member and the upper annular shoulder **61** at the upper end of sub **39** such that the shoulders **60**, **61** are in supporting abutment in the lower position of the sleeve and the extended position of the segments. Accordingly, as seen in FIG. 3, the segments are supported against the downward thrust of the packing element **21** principally by the body member **34** and sleeve member **43** acting in compression and transmitting their compression load directly to the bottom sub **39**. To the extent that the downward thrust of the packing element **21** produces a torque tending to tip the segments further outwardly, such torque is readily overcome by the retaining action of the sleeve member **43**, particularly toward its upper end, in cooperation with the mandrel **27** where it is engaged by the lower rounded end of the segments. The relatively

thick cross section of the segments in the radial direction insures that the bending stress accompanying the application of the torque does not produce a strain beyond the elastic limit of the segment material, even though it be die cast aluminum. Moreover, since the segments are designed to be supported under stress without deformation, they need not remain in their extended position after the packer is released.

In accordance with the invention, the retraction of the segments forming the segmental retainer ring may, in fact, be accomplished positively. To this end, means are employed for displacing the telescopic sleeve member 43 in the direction of the packing element 21, thereby to cam the segments as the packing element is returned to its unstressed condition. While various means may be employed for thus displacing the sleeve member 43, convenient use may be made of an hydraulic actuating system, as illustrated in FIGS. 1 and 3, wherein the chamber 59 is in sealed fluid communication with an annular chamber 63 intermediate mandrel 27 and body member 34 and having shoulders 36 and 37 at its upper and lower ends. One or more radial ports 65 adjacent shoulder 36 place the chambers 63 and 59 in communication, while O-rings 66, 67 and 68, 69 provide sliding seals above and below the respective chambers 59 and 63. To provide a mechanical advantage, the radial dimension of chamber 63 may be substantially less than that of chamber 59, for example, one-third so that telescopic sleeve member 43 travels longitudinally one-third the distance traveled by mandrel 27 but with, say, three times the upwardly directed force which is transmitted through mandrel 27 upon release of the packer.

To facilitate retention of the segmental retainer ring 41 in its retracted position, as when the packer is being lowered into position, a shear pin 70 may extend through the sleeve member 43 and into the body member 34 through holes which are aligned when the sleeve member is in its uppermost, segment-retaining position. The shear pin is designed with a breaking strength such that sleeve member 43 will be free to travel downwardly as a compressive force is developed in packing element 21 during setting of the packer, whereas pin 70 will not break during ordinary manipulation of the packer prior to setting.

In a typical operation utilizing the well packer 20, it is assembled in the condition shown in FIG. 1 with the outside diameter of the packing element 21 and of the segmental retainer ring 41 affording ample clearance for downward travel of the packer into a well. As the packer is lowered, the shear pin 70 maintains the retainer ring 41 in its retracted position while mandrel 27 with its enlargements at either end retains the packer in assembled condition under tension. It may be noted that shear pin 70 not only resists downward movement of sleeve member 43, but also downward movement of mandrel 27 relative to body member 34.

When the desired depth for setting of well packer 20 is reached, weight is imposed on travel head 25 while further downward movement of bottom sub 39 is resisted by use of conventional means such as, for example, casing slips. There results a compressive force transmitted to packing element 21 by upper retainer ring 22 and by segmental retainer ring 41. As this compressive force is increased, the engagement between washer 45 and the tip end 47 of the retainer ring segments cams telescopic sleeve member 43 downwardly, shearing pin 70 and permitting the segments to tilt outwardly to their extended position, illustrated in FIG. 3. With downward travel of sleeve 43, the displacement of hydraulic fluid from chamber 59 to chamber 63 results in a downward travel of mandrel 27. Such downward travel of mandrel 27 is permitted by downward movement of upper retainer ring 22 with the application of compressive force to packing element 21, the overall length of the packer thus being decreased.

With the segmental retainer ring in its outermost extended position the annular clearance between the tip end 47 of the segments and a surrounding wall, such as borehole wall 74 is so diminished that extrusion of packing element 21 downwardly past the segmental retainer ring is effectively prevented. By the retaining action of the ring 41 in cooperation with washer 45 the packing element 21 is so fully supported in its expanded position that a better seal is effected between the packing element and wall 74 with a reduced likelihood of damage to the packing element despite high hydrostatic pressure differentials across the packing element, weakening of the wall 74 and like occurrences.

When it is desired to release the packer 20, weight is relieved from the travel head 25 so that the head is raised upwardly allowing packing element 21 to relax back to its original diameter and configuration. With upward movement of travel head 25 with respect to bottom sub 39 upper retainer ring 22 comes into engagement with stop nut 29 on mandrel 27 so that mandrel 27 likewise travels upwardly with respect to bottom sub 39. With upward travel of mandrel 27, hydraulic fluid is transferred from chamber 63 through port 65 to chamber 59 thereby acting upon sleeve member 43 to force its upward travel with respect to body member 34 and bottom sub 39. Hence, the upward displacement of washer 45 with relaxation of the packing element 21 and the upward travel of sleeve member 43 occur concurrently to rock the retainer segments 41*a*, 41*b*, etc. inwardly against mandrel 27. Since the combined movement of sleeve member 43 and washer 45 results in a closing of the gap through which the segments extend, the segments in effect are pinched or cammed back into their retracted position. Of course, the annular groove 42 defined between the sleeve member 43 and mandrel 27 deepens to accommodate the segments so that they are freely received, the arcuate contour of the flared tip portion 47 of the segments and of the upper interior end of the sleeve member 43 promoting a relatively free rocking movement with the arcuate surfaces in contact. When the packer is stretched to its normal length, the chamber 63 is fully collapsed, thereby insuring that the sleeve member 43 is displaced to its full upward extent and the retainer segments are fully retracted. The packer is then ready for withdrawal from the well or movement to another position at which its setting is desired.

In accordance with another embodiment of the invention, there may be substituted for the hydraulic system a direct mechanical interconnection between the mandrel and the telescopic sleeve member. This connection may be accomplished as seen in FIGS. 5–8, by employing a modified mandrel 27*a*, body member 34*a* and sleeve member 43*a*. The enlarged diameter lower portion 32*a* of mandrel 27*a* again provides an annular upwardly directed shoulder 37 for engagement with downwardly directed shoulder 36 of body member 34*a* for engagement in the extended, unset position of the packer 20*a*. Detachably secured to the outer periphery of enlarged portion 32*a* are laterally extending finger portions 75 of the modified mandrel 27*a*. These finger portions 75 may be secured by means of screws 76 and have inner and outer cylindrical surfaces 77, 78 conforming respectively with the outer surface of enlarged mandrel portion 32*a* and the outer surface of sleeve member 43*a*. Finger portions 75 of the mandrel are thus positioned to underlie and support the sleeve member 43*a*, the finger portions being spaced, for example, on transverse axes to distribute the stress applied to the sleeve member.

The body member 34*a* has lengthwise slots 80 to receive the respective finger portions 75, the slots extending from the upper shoulder 61 of bottom sub 39 to the interior shoulder 36 of body member 34*a*. The slots 80 are thus likewise disposed on transverse axes, leaving cylindrical segment portions 82 to carry stress between the upper reduced bore portion of the body member 34*a*

and the lower threaded end portion thereof, as best seen in FIG. 6.

The operation of the modified well packer **20***a* of FIGS. 5–8 is generally similar to that described in connection with FIGS. 1–4. However, downward travel of mandrel **27***a* relative to bottom sub **39** during setting of the packer directly permits a corresponding downward travel of sleeve member **43***a* so that the segmental retainer ring is quickly brought into its expanded position by outward rocking of the segments. In the set position of the packer, the segments are supported again on the body member **34***a* and sleeve member **43***a*, in this instance the sleeve member **43***a* transmitting a compressive load via finger portions **75** to the bottom sub **39**.

As the mandrel **27***a* is picked up during unsetting or release of the packer **20***a*, the sleeve member **43***a* is correspondingly picked up by the finger portions **75** of the mandrel. The sleeve member **43***a* has a distance to travel equal to the spacing between shoulders **36**, **37**, therefor, and in each position rests on the finger portions **75**. By affording a direct mechanical operation of the sleeve member **43***a*, the arrangement of the modified packer **20***a* provides a simple action and ready maintenance.

If, desired, modifications may be made in the segmental retainer ring employed in either of the embodiments of FIGS. 1 and 5. For example, as illustrated in FIG. 9, a modified washer **45***a* may be employed having an annular ridge portion **84** stepped downwardly from its underface adjacent its outer periphery so as to provide an annular interior shoulder **85** confronting the mandrel **27** and engageable with the raised annular ridge portion **86** projecting upwardly from the upper interior edge of the segments **41***a*, **41***b*, etc. Such interengagement occurs in the extended position of the segments and tends to absorb a portion of the bending load imposed upon the segments by the expanded packing element **21**, as well as serving further to retain the segments within the annular groove **42**.

In FIGS. 10 and 11 are illustrated a modified form of segmental retainer ring **90** composed of segments **91** and **92** of two different types, type **91** having lips **93** flared in opposite directions from the top surface and type **92** having slots **94** correspondingly cut in from opposite sides of the top surface to provide overlapping interengagement between the segments. Further, the segmental retainer ring is provided with an annular groove formed in the outer faces of the segments preferably at a point therealong which remains within the confines of sleeve **43**, to receive an elastic ring **95** formed for example of coiled spring wire. Since the elastic ring **95** is retained at a point above the pivoted lower end of the segments, the elasticity of the ring tends to retract the segments against the mandrel **27**, as well as to retain the segments within the groove **42**.

As will be appreciated, the improved retainer means of the present invention may be employed to prevent extrusion of a packing element not only downwardly but also upwardly, upward extrusion being a problem, for example, in such operations as squeeze cementing and formation fracturing where relatively high pressures may be developed beneath a packer. According to another embodiment of the invention, as illustrated in FIG. 12, the segmental retainer ring **41′** may be disposed adjacent the upper end of packing element **21** and so arranged that the telescopic sleeve member **43′** may be resiliently actuated to restore the ring **41′** to its retracted position. To transmit a compressive force through the segmental ring **41′** when the packer is set, a modified body member **97** is provided with a threaded connection at its upper end **98** with the travel head **25**. Intermediate the lower end of the body member which engages the rounded pivotal end of the segments, and the threaded upper end **98** is an enlarged diameter portion **99** defining a downwardly directed annular shoulder **100** to engage shoulder **60** of sleeve member **43′**. The body member **97** again has a portion **56** of reduced outer diameter relative to portion **55** to provide a stepped periphery conforming with the stepped bore of sleeve member **43′** to define chamber **59**. However, in this embodiment chamber **59** receives a coil spring **101**, which in FIG. 12 is shown compressed as the sleeve is displaced upwardly permitting the segmental ring to be extended outwardly.

To facilitate retention of the retainer segments, the stepped ridge portions **84** and **86** may interengage, as described in FIG. 9, while the elastic ring **95** is received in an annular groove about the segments positioned adjacent the tipped end **47**.

Where a retainer means pursuant to the present invention is not employed also at the lower end of packing element **21**, a lower retainer collar **102** may simply be employed, serving to provide both threaded connection with a well string section therebelow and also interior threaded connection with the lower end of modified mandrel **27***b*.

In a typical operation of the modified well packer **20***b* of FIG. 12, the packer is lowered into the well in assembled condition generally as described in conjunction with FIG. 1. That is, the stop nut **29** secured to mandrel **27***b* rests upon shoulder **31**, here provided by body member **97** and the sleeve member **43′** is in its position nearest the packing element **21** to hold the segmental retainer ring **41′** in its retracted position against the mandrel. The actuating spring **101** is then in its expanded position urging the sleeve member **43′** to remain in proximity to the packing element **21** and off the shoulder **100**.

The packer may then be set, as by applying weight through travel collar **25** and body member **97** while resisting downward movement of lower retainer collar **102** by use of conventional means such as, for example, casing slips. The force transmitted through the segments tends to rock them outwardly into the expanded position shown in FIG. 12, thereby camming sleeve member **43′** upwardly against the bias of spring **101**. The retainer ring is thus positioned in its expanded position to prevent extrusion of the packing element **21** upwardly just as in the previously described embodiments, wherein it was positioned to prevent downward extrusion.

When the packer is to be released or unset, the travel collar **25** is picked up thereby raising body member **97**. Since the actuating spring **101** tends to displace the sleeve member **43′** toward the packing element as the packing element relaxes back to its unstressed diameter, a pinching action is produced at the flared end portion of the segments serving to squeeze them inwardly and upwardly within groove **42′** back to their retracted position abutting mandrel **27***b*. Such retraction is facilitated by elastic ring **95** where such ring is employed.

Thus a variety of means may be employed to accomplish a positive retraction of the segmental retainer ring while affording it sturdy support in its expanded position. It will be evident that various other modifications may be made in the practice of the invention including the arrangement of the packer for setting by applying tension rather than compression to the well pipe, use of casing slips and similar setting devices, incorporation of a control head or bypass valve and the like. The invention accordingly is not to be limited to the embodiments illustrated and described but is of a scope defined in the appended claims.

What is claimed is:

1. A well packer comprising an annular packing element, a mandrel extending through said packing element, means coupled with said mandrel and including an annular portion supported in spaced relation about said mandrel for defining an annular groove opening toward said packing element, a segmental retainer ring having one end portion pivotally confined in said groove and an opposite end portion flared outwardly in confronting relation with one end of said packing element, said opposite end portion lying substantially in a plane transverse

to the axis of said mandrel when said ring is pivoted outwardly to an extended position, the segments of said retainer ring having an inner surface substantially concentric with said mandrel in a retracted position of said ring, and means including a retainer member confronting the other end of said packing element and relatively movable with respect to said retainer ring for expanding said packing element and moving said retainer ring from a retracted to an extended position.

2. A well packer comprising an annular packing element, a mandrel extending through said packing element, means coupled with said mandrel and including an annular member supported in spaced relation about said mandrel for defining therewith an annular groove opening toward one end of said packing element, a segmental retainer ring mounted on said mandrel and having one end portion pivotally confined in said groove, the segments of said retainer ring having a substantially flat opposite end portion flared outwardly to extend beyond said annular member in an extended poistion of said retainer ring for supporting said packing element against extrusion, and means including a retainer member confronting the other end of said packing element and relatively movable with respect to said retainer ring for expanding said packing element and moving said retainer ring from a retracted to an extended position.

3. A well packer, as defined in claim 2, including a washer supported on said mandrel intermediate said packing element and said retainer ring for engagement by said opposite end portion.

4. A well packer comprising an annular packing element, a mandrel extending through said packing element, means coupled with said mandrel and including an annular member supported in spaced relation about said mandrel for defining therewith an annular groove opening toward said packing element, and a segmental retainer ring having a rounded end portion pivotally confined in said groove for radially directed rocking motion, a substantially cylindrical inner surface portion conforming with the exterior of said mandrel in a retracted position of said ring and a substantially flat end portion confronting one end of said packing element and lying in a plane at an obtuse angle with respect to the axis of said inner surface portion, said annular member serving to support said retainer ring in an extended position with said flat end portion lying in a plane transverse to the axis of said mandrel, and means including a retainer member confronting the other end of said packing element and relatively movable with respect to said retainer ring for expanding said packing element and moving said retainer ring from a retracted to an extended position.

5. A well packer, as defined in claim 4, including a washer supported by said mandrel intermediate said packing element and said retainer ring and having a portion interengaging said retainer ring in its extended position to prevent further outward pivoting of said retainer ring.

6. A well packer, as defined in claim 4, wherein said segmental ring has an outwardly curved outer surface portion conforming with an interior arcuate surface portion of said annular member and terminating in a tip portion which extends outward of said annular member when said retainer ring is pivoted outwardly from its retracted position.

7. A well packer comprising an annular packing element, a mandrel extending through said packing element, means coupled with said mandrel and including an annular member slidably supported about said mandrel for defining an annular groove opening toward said packing element, a segmental retainer ring having one end portion pivotally confined in said groove and an opposite end portion confronting one end of said packing element, means including a retainer member confronting the other end of said packing element and relatively movable with respect to said retainer ring for expanding said packing element and moving said retainer ring from a retracted to an extended position and means coupled with said mandrel for sliding said annular member toward said packing element to rock said retainer ring from its extended position to its retracted position.

8. A well packer comprising an annular packing element, a mandrel extending through said packing element, means coupled with said mandrel and including an annular member slidably supported about said mandrel for defining therewith an annular groove opening toward said packing element, a segmental retainer ring having one end portion pivotally confined in said groove and an opposite end portion confronting one end of said packing element for pivotal movement from a retracted position to an extended position wherein said packing element is supported against extrusion, means including a retainer member confronting the other end of said packing element and relatively movable with respect to said retainer ring for expanding said packing element and moving said retainer ring from its retracted position to its extended position and means coupled with said mandrel for sliding said annular member toward said packing element to rock said retainer ring from its extended position to its retracted position while increasing the depth of said groove to receive said retainer ring.

9. A well packer comprising an annular packing element, a mandrel extending through said packing element, means coupled with said mandrel and including a sleeve member slidably supported about said mandrel for defining therewith an annular groove opening toward said packing element, a segmental retainer ring supported between said mandrel and sleeve and having one end portion pivotally confined in said groove, the opposite end portion of said retainer ring being flared outwardly to extend beyond said sleeve member when said retainer ring is pivoted to an extended position, means including a retainer member confronting the other end of said packing element and relatively movable with respect to said retainer ring for expanding said packing element and moving said retainer ring from a retracted position to its extended position and means coupled with said mandrel for sliding said sleeve toward said packing element to rock said retainer ring inwardly against said mandrel to its retracted position.

10. A well packer comprising an annular packing element, a mandrel extending said packing element, a tubular body member slidably receiving said mandrel and having an annular end surface facing said packing element, a sleeve member slidably supported by said body member and extending beyond said end surface to define with said mandrel an annular groove opening toward said packing element, a segmental retainer ring supported at one end portion in said groove for rocking movement and having an opposite end portion confronting one end of said packing element and radially movable between an extended and a retracted position, means including a retainer member confronting the other end of said packing element and relatively movable with respect to said retainer ring for expanding said packing element and moving said retainer ring from its retracted position to its extended position, and means coupled with said mandrel for sliding said sleeve member toward said packing element to rock said retainer ring from its extended position to its retracted position.

11. A well packer comprising an annular packing element, a mandrel extending through said packing element, a tubular body member slidably receiving said mandrel and having an end surface facing said packing element, a sleeve member slidably supported about said body member and extending beyond said end surface toward said packing element to define with said mandrel an annular groove opening toward said packing element, a segmental retainer ring supported at one end portion in said groove for rocking movement and having an opposite end portion confronting one end of said packing element and radially movable between an extended and a retracted

position, said body member defining with said mandrel and said sleeve member respective annular fluid chambers in fluid communication through said body member for hydraulically transforming movement of said mandrel into movement of said sleeve member with respect to said body member, said sleeve member serving to rock said retainer ring from its extended position to its retracted position, and means including a retainer member confronting the other end of said packing element and relatively movable with respect to said retainer ring for expanding said packing element and moving said retainer ring from its retracted to its extended position.

12. A well packer, as defined in claim 11, including means defining an annular shoulder about said body member to provide endwise support for said sleeve member when said retainer ring is in its extended position.

13. A well packer, as defined in claim 11, wherein the fluid chamber defined with said mandrel has a smaller radial dimension than the chamber defined with said sleeve member whereby a given stroke of said mandrel results in a lesser stroke of said sleeve member relative to said body member.

14. A well packer comprising an annular packing element, a mandrel extending through said packing element, means coupled with said mandrel and including an annular member supported about said mandrel for defining an annular groove opening toward said packing element, a segmental retainer ring having one end portion pivotally retained in said groove and an opposite end portion confronting one end of said packing element, means including a retainer member confronting the other end of said packing element and relatively movable with respect to said retainer ring for expanding said packing element and moving said retainer ring from a retracted to an extended position, and means actuated mechanically by movement of said mandrel for moving said annular member toward said packing element to rock said retainer ring from its extended position to its retracted position.

15. A well packer comprising an annular packing element, a mandrel extending through said packing element, a tubular body member slidably receiving said mandrel and having an end surface in confronting relation to said packing element, a sleeve member slidably supported about said body member and extending beyond said end surface toward said packing element to define with said mandrel an annular groove opening toward said packing element, and a segmental retainer ring having one end portion pivotally confined in said groove and having an opposite end portion confronting one end of said packing element for radial movement between a retracted position adjacent said mandrel and an extended position to support said packing element against extrusion, said mandrel having portions extending through lengthwise slots in said body member to engage said sleeve member for movement with said mandrel relative to said body member whereby said sleeve member may be displaced toward said packing element to rock said retainer ring from its extended position to its retracted position, and means including a retainer member confronting the other end of said packing element and relatively movable with respect to said retainer ring for expanding said packing element and moving said retainer ring from its retracted position to its extended position.

16. A well packer comprising an annular packing element, a mandrel extending through said packing element, means coupled with said mandrel and including an annular member slidably supported in spaced relation about said mandrel for defining an annular groove opening toward said packing element, a segmental retainer ring having one end portion pivotally received in said groove and having an opposite end portion confronting one end of said packing element for radial movement between a retracted position and an extended position, means including a retainer member confronting the other end of said packing element and relatively movable with respect to said retainer ring for expanding said packing element and moving said retainer ring from its retracted position to its extended position and resilient means for urging said annular member toward said packing element to rock said retaining ring from its extended position to its retracted position.

17. A well packer comprising an annular packing element, a mandrel extending through said packing element, a body member slidably receiving said mandrel and having an end face confronting said packing element, a sleeve member slidably supported about said body member and extending beyond said end face toward said packing element to define with said mandrel an annular groove opening toward said packing element, a segmental retainer ring having an end portion pivotally confined in said groove and an opposite end portion confronting one end of said packing element for pivotal movement between a retracted position adjacent said mandrel and an extended position to support said packing element against extrusion, means including a retainer member confronting the other end of said packing element and relatively movable with respect to said retainer ring for expanding said packing element and moving said retainer ring from its retracted position to its extended position and spring means acting between said body member and said sleeve member to urge said sleeve member towards said packing element to rock said retainer ring from its extended position to its retracted position.

18. A well packer comprising: an annular packing element; a mandrel extending through said packing element and having a portion defining an annular end surface facing and spaced from one end of said packing element; a retainer member coupled with said mandrel and confronting the other end of said packing element; a segmental retainer ring comprising a plurality of segmental elements, each of said segmental elements having one end portion supported by said annular end surface for pivotal movement between an extended and a retracted position, an inner surface portion supported against said mandrel in the retracted position, and an opposite end portion confronting said one end of said packing element, said opposite end portion having a surface disposed at an obtuse angle with respect to said inner surface portion so that said opposite end portion may be displaced radially to the extended position upon relative movement of said retainer member and said segmental retainer ring toward one another; and means coupled with said segmental elements for yieldably constraining said elements in the retracted position.

19. A well packer comprising: an annular packing element; a mandrel extending through said packing element; a tubular body member supported on said mandrel and having an annular end surface facing and spaced from one end of said packing element; a sleeve member slidably supported by said body member and extending beyond said end surface to define with said mandrel and said annular end surface an annular groove opening toward said one end of said packing element; a retainer member coupled with said mandrel and confronting the other end of said packing element; a segmental retainer ring supported in said groove and comprising a plurality of segmental elements, each of said segmental elements having one end portion supported by said annular end surface for pivotal movement between an extended and a retracted position, an inner surface portion supported against said mandrel in the retracted position, and an opposite end portion confronting said one end of said packing element, said opposite end portion having a surface disposed at an obtuse angle with respect to said inner surface portion so that said opposite end portion may be displaced radially to the extended position by said one end of said packing element and so that said sleeve member may be moved away from said packing element by said segmental elements upon relative movement of said re-

tainer member and said segmental retainer ring toward one another.

20. A well packer comprising: an annular packing element: a mandrel extending through said packing element; a tubular body member supported on said mandrel and having an annular end surface facing and spaced from one end of said packing element; a sleeve member slidably supported by said body member and extending beyond said end surface to define with said mandrel and said annular end surface an annular groove opening toward said one end of said packing element; a retainer member coupled with said mandrel and confronting the other end of said packing element; a segmental retainer ring supported in said groove and comprising a plurality of segmental elements, each of said segmental elements having one end portion supported by said annular end surface for pivotal movement between an extended and a retracted position, an inner surface portion supported against said mandrel in the retracted position, and an opposite end portion confronting said one end of said packing element, said opposite end portion having a surface disposed at an obtuse angle with respect to said inner surface portion so that said opposite end portion may be displaced radially to the extended position by said one end of said packing element and so that said sleeve member may be moved away from said packing element by said segmental elements upon relative movement of said retainer member and said segmental retainer ring toward one another; means coupled with said tubular body member and said retainer member for moving one of said tubular body member and said retainer member toward the other; and means coupled with said mandrel for sliding said sleeve member toward said packing element to rock said retainer ring from its extended position to its retracted position.

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