

July 18, 1967

C. B. COCHRAN

3,331,440

WELL PACKER

Filed April 16, 1965

3 Sheets-Sheet 1

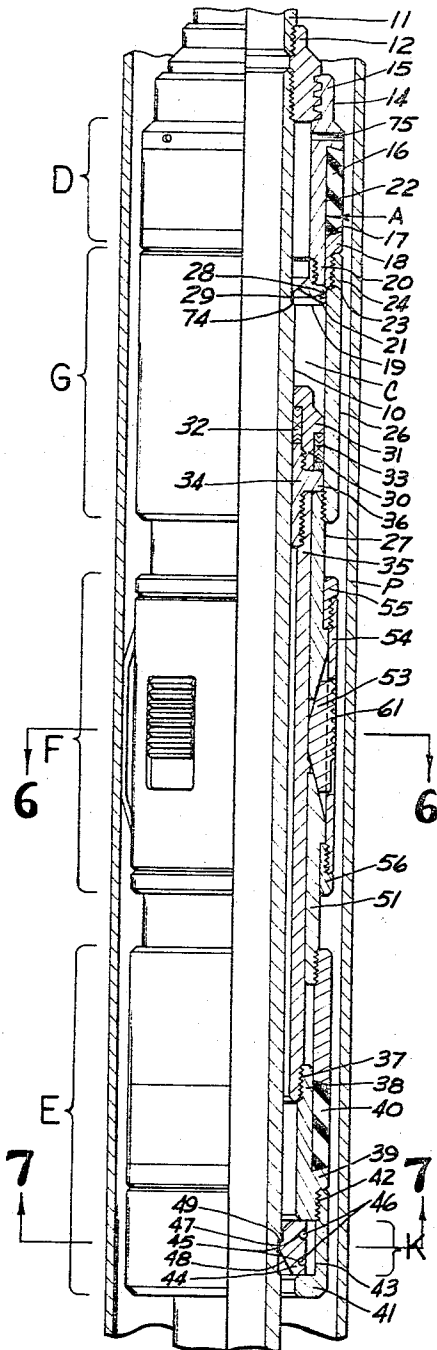


Fig. 1

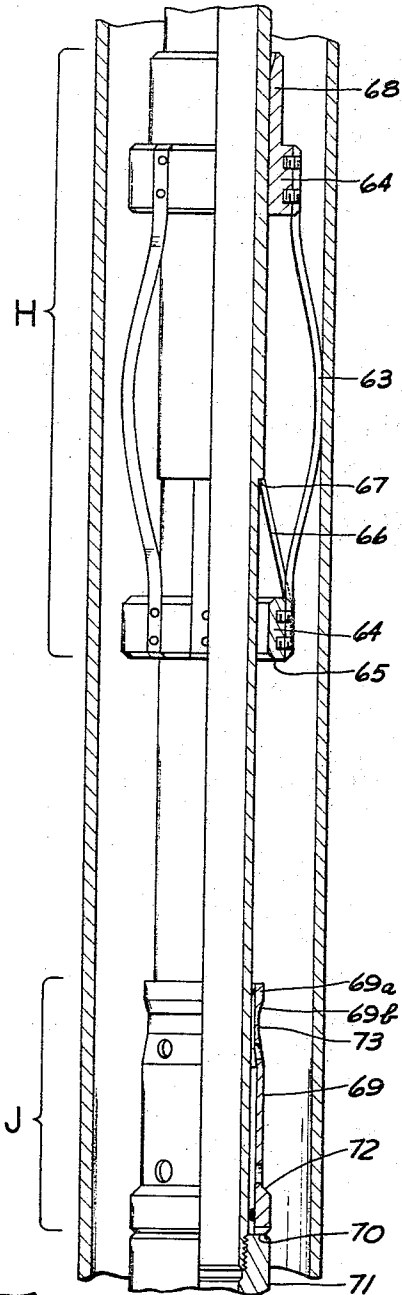


Fig. 1A

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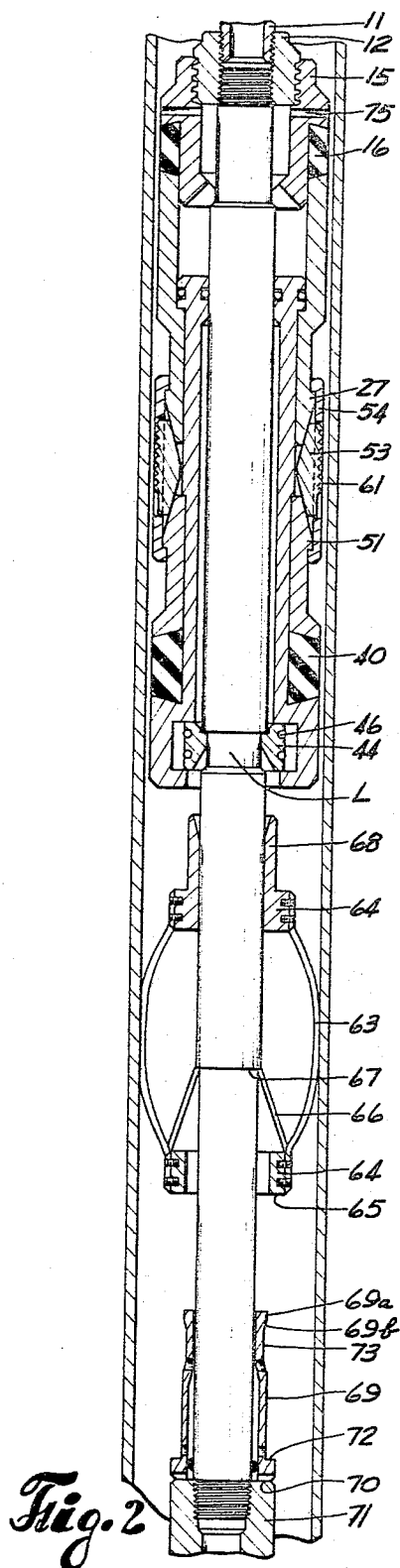
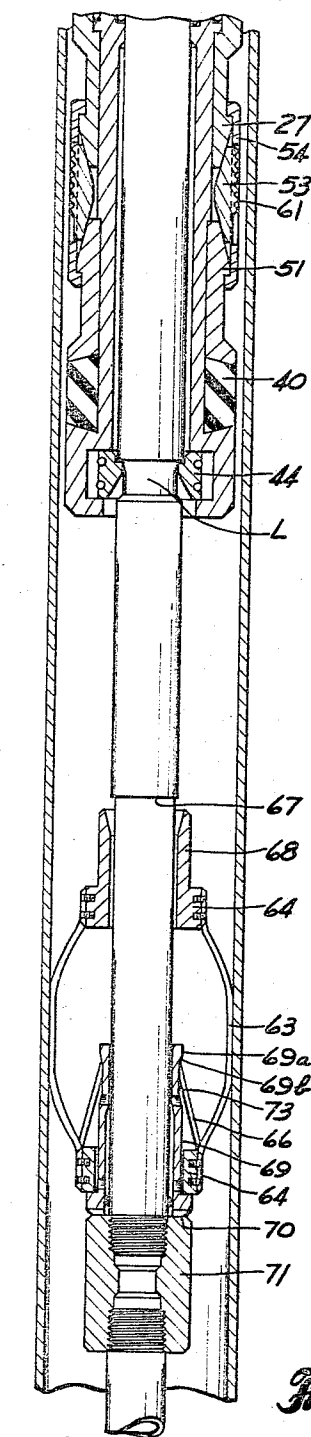
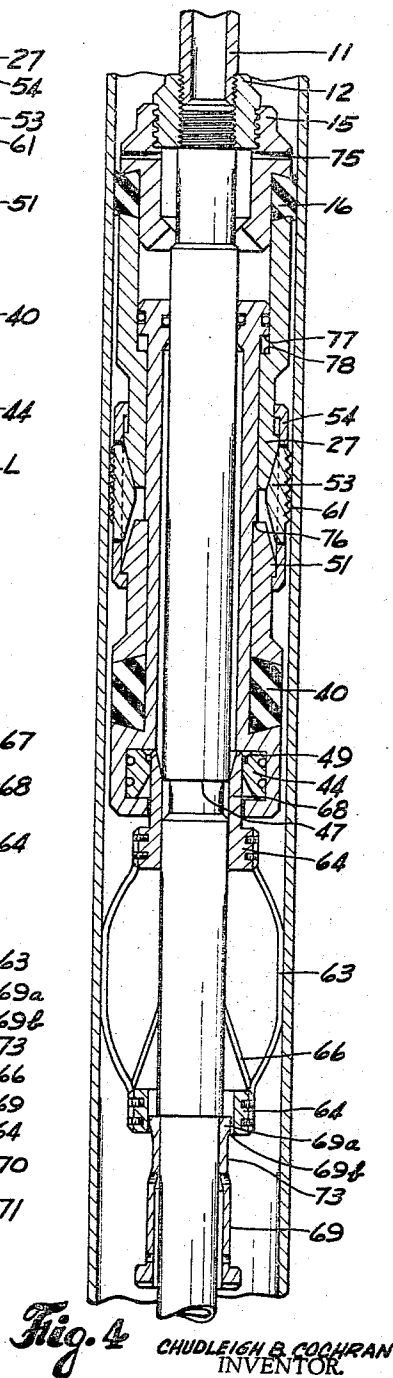
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Fig. 5

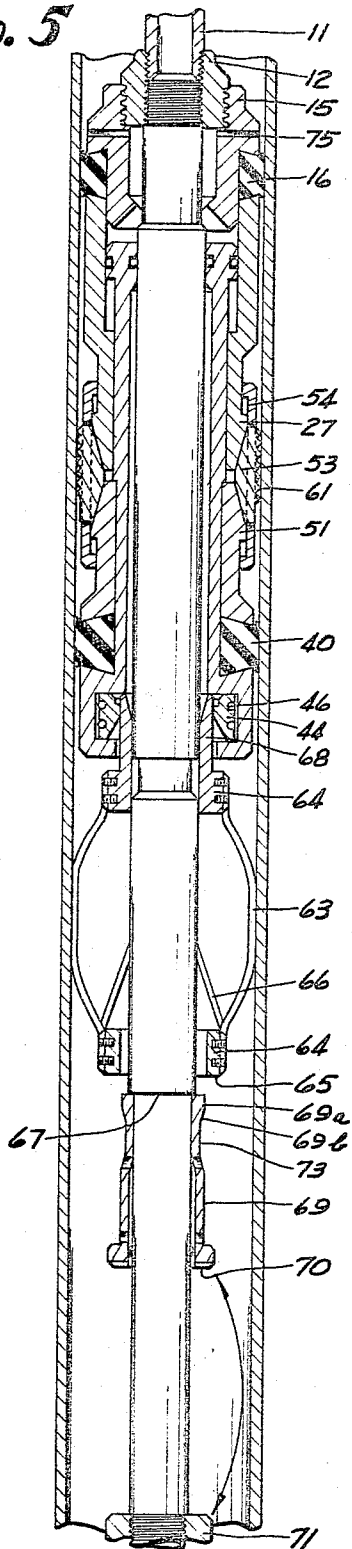


Fig. 6

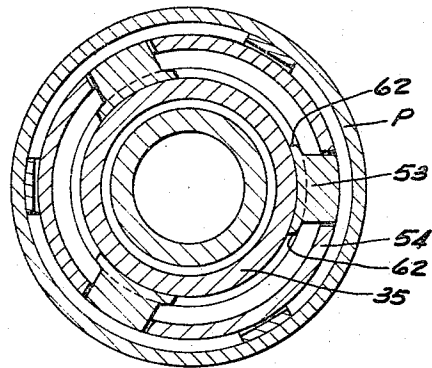
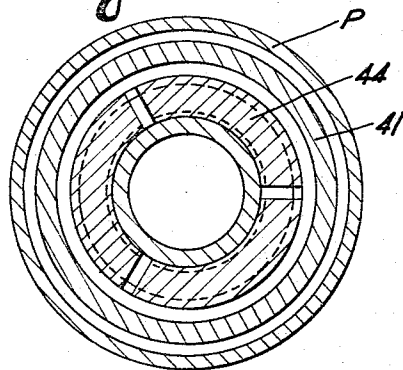


Fig. 7



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WELL PACKER

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5 Claims. (Cl. 166—120)

This invention relates to new and useful improvements in a well packer and anchoring means assembly for use in a well bore and more particularly relates to a well packer and anchoring means assembly for withstanding axial forces in either direction which is readily set and released by reciprocation of the tubing string without having to rotate the tubing string.

As wells become deeper the setting and releasing of down-the-hole equipment by rotation of the tubing string become increasingly more difficult. It is therefore very important that the setting and releasing of such equipment be positive and as simple as possible. The C. C. Brown reissue patent, Re. 25,381, issued May 7, 1963, discloses a well packer and anchor which will withstand axial forces in either direction and which are set by axial movement of the tubing and responsive to the hydraulic pressure in the annulus but require rotation of the tubing string to equalize the pressure to release the hold-down anchor buttons. These buttons have worked well but have the inherent disadvantage of multiplying the packing requirements which in turn multiply leakage possibilities.

It is therefore one important object of this invention to provide an improved well packer that can be set and released by reciprocal movement of the carrying string and which will hold a pressure differential from either above or below the device.

Another object of this invention is to provide a well packer having pressure-responsive actuating means for setting and releasing the lower seal assembly and a portion of the anchor assembly responsive to pressure in the annulus between the casing and the tubing string.

Another object of this invention is to provide a well packer with an upper seal and anchor mechanism that can be set to hold a differential from above by weight of the tubing string and a lower seal and anchor mechanism that can be set hydraulically by a differential pressure from below the packer.

A still further object of this invention is to provide a reciprocal weight and hydraulic set packer which does not require rotation for setting or releasing.

The construction designed to carry out the invention will be hereinafter described together with other features thereof.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown, and wherein:

FIGURE 1 is a longitudinal quarter-sectional view of the well packer of this invention illustrating the relationship of the parts thereof as the well packer is inserted in a well pipe.

FIGURE 1A is a continuation of FIGURE 1.

FIGURE 2 is a longitudinal sectional view of the well packer of this invention shown in less detail but in the same position as FIGURES 1 and 1A.

FIGURE 3 is a longitudinal sectional view of the well packer illustrating the relative position of the parts when the tubing is raised in order to trip the setting mechanism for setting the packer.

FIGURE 4 is another longitudinal sectional view of the well packer illustrating the relative position of the parts when the packer is initially set to hold differential pressure from above.

FIGURE 5 is a view similar to FIGURE 4, but shows

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the relative position of the parts when a pressure differential from below occurs to set the lower seal and anchor.

FIGURE 6 is a horizontal sectional view taken on line 6—6 of FIGURE 1 and illustrates the gripping members in the unset position as the packer is being run or pulled from the well bore.

FIGURE 7 is a horizontal sectional view taken on line 7—7 of FIGURE 1 and illustrates the details of the segmented members of the latch mechanism.

The well packer of the present invention is designed to provide a seal and an anchor between the tubing and casing in a well bore, and such seal should be able to withstand a pressure differential from above and below. The well packer of the present invention is set and released by reciprocating movement of the carrying tubing string and no rotation of the tubing string is necessary for setting or releasing of the well packer.

The well packer includes a tubular support 10 having connections above and below for attaching to the carrying tubing string or pipe string, an upper seal assembly D for holding a pressure differential from above, a lower seal assembly E for holding a pressure differential from below, a two-way anchor assembly F, a pressure-responsive actuating mechanism assembly G, a latch mechanism K for holding the apparatus on the tubular support 10 in the released extended position while lowering the apparatus in and out of the hole, the friction-type release means H and the tripping sleeve J. As shown in FIGURE 1, the anchor assembly F is positioned between the upper and lower seal assemblies D and E. The actuating mechanism G is positioned above the anchor assembly F. The latch mechanism K is positioned below the lower seal assembly E and engages within the groove L in the exterior of tubular support 10. The well packer is held in extended position by the latch mechanism K for running into a well bore defined by a well pipe or casing P. Means are provided to retain the friction-type release means H in position on the tubular support 10 out of engagement with the latch mechanism K until such time as it is desired to set the well packer. When the packer is to be set, the tubing string 11 carrying the well packer is raised high enough so that the tripping sleeve J releases the friction-type release means H. Thereafter, the tubing string 11 is lowered until the release means H engages the latch mechanism K and releases it from engagement in the groove L. As the tubing string 11 is further lowered, the friction-type release means H by its frictional engagement with the interior wall of the casing P will support the lower end of the packer assembly to allow the upper seal assembly D and the anchor assembly F to be set responsive to the lowering of the tubing string 11. Once the anchor assembly F is set, further weight on the anchor will set the upper seal assembly D and assure positive setting of the two assemblies D and F. Thereafter, formation pressure in the annulus between the tubing string and the casing below the unit will be exerted on the actuating mechanism assembly G so that the lower seal assembly E will be set responsive to such pressure. The movement of actuating mechanisms in the assembly G will also move to firmly set the anchor assembly F. In this position the well packer of the present invention is set and provides upper and lower pressure seals across the annular space between the tubing string 11 and the well pipe P and is firmly anchored to the interior of the well pipe P.

To release the well packer, it is only necessary to increase the pressure in the annulus above the upper seal assembly D to a level above the formation pressure. The pressure above seal assembly D is conducted to the actuating mechanism assembly G. If such pressure is sufficiently in excess of the annulus pressure below the lower seal assembly E (formation pressure), the actuating

mechanism assembly G will be actuated thereby releasing the lower seal assembly E and a part of the anchor assembly F. Complete release is thereafter accomplished by raising the tubing string 11 which releases upper seal assembly D and the remainder of anchor assembly F.

In the drawings, particularly FIGURES 1 and 1A, the well packer of the present invention is shown inserted within the well casing P and connected to the tubing string 11 by conventional tool joints, or couplings 12. As shown in FIGURE 1, the coupling 12 engages the lower end of the tubing string 11 above the device and engages the upper end of the tubular support 10 on its interior and the sleeve support 14 on its exterior through the threaded connection 15. The upper seal assembly D includes the sleeve support 14, the upper seal element 16 and the compression ring 18 which abuts the lower face 17 of the upper seal element 16. The compression ring 18 is mounted for longitudinal or axial movement with the sleeve support 14 and is retained on the sleeve support 14 by the retainer ring 19 which is secured to the lower end of the sleeve support 14 by the threads 20. The retainer ring 19 has an enlarged flange 21 which has a slightly larger outside diameter than the diameter of the surface 22 on the sleeve support 14. The lower face 23 of the compression ring 18 abuts the flange 21 to retain the ring 18 on sleeve support 14. The lower portion of the compression ring 18 is threadedly engaged into the upper portion of cylinder member 26 by the threads 24. The lower end of cylinder member 26 is provided with a suitable threaded connection to the upper expander 27 which forms a part of the two-way anchor assembly F. The inside diameter of the cylinder member 26 is slightly larger than the outside diameter of the flange 21 on retainer ring 19, and a suitable seal, such as O-ring 28 in the groove 29 cut in the exterior of the flange 21, provides a seal against the interior of the cylinder member 26.

Cylinder member 26 and the tubular support 10 define the annular chamber C containing the piston member 30. The actuating mechanism assembly G includes the chamber C and the piston 30, and, as is hereinafter more clearly pointed out, the piston 30 is movable within the chamber C responsive to the differential in pressure in the annulus above and below the upper seal assembly D. The annular chamber C is provided with a suitable connection hereinafter defined to the annulus above the upper seal element 16. The piston member 30 surrounds the tubular support 10 and seals off therewith by means of the packing 32. The piston member 30 is slidable in a vertical or axial direction in relation to the tubular support 10 and the cylinder member 26. Suitable packing 33 is provided for sealing off the piston member 30 with the interior of the cylinder member 26. The upper piston part 31 is recessed for the packings 32 and 33. The adapter 34 is threadedly engaged with the upper piston part 31 and also threadedly engaged to the tie tube or lower piston part 35. The adapter 34 is provided with a flange portion 36 which extends into close spaced relationship to the interior surface of the cylinder member 26 and serves to retain the packing 33. The lower face of the adapter flange 36 engages the upper extremity of the upper expander 27 and such engagement serves to retain the piston member 30 within the chamber C in the extended position illustrated in FIGURE 1.

The tie tube 35 extends downwardly in the annular space between tubular support 10 and the anchor assembly F and is threadedly engaged with lower seal support 38 by the threads 37. Lower seal support 38, compression ring 39 and lower seal element 40 form the lower seal assembly E. As shown, the ring 39 is slidably movable with respect to the lower seal support 38 so as to compress the lower seal element 40 between the upwardly facing portion of the lower seal element 38 and the downwardly facing portion of the ring 39.

The latch mechanism K includes the latch housing 41 which threadedly engages with the lower portion of lower

seal support 38 through the suitable threads 42 and surrounds the segmented latch members 44. As shown in FIGURE 1, the interior surface 43 of the latch housing 41 is sufficiently large to allow outward radial movement of the segmented members 44. The lower portion of the latch housing 41 extends inwardly to provide a lower support for members 44 and to contain the members 44 within the latch housing 41. It should be noted that such inward projection of latch housing 41 is, however, spaced outwardly from the exterior of the tubular support 10. The segment members 44 are provided with the grooves 45 around their outer periphery. The grooves 45 receive the resilient springs 46 which will engage the segment members 44 and urge them inwardly into latching engagement with the groove L in the tubular support 10. The upwardly facing shoulder 47 is provided on the interior of the segment member 44 and will engage the downwardly facing shoulder 49 on the tubular support 10 when the latch mechanism K is latched with the segment members 44 positioned in the groove L. The lower portion of such segmented latch members is provided with an upwardly and inwardly tapering conical surface 48 for the reason hereinafter more fully explained.

The anchoring assembly F includes the lower expander 51 and the upper expander 27 which both engage tapered interior portions of the gripping members 53 urging such gripping members outwardly when the expanders are moved axially toward each other. The cage 54 having upper and lower cage retainers 55 and 56 is positioned in surrounding relationship to the upper expander 27 and the lower expander 51, and includes windows through which the gripping member 53 may move outwardly. Upper cage retainer 55 surrounds the reduced diameter portion of upper expander 27 and allows a downward sliding movement of the upper expander 27 therein. The lower portion of upper retainer 55 provides a downwardly facing shoulder engaging the upwardly facing shoulder on the upper expander 27 which prevents the upper expander 27 from pulling completely out of the anchor assembly F. In a similar manner the lower cage retainer 56 is positioned surrounding the reduced diameter portion of the lower expander 51 and provides an upwardly facing shoulder to engage the downwardly facing shoulder on the lower expander 51 to prevent the lower expander from being completely withdrawn from the anchor assembly F.

Each of the gripping members 53 has its inner surface beveled to mate with the tapers on the upper and lower expanders 27 and 51. In the extended position of the apparatus as shown in FIGURE 1, the outside teeth 61 of the gripping members 53 are protected by the cage 54. As seen in FIGURE 6, the gripping members 53 are retained from falling through the windows by the projections 62 provided on the sides of the gripping members 53. Sufficient clearance is provided between the projections 62 and the inside diameter of the cage 54 to allow expansion of the gripping members 53 into gripping contact with the casing P.

The tubular support 10 extends below the latch housing 41 and has mounted thereon in axial sliding relationship the friction-type release means H. The means H is constructed to include a plurality of leaf springs 63 extending between two annular rings 64 and 65. Suitable screws are used for securing the leaf springs 63 to the rings 64 and 65. Sufficient bow is provided in the leaf springs 63 to provide a drag against the interior of the casing P when the unit mounted on the tubular support 10 is run into the casing P. The means H provides a frictional force resisting movement of the means either downwardly or upwardly in the casing P. The tripping springs 66 are mounted on the exterior of the lower annular ring 65 and extend inwardly to engage and press against the exterior of the tubular support 10. The inner ends of these tripping springs 66 engage the downwardly facing shoulder 67 on the tubular support 10 during the running of the well packer into the hole. The friction of the leaf spring 63

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against the casing P will hold the tripping springs 66 against the shoulder 67 during downward movement of the device.

The upper annular ring 64 is provided with a reduced diameter, upwardly extending projection 68 which will extend into the latch housing 41 and engage the surface 48 to trip the segment members 44, release the latch mechanism K and allow telescopic movement of the parts in order to set the device. The tripping ring 69 surrounds the lower portion of the tubular support 10 and engages the upper face 70 of the bottom coupling or connection 71. This bottom coupling 71 is threadedly engaged with the lower end of the tubular support 10 and is provided with suitable threading to engage with a tubing string which extends downwardly therebelow. The upper end 69a of the tripping ring 69 has an outside diameter slightly smaller than the inside diameter of the lower annular ring 65 in the release means assembly H. Immediately below the upper end portion 69a the exterior surface of the tripping ring 69 is beveled inwardly along surface 69b to provide a reduced diameter section 73. The lower portion of the tripping ring 69 is provided with externally upwardly facing shoulder 72 for engagement with the lower surface of the annular ring 65 as hereinafter more fully explained.

The tubular support 10 is provided with an upwardly facing shoulder 74 which will engage with the lower interior surface of retaining ring 19 as hereinafter more fully explained. The communication to the annular chamber C is established by the port 75 extending through the sleeve support 14 which places the annulus above the upper seal element 16 in communication with the annular chamber C through the port 75, the annular space between the interior of the sleeve support 14 and the tubular member 10 and the passageway established through the retainer ring 19 as shown. The shoulder 76 on the exterior of the tie tube 35 is provided to engage the upper end of the lower expander member 51.

The operation in running and setting the well packer of the present invention is best illustrated by a comparison of the FIGURES 2, 3, 4 and 5 which illustrate the different stages thereof. In FIGURE 2 the well packer of the present invention is illustrated in the position in which it would be run into the bore of the casing P. The component parts of the device are positioned as shown with the seal assemblies D and E, the anchor assembly F and the actuating mechanism assembly G all latched in extended nonset position by the latch mechanism K. The friction release means H is positioned below and spaced from the latch mechanism K with its tripping spring 66 in engagement with the downwardly facing shoulder 67 on the tubular support 10. The tripping sleeve J is positioned at the lower end of the tubular support 10 and is in engagement with the bottom coupling 71. The spacing between the friction means H and the tripping sleeve J must be such that the tripping spring 66 will at all times during the normal running in of the tubing string 11 be in engagement with the shoulder 67 and at no time released therefrom by becoming engaged with tripping ring 69. A spacing between these two members will be sufficient if it allows for the picking up and sitting down of the tubing string to set the tubing slips at the surface without causing the tripping ring 69 to release the engagement of the springs 66 from the shoulder 67.

When the well packer of the present invention has been run down into the interior of the casing P to a point at which it is desired to be set, the tubing string 11 will be lifted a sufficient distance to allow the tripping sleeve J to extend through the lower interior of annular ring 65 and to cause the tripping spring 66 to pass onto the exterior of the tripping ring 69 and come into engagement with the beveled surface 69b, as best illustrated in FIGURE 3. It should be noted that the friction of the release means H against the interior of the casing P will maintain the position of the means H during these operations.

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When the tubing string 11 has been lifted a sufficient distance to assure the tripping of the tripping spring 66 as shown in FIGURE 3, the tubing string will then be lowered. During the lowering of the tubing string, the tubular support 10 will move downwardly through the friction release means H, and the shoulder 67 will engage with the upper edge of the tripping ring 69 and move it downwardly out from under the tripping spring 66. It should be noted, however, that such downward movement and the engagement by the shoulder 67 with the upper part of tripping ring 69 will prevent the tripping springs 66 from coming into engagement with the shoulder 67 and will therefore allow the projection 68 on the upper annular ring 64 to extend into and release the latch mechanism K.

Upon further downward movement of the tubing string 11 and tubular support 10, the projection 68 will engage the surface 48 and force the segment members 44 outwardly against the inward force provided by the spring 46. This outward movement of the segment members 44 will disengage the shoulder 47 from the shoulder 49 in the groove L and thereby allow relative movement of the assemblies D, E, F and G with respect to the tubular support 10. The upper end of the projection 68 will engage the lower end of the tie tube 35 as seen in FIGURE 4. The friction provided by the release means H will be sufficient to support tie tube 35 allowing the remainder of the components to move downwardly with respect thereto with the continued downward movement of the tubular support 10. The telescoping or parts supported by the friction release means H will move the upper expander 27 downwardly under the gripping members 53 forcing them outwardly into engagement with the interior of the casing P and will cause a partial compression of both the upper and lower sealing elements 16 and 40. When the gripping elements have been moved into firm engagement with the interior of the casing, a further downward movement will result in placing additional weight on the device which will further move upper expander 27 downwardly on the gripping members 53 thereby completing the setting of the anchoring assembly F. Such downward movement will also cause the upper seal element 16 to be compressed between the sleeve support 14 and the compression ring 18 whereby it will deform outwardly into sealing engagement with the interior of the casing as best shown in FIGURE 4.

The well packer of the present invention, as shown in FIGURE 4, will be anchored in the desired position and will have its seal assembly D completely set to protect against pressures in the annulus above the unit. The weight of the tubing string 11 upon the upper seal assembly D will also allow it to withstand a pressure in the annulus below the unit which normally will be the formation pressure. Such pressure from below, when it exceeds the pressure in the annular chamber C, will cause relative movement of the parts with the tie tube 35 and piston member 30 moving upwardly whereby the lower seal assembly E is set as is shown in FIGURE 5.

With both seal assemblies D and E completely set and with the anchor assembly F fixed with its gripping members 53 in gripping engagement with the interior of the casing P, the device is set and will withstand pressure differentials from above and below provided that the weight applied to set the upper seal assembly is maintained. In the event that it is desired to release the well packer of the present invention from its position as shown in FIGURE 5, it is only necessary to provide pressure in the annulus above the upper seal assembly D which exceeds the pressure in the annulus below the lower seal assembly E or the formation pressure. This pressure in the upper annulus area is conducted through the port 75 into the annular chamber C and will act upon the upper surface of the piston member 30. The downward movement of the piston member 30 will move the tie tube 35 downwardly to unset and completely release the

lower seal assembly E, and shoulder 76 on tie tube 35 will move lower expander 51 downwardly and out of engagement with the gripping members 53. Thus, the pressure will have returned the parts of the device to the approximate position illustrated in FIGURE 4. Thereafter, the upper seal assembly D may be unset by a lifting of the tubing string 11 to relieve the upper seal assembly D of the weight. As the tubing string 11 is further raised, the flange 21 of retainer ring 19 will engage the compression ring 18 whereby the upper expander 27 will be moved upwardly with respect to the gripping members 53 causing them to return to their retracted position within the cage 54.

As the unit is further lifted, the segmented members 44 of the latch mechanism K will again engage in the annular groove L in the tubular support 10 locking the well packer device of the present invention in its extended position to prevent it from being set during its removal. Thus, the device which has been unset as described will appear as illustrated in FIGURE 3 during its removal.

If it is desirable to release the well packer from one location and move it to another lower location in the same casing, this may be accomplished by controlling the distance the carrying string is lifted during the final release of upper seal assembly D and anchor assembly F. The unit should be lifted so that the tripping springs 66 are in engagement with tubular support 10 below shoulder 67 but not so far that tripping sleeve J is again brought into engagement with tripping springs 66. If the well packer is to be removed from the well bore, then it may be lifted in the position as shown in FIGURE 3. In the same position the well packer may be set at any position above its original set position. To move the well packer downwardly, it must assume the position shown in FIGURES 1, 1A and 2. Any other position will cause the well packer to be set by the lowering of the carrying string as above described. However, it is a relatively simple matter to release the well packer of the present invention, move it to another position in the same casing and reset it at such new position.

From the foregoing it can be seen that the well packer of the present invention is readily set by the reciprocal movement of the carrying string and will hold pressure differentials from above or below the device. As shown further, the well packer may have its lower seal assembly and the lower portion of the anchoring assembly firmly set and also released by a pressure-responsive actuating means which is actuated by a pressure differential in the annulus between the casing and carrying string above and below the packer. The well packer of the present invention does not in any way require rotation or tubing pressure to be set or released.

What is claimed is:

1. A well packer for use in a well pipe comprising,
 - a tubular support,
 - an upper seal assembly mounted surrounding the upper portion of said tubular support,
 - a lower seal assembly mounted surrounding said tubular support below said upper seal assembly,
 - an anchor assembly mounted surrounding said tubular support between said upper and lower seal assemblies,
 - pressure-responsive means mounted on said tubular support and connected to actuate said lower seal assembly,
 - said seal assemblies and said anchor assembly being movable in a telescoping manner to set said seal assemblies and said anchor assembly,
 - latch means holding said assemblies in extended unset position in relation to said tubular support whereby said well packer may be run to a desired position in a well pipe, and
 - release means for releasing said latch means preparatory to the setting of said assemblies,
 - said release means being actuated responsive to a lifting

of the tubular support and thereafter a lowering of said tubular support to release said latch means and support said assemblies whereby said anchor assembly and said upper seal assembly are set by the lowering of said tubular support,

said pressure-responsive means being responsive to the pressure differential in the annulus above and below said well packer whereby a larger pressure in the annulus below will actuate said pressure responsive means to telescope said lower seal assembly into sealing position with said well pipe and a larger pressure above will actuate said pressure-responsive means to extend said lower seal assembly to a released and unset position.

2. A well packer according to claim 1 wherein, said well packer is released from set position by pressuring the annulus above said well packer to a pressure greater than the pressure in the annulus below said well packer to actuate said pressure-responsive means to unset said lower seal assembly and lifting said tubular support to unset said upper seal assembly and said anchor assembly.
3. A well packer for use in a well pipe comprising,
 - a tubular support,
 - an upper sealing assembly surrounding said tubular support and adapted to be extended outwardly into sealing engagement with the interior of said well pipe by telescoping together of said assembly,
 - the upper abutment for said upper sealing assembly connected to said tubular support,
 - an anchoring assembly surrounding said tubular support and including gripping members adapted to move outwardly into gripping engagement with the interior of said well pipe responsive to telescoping together of said anchoring assembly,
 - an annular chamber formed surrounding said tubular support,
 - a piston positioned for axial movement in said annular chamber,
 - a lower sealing assembly surrounding said tubular support and adapted to be extended outwardly into sealing engagement with the interior of said well pipe by telescoping together of said lower sealing assembly,
 - said piston being connected to said lower sealing assembly,
 - latch means releasably securing said piston to said tubular support, and
 - friction-type release means adapted to be held out of contact with said latch means during normal running of said packer and to release said latch means responsive to a lifting followed by a lowering of said tubular support,
 - said friction-type release means supporting said packer after release of said latch means to allow said upper sealing assembly and said anchoring assembly to be set responsive to the weight of lowering of the tubing string,
 - said lower sealing assembly being set by pressure in the annulus below said packer exceeding the pressure in said annular chamber.
4. A well packer according to claim 3 wherein, said lower sealing assembly unsets responsive to pressure in said annular chamber moving said piston downwardly and
- said upper sealing assembly and said anchoring assembly are thereafter unset by lifting the tubing string.
5. A well packer for use in a well pipe comprising,
 - a tubular support,
 - an upper seal assembly mounted on said tubular support,
 - said tubular support forming the upper abutment for said upper seal assembly,
 - gripping elements adapted to move outwardly into gripping engagement with the well pipe,

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an upper conical member having a conical surface for moving said gripping elements outwardly into gripping position against said well pipe, the upper portion of said upper conical member forming the lower abutment for said upper seal assembly, 5 said upper conical member defining the exterior of a chamber surrounding said tubular support, a piston member positioned within said chamber for axial movement therein responsive to pressures in the annulus above and below said well packer, 10 a lower seal assembly, latching means latching said piston to said tubular support at a position below said lower seal assembly, a lower conical member having a conical surface for moving said gripping elements outwardly into gripping position against said well pipe, 15 the lower portion of said lower conical member forming the upper abutment for said lower seal assembly, a lower abutment for said lower seal assembly connected to said piston member, and 20 releasing means engageable with said latch member to release said latch member allowing movement of said piston relative to said tubular support,

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said releasing means having frictional engagement with said well pipe whereby said releasing means provides support for said packer, said gripping elements and said upper seal assembly being weight set by lowering said tubular support against the support provided by said releasing means, said piston member thereafter setting said lower seal assembly responsive to the pressure in the annulus from the producing formation below said well packer.

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