Jan. 4, 1955 C. C. BROWN 2,698,663

WELL PACKER

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Fig. 1

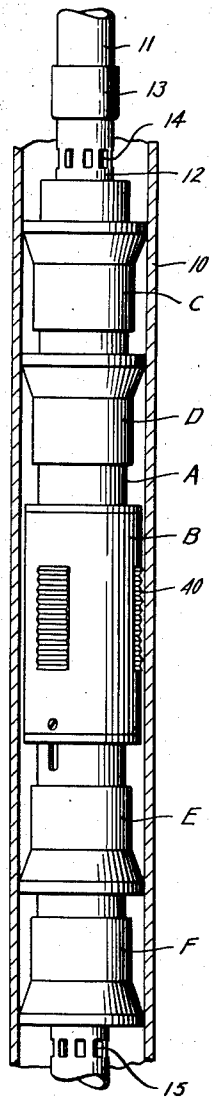

Fig. 5

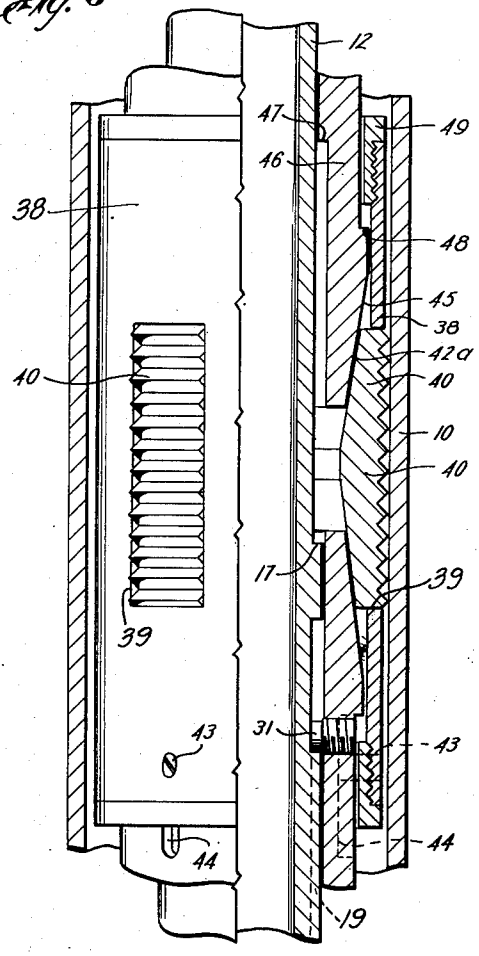

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Fig. 2

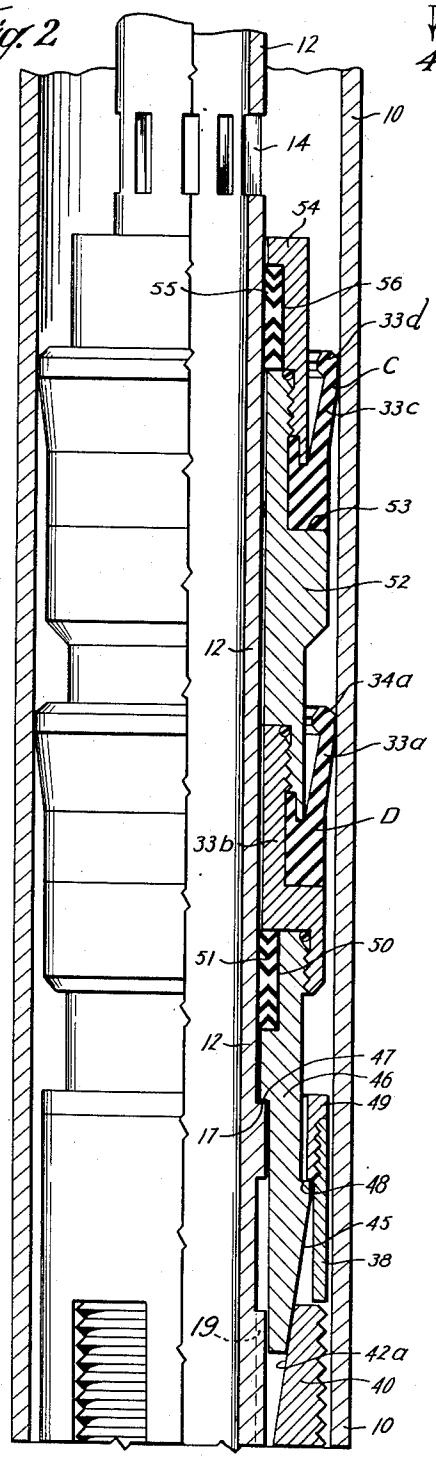

Fig. 3

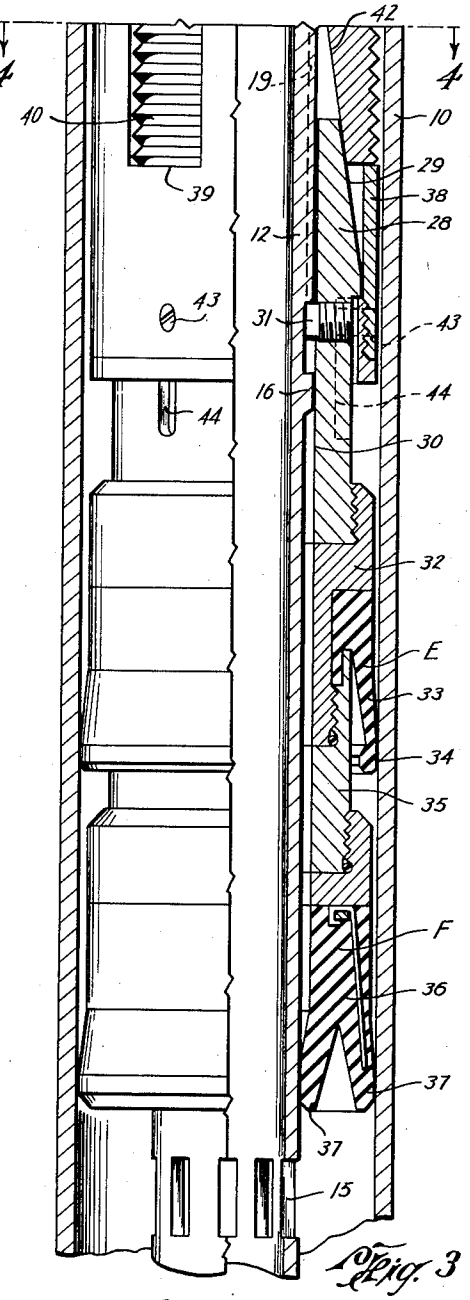

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Fig. 6

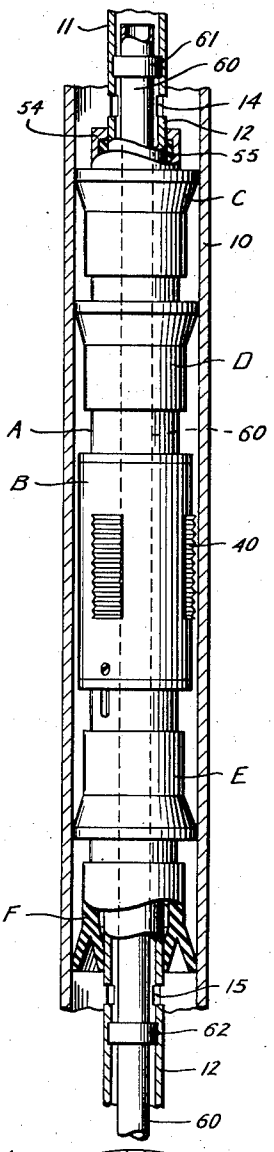


Fig. 7

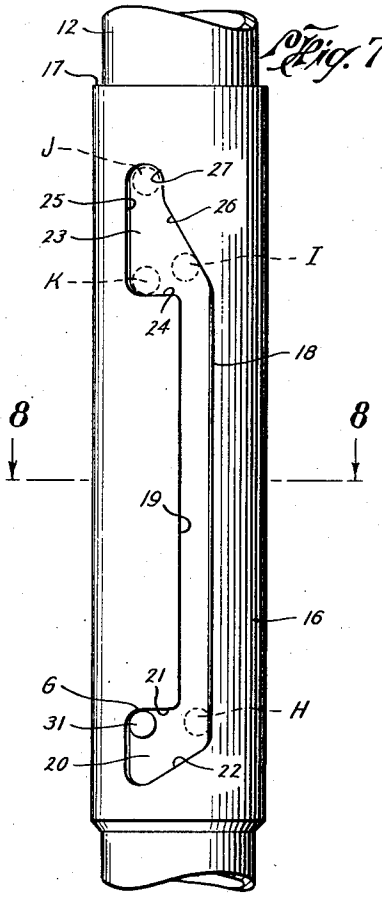


Fig. 8

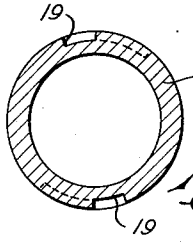
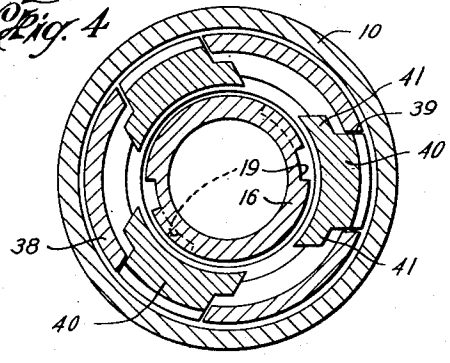


Fig. 4



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WELL PACKER

Cicero C. Brown, Houston, Tex.

Application December 1, 1950, Serial No. 198,678

8 Claims. (Cl. 166—121)

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

One object of the invention is to provide an improved well packer for sealing off the annular space between pipe strings in a well bore, which packer is adaptable for use either as an ordinary production packer or as a packer such as is employed in carrying out squeeze operations within the well.

An important object of the invention is to provide an improved well packer which is maintained in set position by the pressure differential thereacross, whereby the weight of the pipe string to which the packer is attached is not depended upon to maintain the packer in its anchored sealing position.

A particular object is to provide an improved packer wherein the gripping slip assembly is mounted to float or move independently relative to a pair of slip expanding members, which slip expanding members are movable independently of each other, together with pressure actuated packing means connected with said expanding members, whereby pressure above and below the packer acting upon said packing means functions to impart movement to the slip expanding members to initially cause and subsequently maintain the gripping slips of the slip assembly in an expanded gripping position.

A further object is to provide a packer, of the character described, wherein the packer unit is adapted to be latched to a lowering pipe in inactive position to facilitate lowering and raising of the unit within the well, said unit being released for operation by a rotation of the lowering pipe; downward movement of the lowering pipe subsequent to the rotation thereof functioning to automatically and mechanically lock the packer against release from its set position, whereby said packer cannot be removed until the lowering pipe is again rotated to unlock the same for release.

Still another object is to provide a well packer, of the character described, wherein the differential of pressures above and below the packer maintain the anchoring means and the packing elements of the packer in their set and sealing positions; the arrangement being such that any differential, regardless of whether the higher pressure is above or below the packer will function to accomplish the purpose.

Other objects will hereinafter appear.

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 an elevation of a well packer, constructed in accordance with the invention and illustrating the same being lowered within a well casing,

Figure 2 is an enlarged view, partly in section and partly in elevation of the upper portion of the well packer with the parts in the position shown in Figure 1,

Figure 3 is a continuation of Figure 2 illustrating the lower portion of the packer,

Figure 4 is a horizontal cross-sectional view, taken on the line 4—4 of Figure 3,

Figure 5 is a view, partly in section and partly in elevation showing the anchoring slips in set position,

Figure 6 is a view, partly in section and partly in elevation, of a modified form of the invention,

Figure 7 is an enlarged elevation of the connecting slot and pin arrangement, and

Figure 8 is a horizontal cross-sectional view taken on the line 8—8 of Figure 7.

In the drawings, the letter A generally indicates the improved well packer which is adapted to be lowered into a well pipe **10** by means of a lowering pipe or conductor **11**. The packer includes an anchoring assembly B, upper packer elements C and D and lower packer elements E and F (Figure 1). The anchoring assembly B is arranged to be set or anchored within the well pipe **10** and the packer elements seal off the annulus between the lowering conductor **11** and the well pipe **10**. As will be described in detail, the upper packer elements C and D are acted upon by pressure above the assembly while the lower elements E and F are acted upon by pressure below the assembly, whereby the differential in the pressures above and below the packer maintain the same in its set or anchored position.

As is shown in detail in Figures 2 and 3, the packer includes a tubular mandrel **12** which has its upper end connected by a coupling **13** with the lowering pipe **11**. The mandrel extends entirely through the packer assembly and is provided with upper circulating ports or openings **14** and similar lower circulating ports **15**. The intermediate portion of the mandrel **12** is formed with an enlarged portion **16** (Figure 7) and the upper end of this enlarged portion provides an external annular shoulder **17**. An elongate slot **18** extends through the wall of the mandrel and comprises a longitudinal portion **19** having a lateral offset **20** at its lower end. The upper wall **21** of the offset **20** provides a horizontal shoulder, while the lower wall **22** of the offset is generally inclined. The upper end of the longitudinal portion **19** of the slot **18** is also provided with an offset **23** and the lower wall **24** defining this offset also provides a horizontal shoulder. One wall **25** of the offset portion **23** extends substantially longitudinally while the opposite wall **26** provides an inclined surface which connects with an upper recess **27**, the recess **27** forming the extremity of the offset **23**. As will be hereinafter explained, the slot **18** is adapted to provide a connection between the anchoring assembly B of the packer and the mandrel **12**.

The anchoring assembly B includes a lower annular expander member **28** which surrounds the lower portion of the enlargement **16** on the mandrel. As is clearly shown in Figure 3, the upper external surface **29** of the expander **28** is generally inclined, while the bore **30** of said expander slidably engages over the enlarged portion **16** of the mandrel. The expander **28** has an inwardly directed pin or key **31** which is adapted to engage and ride within the connecting slot **18** of the mandrel **12**.

It will be evident that when the pin **31** is in the position G shown in full lines in Figure 7, said pin is abutting the wall **21** of the lower offset **20** of the slot and the expander is locked against upward movement with respect to the mandrel. A rotation of the mandrel **12** to move the pin **31** to the dotted line position H of Figure 7 aligns said pin with the longitudinal portion **18** of the mandrel and thus, the mandrel **12** may be lowered with respect to the expander **28**, the pin **31** riding upwardly through the longitudinal portion **19** of the connecting slot. As the mandrel moves downwardly the pin **31** will ultimately assume the position shown in the dotted line I in Figure 7 so that the inclined wall **26** of the upper offset **23** strikes said pin and due to the cam action the pin will be guided into the upper recess **27** assuming the position shown in the dotted line J. Any downward movement of the expander or upward movement of the mandrel after the pin has assumed the position J will cause the pin to engage the shoulder **24** as indicated by the dotted lines K and at this point further movement of the expander downwardly with respect to the mandrel will be prevented. As will hereinafter appear, the surface **24** provides a lock which can be released only upon a subsequent rotation of the mandrel in a direction which will again align the pin **31** with the longitudinal portion of the slot.

The lower end of the expander is connected through a coupling **32** on which the packer element E is mounted. The packer element is in the form of a pressure respon-

sive packing cup 33 having a downwardly directed sealing lip 34. A spacer 35 connects the packing cup assembly with the lowermost packer element F which comprises an annular packing cup 36 having downwardly directed sealing lips 37. It is evident that the pressure below the cups 36 and 33 will tend to urge the lower expander member 28 in an upward direction.

Surrounding the lower end of the expander is the lower portion of a slip carrier sleeve or housing 38. This sleeve is provided with a plurality of radial openings 39 provided in its intermediate portion and gripping elements or slips 40 are radially expansible through said openings. Each slip is provided with longitudinal projections 41 (Figure 4) which coact with the inner wall of the slip carrier to prevent complete outward displacement of each slip through its respective opening 39. The lower portion of the inner surface of each slip is inclined as indicated at 42, and this inclined surface coacts with the inclined slip expanding surface 29 of the lower expander member 28. The lower end of the slip carrier 38 is connected with the slip expander 28 by means of a pin 43 which extends inwardly from the slip carrier and which engages an external groove or keyway 44 in the expander. The expander may thus undergo a limited longitudinal movement with respect to the carrier and with respect to the slips 40 mounted in such carrier. It will be evident that when the expander 28 is moved upwardly with respect to the slips 40, said slips are expanded radially outwardly.

The upper portion of the inner surface of each slip 40 is also inclined as indicated at 42*a* and this inclined surface is adapted to coact with the slip expanding surface 45 of an upper slip expander member 46. The member 46 is annular and is formed with an internal shoulder 47 which is adapted to engage the external shoulder 17 formed on the mandrel 12 (Figure 2) whereby downward movement of the expander 46 is limited. The expander is also formed with an external annular shoulder 48 which is engaged by a stop collar 49 which is threaded into the upper end of the bore of the slip carrier sleeve or housing 38. The engagement of the stop collar 49 with the shoulder 48 limits downward movement of the slip carrier sleeve wtih respect to the expander 46.

The upper end of the expander has an internal recess 50 which receives suitable packing 51 for packing off between the expander and the external surface of the mandrel 12. The packer element D is connected to the upper end of the upper expander 46 and comprises an annular packing cup 33*a* similar in construction to the packing cup 33. The annular sealing lip 34*a* of the cup 33*a* is directed upwardly. A spacer 52 having an external shoulder 53 is connected to the tubular body 33*b* of the packing cup assembly D and the upper packer element C is mounted on this spacer. The element C comprises a cup 33*c* similar to the cup 33*a* with its sealing lip 33*d* projecting upwardly. The cup 33*c* is retained in position abutting the shoulder 53 of the spacer 52 by a retaining gland 54 threaded onto the upper end of the spacer. The gland 54 has suitable packing 55 contained within a recess 56 formed in the bore thereof.

In the operation of the packer the parts are disposed in the positions shown in Figures 2 and 3, in which position the gripping slips 40 of the anchoring assembly are retracted. At this time the connecting pin 31 of the lower slip expander 28 is disposed in the lower lateral offset 20 of the connecting slot 18 and movement of the expander 28 longitudinally of the mandrel is thereby prevented. The upper expander 46 is supported upon the external shoulder 17 of the mandrel and the carrier sleeve or housing 38 is suspended from the external shoulder 48 (Figure 2) of the upper expander. In this position the upper expander is at the upper limit of its movement relative to the slip carrier and the lower expander is in a lowered position with respect to said slip carrier, with the result that the gripping slips 40 are in a retracted position. At this time the circulating ports 14 in the upper portion of the mandrel are above the uppermost packer C, while the lower circulating ports 15 in the mandrel are below the lowermost packer F. Thus, as the device is lowered through the well pipe 10 a by-pass of fluid around the packer elements may occur through the circulating ports 14 and 15.

When the packer reaches the position at which it is to be set the lowering pipe 11 and mandrel 12 which is attached thereto is rotated to move the connecting pin 31 of the lower expander 28 from the position G to the position H in Figure 7 to align said pin with the longitudinal portion 19 of the connecting slot 18. It is then possible to lower the mandrel 12 with respect to the anchoring assembly B and the packer elements, because the packer elements will be held stationary due to their frictional engagement with the wall of the pipe 10. The lower elements E and F are directly connected to the lower expander which is also held stationary and the upper packer elements C and D have a direct connection with the upper expander to hold such expander stationary. As soon as the connecting pin 31 moves into alignment with the longitudinal portion 19 of the slot, it is not only possible for the mandrel to be lowered with respect to the expanders but if the pressure below the device is sufficient, the lower expander may be moved upwardly with respect to the mandrel, such action being obtained by the pressure acting against the lower packing element F.

As the mandrel 12 is lowered the shoulder 17 is moved away from the shoulder 47 of the upper expander so that the pressure above the unit may act on the upper packer elements C and D to urge the upper expander downwardly. It is therefore obvious that pressure from above and below the device will act upon the expanders 46 and 28 to move these expanders inwardly of the slip carrier, and gripping slips, to thereby expand the gripping slips radially outwardly. Downward movement of the mandrel is continued until the connecting pin 31 of the lower expander engages the inclined surface 26 of the connecting slot and when this occurs, the cam action between said inclined surface and the pin imparts sufficient rotation to the mandrel to allow the pin to move upwardly into the recess 27 at the extreme upper end of the connecting slot. At this time the expanders have functioned to engage the slips with the well pipe and the assembly is locked within said pipe. Downward movement of the lower expander with respect to the mandrel will be limited by the engagement of the pin 31 with the shoulder 24, as shown by the position K in Figure 7, and thereafter any further downward movement of the expander which might allow disengagement of the slips is prevented. It is thus apparent that the anchoring assembly is locked against disengagement from its set position. By the time that the mandrel has been moved downwardly relative to the anchoring assembly to locate the pin 31 in the upper offset 23 the upper circulating ports 14 of the mandrel have moved between the two packing assemblies 51 and 55 to effectively close said circulating ports.

With the anchoring assembly set and with the connecting pin 31 engaging the shoulder 24 of the slot 18 the anchoring assembly cannot be disengaged from the pipe and the unit is effectively locked within said pipe. At the same time the pressure differential above and below the packer holds the anchoring assembly in its tightly engaged position. If the pressure above the packer is greater, then the upper expander 46 is moved further inwardly of the slip carrier; on the other hand, if pressure from below is greater, the lower expander is moved further inwardly of the carrier, this movement being permitted by the space between the shoulder 24 and the recess 27 of the connecting slot. The pressure acting upon the packer elements will also function to maintain said elements in tight sealing engagement with the wall of the pipe.

In removing the packer, it is only necessary to rotate the mandrel 12 to disengage the pin 31 from the offset 25 of the connecting slot and to align said pin with the longitudinal portion 19 of said slot, after which the mandrel may then be moved upwardly with the pin traveling downwardly within the slot. As the pin reaches the lower end of the slot at the position H in Figure 7, it will subsequently strike the inclined surface 22, which will automatically impart rotation to the mandrel and engage the pin beneath the shoulder 21 of the lower offset 20. This returns the parts to their initial position as shown in Figures 2 and 3 with the anchoring slips retracted and the circulating ports 14 open. The packer may then be withdrawn from the well pipe. It is noted that the construction of the connecting slot 18 automatically locks the anchoring assembly against operation during the lowering operation and also automatically locks the anchoring assembly against actuation or release after said assembly is set. The weight of the pipe 11 which lowers the

packer into position is not depended upon to maintain the sealing contact of the packing elements.

The packer may be employed as a production packer or for any ordinary use in well operations and with slight modification may be employed as a packer used in various squeeze operations. In Figure 6 a modification is illustrated which will adapt the packer for use in the introduction of acid, cement or other material into the well bore below said packer. In this case a wash pipe or conductor **60** is mounted axially within the mandrel **12**. The upper portion of this pipe extends above the circulating ports **14** and has its external surface sealed off with the bore of the lowering conductor **11** by suitable packing **61**. The lower portion of the pipe **60** is also sealed off with the bore of the mandrel **12** at a point below the lower circulating ports **15** by a suitable packing **62**.

In operation this form is set in exactly the same manner as heretofore described, and after setting of the packer the material to be introduced is pumped downwardly through the conductor **60**. The conductor then carries the material downwardly to a point somewhere below the point at which the packer is set and the pressure of the material being introduced will, of course, act beneath the lowermost packer element F to assure maintenance of the anchoring assembly in its set position. It will be evident that when the packer is set the upper circulating ports **14** are closed in the manner hereinbefore described, and thus the packer will efficiently function for the carrying out of squeeze operations.

Having described the invention, I claim:

1. A well packer including, a tubular mandrel, an upper slip expander surrounding the mandrel and normally suspended therefrom whereby from such normal position the mandrel may move downwardly but not upwardly with respect to said expander, a tubular slip carrier normally suspended from the upper expander, whereby from such normal suspended position the slip carrier may move upwardly but not downwardly relative to the upper expander, gripping slips mounted for radial movement in the carrier and adapted to coact with the upper expander to undergo radial movement when the upper expander is moved relative to the carrier sleeve, said slips being retracted when the upper expander and the slip carrier are in their respective normally suspended positions, a lower slip expander surrounding the mandrel, means for connecting the lower expander to the slip carrier to allow limited longitudinal movement of the carrier with respect to said lower expander, said lower expander being adapted to coact with the gripping slips upon movement of the carrier relative to the lower expander, a releasable latching connection between the lower expander and the mandrel for latching the lower expander against longitudinal movement on the mandrel and also for latching the carrier sleeve in a position preventing relative movement of the carrier sleeve with respect to both expanders in which position the gripping slips are retracted, actuation of the releasable connection disconnecting the lower expander for limited longitudinal movement on the mandrel and releasing the sleeve for movement relative to the expanders in a direction to effect movement of the gripping slips into expanded position, an upper annular packing element surrounding the mandrel and exposed to pressure above the assembly and secured to the upper expander, and a lower annular packing element surrounding the mandrel and exposed to pressure below the assembly and secured to the lower expander.

2. A well packer as set forth in claim 1, wherein the upper annular packing element comprises a packing cup having an upwardly directed sealing lip and wherein the lower annular packing element comprises an elastic packing cup having a downwardly directed sealing lip.

3. A well packer as set forth in claim 1, wherein the releasable latching connection includes a second latching position for reconnecting the lower expander to the mandrel after said lower expander has moved a predetermined distance upwardly with respect to the carrier and mandrel, whereby retraction of the lower expander from within the carrier is prevented.

4. A well packer as set forth in claim 1, wherein the releasable latching connection between the lower expander and the mandrel is operated by a rotation of the mandrel with respect to the lower expander followed by a subsequent longitudinal movement of the mandrel with respect to said lower expander.

5. A well packer as set forth in claim 1, wherein the releasable latching connection between the lower expander and the mandrel comprises a longitudinal coupling slot in the mandrel and a connecting pin on the lower expander engageable within said slot, the lower end of said slot having a lateral offset which when engaged by said pin locks the lower expander on the mandrel, rotation of the mandrel relative to the lower expander moving the connecting pin into alignment with the longitudinal portion of the coupling slot to disconnect the lower expander from the mandrel.

6. A well packer as set forth in claim 1, wherein the releasable latching connection between the lower expander and the mandrel comprises a longitudinal coupling slot in the mandrel and a connecting pin on the lower expander engageable within said slot, the lower end of said slot having a lateral offset which when engaged by said pin locks the lower expander on the mandrel, rotation of the mandrel relative to the lower expander moving the connecting pin into alignment with the longitudinal portion of the coupling slot to disconnect the lower expander from the mandrel, disconnection of the lower expander permitting relative movement of both expanders with respect to the carrier sleeve and slips to expand the same, said slot having a second lateral offset at its upper end with one wall of the offset being inclined for coaction with the connecting pin to cause said pin to move into said offset after a predetermined upward movement of the lower expander with respect to the mandrel, engagement of the connecting pin within the upper offset locking the gripping slips against retraction.

7. A well packer including, a tubular mandrel, an upper expander surrounding the mandrel and slidable thereon within limits, means on the mandrel engageable by the upper expander for limiting the downward movement of the upper expander relative to the mandrel whereby said upper expander is normally supported by said mandrel, a slip carrier sleeve surrounding the mandrel and movable longitudinally within limits on said mandrel and with respect to the upper expander, gripping slips mounted in the slip carrier for radial movement with respect thereto, the lower portion of the upper expander extending into the upper end of the carrier sleeve and being adapted to coact with the gripping slips to effect radial movement thereof when the carrier sleeve and upper expander are moved relative to each other, a lower slip expander surrounding the mandrel below the slip carrier sleeve and having its upper portion extending into the slip carrier sleeve, said lower expander being movable longitudinally within limits with respect to the carrier sleeve and being adapted to coact with the gripping slips to effect radial movement thereof when the lower expander is moved relative to the carrier sleeve, a releasable connection between the lower expander and the mandrel for latching said lower expander against movement on the mandrel and for latching the carrier sleeve against movement with respect to the expanders and in a position with the gripping slips retracted, release of said connection freeing the lower expander for longitudinal movement on the mandrel and simultaneously freeing the carrier sleeve for independent movement with respect to both expanders, whereby the expanders may coact with the gripping slips to move the same radially outwardly to a gripping position, an upper annular packing element surrounding the mandrel and exposed to pressure above the assembly and secured to the upper expander for urging the same downwardly, and a lower annular packing element surrounding the mandrel and exposed to the pressure below the assembly and secured to the lower slip expander for urging the same in an upward direction.

8. A well packer including, a tubular mandrel having an external supporting shoulder thereon and having a longitudinal slot provided with a lateral offset at its lower end, an upper slip expander surrounding the mandrel with its downward movement on the mandrel being limited by said shoulder, a lower slip expander surrounding the mandrel and connected thereto by a pin engageable within the slot, an annular slip carrier surrounding the slip expanders and suspended from the upper expander, radially movable gripping slips mounted on the carrier, means connecting the lower expander with the carrier for limited movement relative to the carrier, the expanders being movable inwardly relative to the slip carrier

to coact with and expand the slips radially outwardly, engagement of the connecting pin in the lateral offset of the connecting slot latching the lower expander to the mandrel in a position outwardly of the carrier and latching the carrier in suspended position from the upper expander with the gripping slips retracted, rotation of the mandrel aligning the longitudinal portion of the connecting slot with the pin to release the expanders for movement relative to the gripping slips, a pressure-actuated packing means connected to the upper slip expander thereabove, and another pressure-actuated packing means connected to the lower slip expander therebelow, whereby the pressures above and below the expanders move said expanders relative to the gripping slips in a direction to expand said slips.

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