

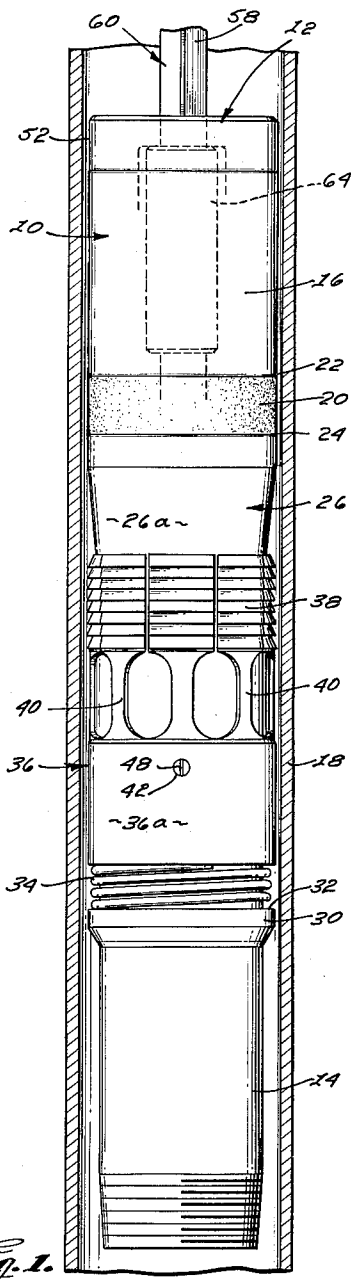
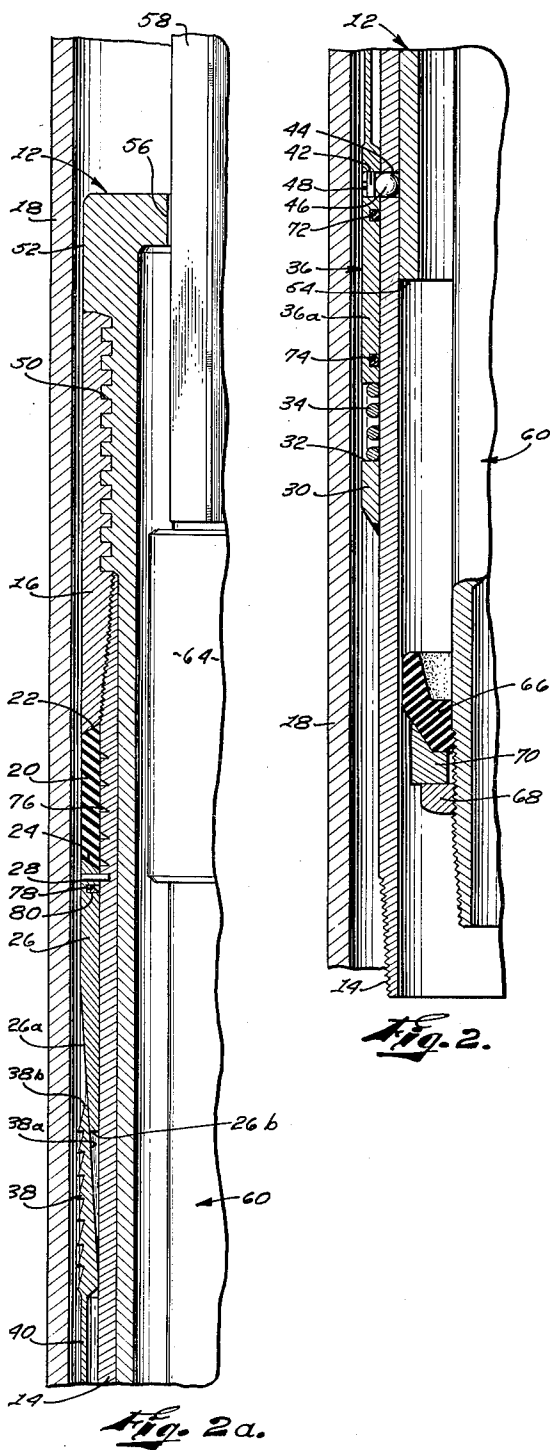
Jan. 30, 1962

A. L. SPRINGER
MECHANICAL LINER HANGER

3,018,830

Filed March 10, 1958

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

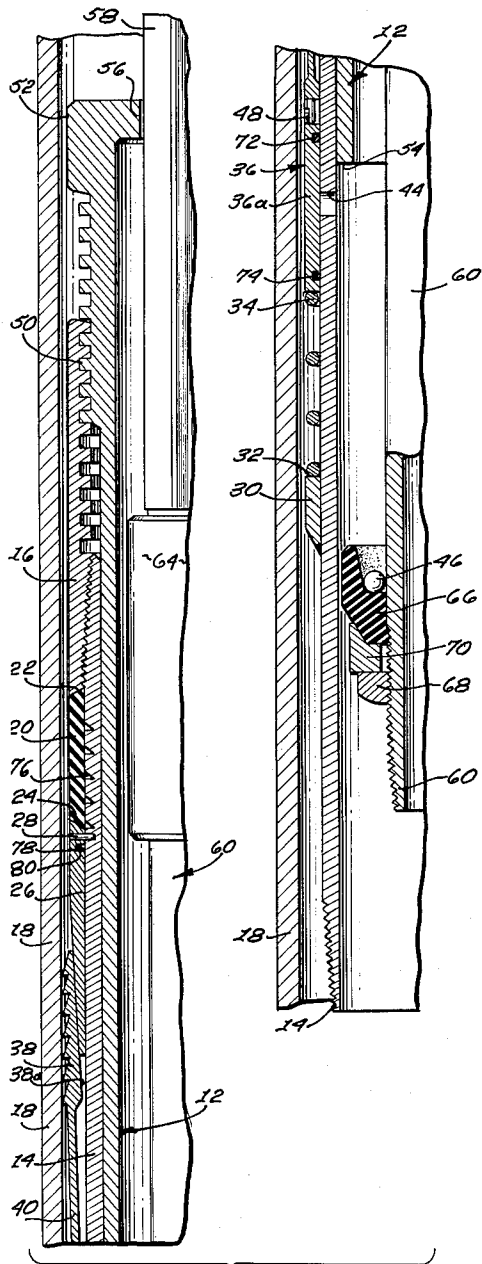


Fig. 3.

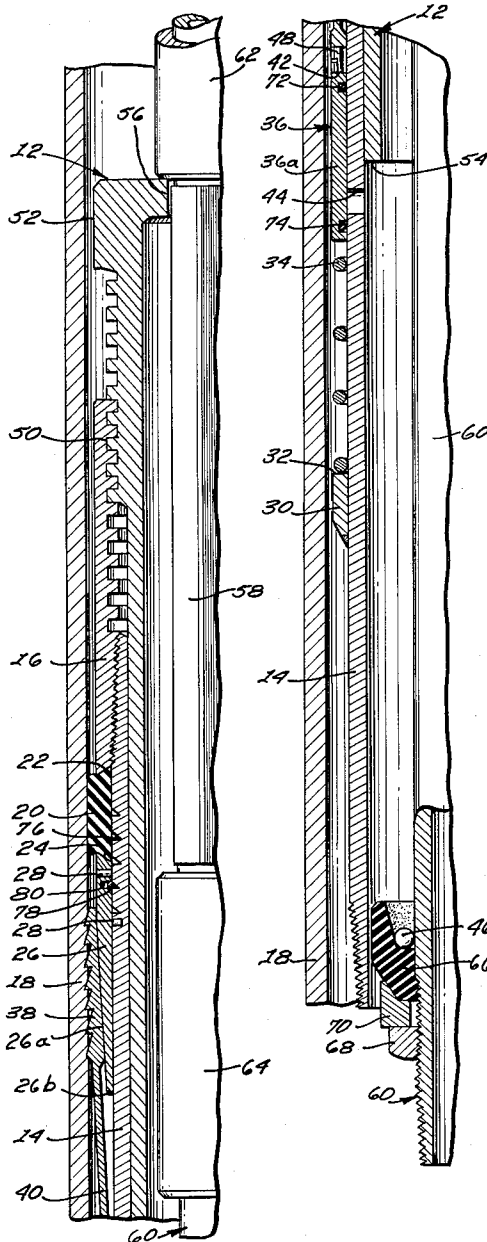


Fig. 4.

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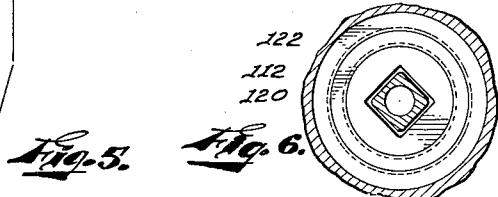
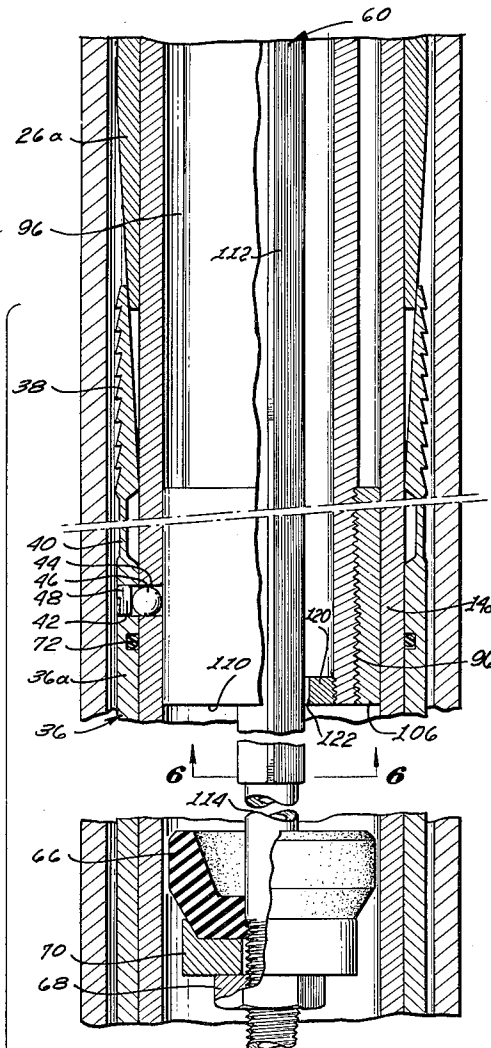
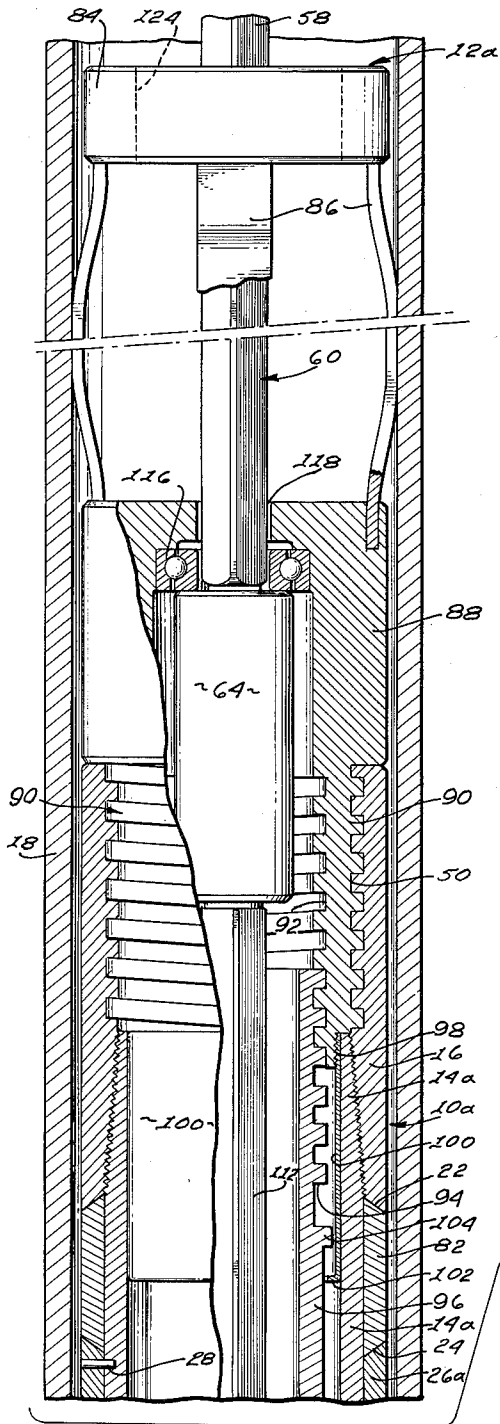
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3 Sheets-Sheet 3



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MECHANICAL LINER HANGER
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Filed Mar. 10, 1958, Ser. No. 720,357
13 Claims. (Cl. 166-124)

The present invention relates generally to oil well tools and more particularly to a liner hanger and packer.

In completing an oil well a liner is assembled at the well head and lowered into its intended position in the well. In most instances it is preferable to suspend the liner from the next larger string of casing thereabove so that the liner does not rest on the bottom. For this purpose, as well as to close off the annular space between the casing and the upper end of the liner, a liner hanger combined with a packer is attached to the upper end of the liner and equipped with slip jaws that are released to grip the inside surface of the casing when the liner is in the desired position. The packer is then collapsed by a setting tool mechanism to seal off the annular space between the liner and casing.

An object of my invention is to provide a combined liner hanger and packer of this type.

Another object of the invention is to provide a tool of this character in which the slip jaws are locked in retracted position so as to make it impossible for the hanger to be set until actuated by the setting tool. For this purpose I have provided an improved form of lock which will maintain the slip jaws in fully retracted position so that they cannot hang up while the tool is being lowered in the hole.

A further object of the invention is to provide a liner hanger in which the slip jaws can be set and the setting tool retrieved without any left-hand turning of the rotary table.

A still further object of the invention is to provide a liner hanger having improved means for the setting of a packer made of rubber or other resilient material.

Another object of the invention is to provide a liner hanger that is provided with a setting tool which permits the hanger to be set at any point in the hole without first running to the bottom to unlock the slip jaws.

These and other objects and advantages of my invention will be apparent from the following description thereof when taken in conjunction with the annexed drawings in which:

FIGURE 1 is a vertical elevation of a liner hanger and packer embodying my invention shown in its preset condition being lowered in a casing;

FIGURE 2 is a partial vertical sectional view of the hanger of FIGURE 1 showing interior details of construction thereof as well as the relative disposition of the parts prior to releasing the slip jaws;

FIGURE 2a is a partial, sectional view of the slip jaw construction;

FIGURE 3 is a view similar to FIGURE 2 showing the position of the parts after the slip jaws have been released but prior to locking the hanger against the hole casing;

FIGURE 4 is a view similar to FIGURES 2 and 3 showing the appearance and relative position of the parts after the hanger has been set and the packer expanded but prior to retrieving the setting tool;

FIGURE 5 is a vertical sectional view of another form of liner hanger and packer embodying my invention which permits setting of the hanger without first running to the bottom of the hole; and

FIGURE 6 is a transverse sectional view taken on the line 6-6 of FIGURE 5.

In general, my improved hanger-packer device in-

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cludes a hanger assembly 10 removably mounted on a setting tool 12, the latter being coupled to the running-in string of the well so that the device can be lowered into place in a hole casing 18. An oil string or liner (not shown) is fastened to the lower end of hanger assembly 10 and when set on the hole bottom, its weight combined with that of hanger assembly 10 holds it and assembly 10 against rotation while the running-in string rotates setting tool 12 a predetermined number of turns, preferably in a right hand direction. A spring loaded slip cage 36 is normally held in retracted position on assembly 10 by a plurality of locking elements or balls 46 but in response to rotation of the running-in string a wall section of setting tool 12 frees the balls 46. The slips are then freed to expand on a cone 26 carried by assembly 10 and as slip cage 36 rises on cone 26 it cams the balls 46 into the interior of the device.

After slip cage 36 has been freed the device is hoisted on the running-in string to the desired elevation in casing 18 and the slips then set, the slip jaws 38 being adapted to cooperate with cone 26 in such a way that all of the jaw teeth simultaneously engage casing 18 to provide an improved grip. Dropping of the running-in string to set the slips also forces expansion of a resilient packing ring 20 interposed between the cone 26 and the head 16 of assembly 10. In order to prevent a tendency of packer 20 to retract between drops of the string, unidirectional latching or ratcheting means 76, 78 on cone 26 and assembly 10 co-act to resist relaxation of the packer. After packer 20 has been fully expanded to seal the annular space between casing 18 and assembly 10, the setting tool 12 is retrieved by turning it to disengage from assembly 10 and then hoisting it.

More specifically, hanger assembly 10 and setting tool assembly 12 are assembled in the manner shown in FIGURE 1. In this view the general exterior appearance of the hanger 10 is clearly visible, but the major portion of the setting tool 12 is obscured from view, being received within the hanger 10. Only the head of the setting tool 12 is visible at the upper end of the hanger 10.

The hanger 10 includes an elongate tubular mandrel 14 whose lower end is suitably threaded for coupling thereto the oil string or liner (not shown) which it is desired to hang. At its upper end the mandrel 14 is provided with a head 16 of enlarged diameter, but of smaller diameter than the inside diameter of the casing 18 in which the liner is to be suspended. The mandrel head 16 may be formed integrally with mandrel 14, but preferably takes the form of a collar rigidly threadedly mounted on the upper end of the mandrel 14, as is shown in FIGURE 2.

In order to provide a seal in the annular space between the hanger 10 and casing 18, packer 20, taking the form of a rubber ring, is disposed around the mandrel 14 between shoulders defined by the lower end 22 of the mandrel head 16 and the upper end 24 of the cone 26 slidably mounted on the mandrel 14. In order to hold the cone 26 in place prior to expansion of the packer 20, it is fastened to the mandrel 14 by a shear pin 28.

Towards its lower end the mandrel 14 rigidly mounts a base ring 30 having a flat upper face 32 defining a shoulder with the mandrel 14. This shoulder serves as a fixed abutment for a giant spring 34 coiled around the mandrel 14. Slip cage 36 is slidably mounted on the mandrel 14 between the cone 26 and compression spring 34.

Slip cage 36 comprises a bottom ring 36a which supports a plurality of circumferentially grouped slips or jaws 38 on a like plurality of vertically extending arms 40 spaced radially outwardly out of contact with the mandrel 14 so as not to drag against the mandrel during slid-

ing movement of slip cage 36. FIGURE 2a shows the appearance of slip cage 36 in slightly stressed condition of the jaws 38. In unstressed condition (as when entirely removed from the assembled hanger) it is to be understood that the biting edges of the jaw teeth define or lie within a frusto-conical surface tapering upwardly to a reduced diameter, i.e. an external taper equal in angle and opposite in inclination to the external downwardly tapered, frusto-conical surface 26a of cone 26. When unstressed, the inner surfaces 38a of the slips define a cylinder rather than an internal taper.

The structure of slip cage 36 just described provides an improved purchase of the jaw teeth on the casing 18. In some of the conventional slip cages I have observed a tendency of the uppermost ring of jaw teeth to engage the casing before the lower rings of teeth. This tendency is eliminated with slip cage 36 so that all of the rings of teeth simultaneously engage the casing 18. This result is due to the fact that as the jaws 38 are expanded on cone 26 they bear on the cone along their upper edge 38b as well as against the lower edge 26b of cone 26. As a result, the toothed outer surfaces of jaws 38 are maintained in cylindrical arrangement whereby they will simultaneously engage casing 18. On the other hand, slip cages wherein the taper is on the inner surface of the jaws and the jaw supporting arms are flush with the mandrel, the jaws bear against the lower edge of the cone as they expand so that their upper edges are sprung radially outwardly from contact with the cone and the upper ring of teeth tends to engage the casing before the lower rings of teeth.

Referring now to FIGURES 1 and 2, it will be apparent that during lowering of the hanger into casing 18 the slip jaws 38 must be retracted to a diameter less than the interior diameter of the casing 18 so as to avoid inadvertent setting or hanging up of the device. To this end, it is desired that the upper ends of slip jaws 38 in retracted position just overlap the lower end of cone 26 (FIGURE 2) and that the spring 34 be held in fully compressed condition as in FIGURE 1 by locking the slip cage 36 to the mandrel 14.

In order to hold the slip cage 36 down against the compression spring 34 to maintain the jaws 38 in the retracted positions of FIGURES 1 and 2, the slip cage in the lower end ring portion thereof is formed with a plurality of equally circularly spaced tapped bores 42 extending radially through the wall thereof that register with a like number of equally circularly spaced radial bores 44 formed in the wall of the mandrel 14 (FIGURE 2). Each pair of aligned bores 42 and 44 receives a locking ball 46 having a diameter greater than the wall thickness of the mandrel 14. The balls 46 are prevented from moving radially outwardly of the bores 42 by headless screws 48 in bores 42.

As the balls 46 intersect the plane of the contacting walls of mandrel 14 and slip cage 36, the slip cage is prevented from moving upwardly on the mandrel 14 whereby the jaws 38 are maintained in retracted position. Since less than half of each of the locked balls 46 is intersected by the slip cage 36, it will be apparent that if the balls 46 are released from confinement in the aligned bores 42 and 44 that they will be cammed inwardly as the slip cage 36 moves upwardly on the mandrel 14.

At the inner end of the aligned bores 42 and 44 the locking balls 46 are confined against radially inward movement by the setting tool 12, which is an elongate tubular member slidably received within the body of mandrel 14 and having an enlarged upper end threadedly connected to the mandrel head 16, as indicated by the numeral 50. The cap 52 of setting tool 12 is further enlarged and is of approximately the same diameter as the mandrel head 16. The thread means 50 are left hand threads, and it will be observed that when the setting tool 12 is fully threadedly engaged with the mandrel 14 the lower end face 54 of setting tool 12 is disposed in a posi-

tion lower than the bore 44, thus providing a wall portion of the setting tool 12 which confines the balls 46 in position for locking the slip cage 36 and mandrel 14 against relative movement.

In order to raise the setting tool 12 relative to the mandrel 14 for releasing the locking balls 46, and for retrieving the setting tool 12 from the hanger 10, the cap 52 of setting tool 12 is formed with a central square hole 56 that slidably receives a kelly 58 interposed in a running-in string 60. At its upper end the kelly 58 is connected to string 60 by a coupling 62 (FIG. 4) while a continuation of the string 60 depends from the kelly 58 by a lower coupling 64. The kelly is thus capable of limited axial movement relative to the setting tool 12 while at the same time being drivingly coupled thereto. The couplings 62 and 64 are of larger diameter than the side dimensions of the square hole 56 in the cap 52, so that when the device is being lowered into the casing 18 as in FIGURE 1 (or being retrieved from the casing), it is suspended from the upper face of the lower coupling 64 and when it is desired to expand the packer 20, the entire weight of the running-in string 60 can be brought to bear on the setting tool cap 52 through upper coupling 62, as in FIGURE 4.

In the use of the tool the liner or oil string which it is desired to hang is first connected to the lower threaded end of the mandrel 14. The liner and tool are then lowered into the hole as in FIGURE 1 until the liner rests on the bottom of the hole. As has just been noted, during lowering of the tool and liner the combined weight thereof is suspended from the collar 64 at the lower end of kelly 58. After the liner hits the hole bottom the running-in string 60 will continue to be lowered momentarily before being halted by the operator. The liner hanger and liner will then be entirely supported on the hole bottom, as in FIGURE 2, rather than being supported on the running-in string 60.

In order to release the slip cage 36 from its retracted position of FIGURES 1 and 2, the running-in string 58 is next rotated in a clockwise direction for a predetermined number of turns until the setting tool 12 has advanced upwardly relative to the hanger assembly 10 to the position shown in FIGURES 3 and 4, wherein the lower end 54 of the setting tool 12 is above the aligned bores 42 and 44. During such rotation of the setting tool 12 the hanger assembly 10 and the liner supported on the lower end thereof are held against rotation by virtue of their combined weight resting on the bottom of the hole.

Referring now to FIGURE 3, it will be observed that inasmuch as the wall of the setting tool 12 no longer obstructs the inner end of the aligned bores 42 and 44, the locking balls 46 drop out of said bore and into a cup seal 66 fastened to the lower end of the running-in string 60 by a lock nut 68 and retainer 70. This ejection of the lock balls 46 occurs in response to the action of the spring 34 which forces the slip cage 36 upwardly on the mandrel 14 thus camming the lock balls 46 inwardly to fall into the cup seal 66.

Upon release of the locking balls 46 the slip jaws 38 rise on cone 26 to the position shown in the left hand portion of FIGURE 3 wherein the jaws frictionally engage but do not bite into the casing 18, the strength of the spring 34 being insufficient to produce biting engagement. Referring to the right hand portion of FIGURE 3, it will be observed that the inner wall of the bottom ring of the slip cage 36 at the upper and lower ends thereof is provided with resilient O-ring seal members 72 and 74 which are moved into position on opposite sides of the bores 44 in mandrel 14 so as to provide a fluid seal. As will presently appear, this arrangement permits an annulus pressure test to be made immediately upon hanging of the liner and expanding of the seal.

After the slip cage 36 has been released the liner or oil string is elevated to the desired position relative to

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casing 18 by lifting the running-in string 60, whereupon the upper end of the lower collar 64 engages the underside of the setting tool cap 52 to carry the device upwardly. After the liner or oil string is disposed in the desired position, the slip jaws 38 are set and the packing ring 20 is expanded in the following manner.

The weight of the running-in string is first lowered as in FIGURE 4 until it is entirely supported on the upper face of the setting tool cap 52. The running-in string weight is thereby transmitted through the setting tool 12 and hanger assembly 10 to set the slip jaws 38 into biting engagement with the inner wall of the casing 18.

In order to increase the force of the wedging engagement of the slip jaws 38 and cone 26, the cone 26 is held on the mandrel 14 solely by a single shear pin 28. Thus, when the weight of the running-in string 60 is first dropped on top of the setting tool 12, the shear pin breaks whereby successive impacts of running-in string 60 on the setting tool 12 force the cone 26 to slide downwardly relative to the slip jaws 38, thus increasing the force of the wedging engagement therebetween. At the same time, the impacts on the setting tool 12 force the expansion of the seal ring 20 into sealing engagement with the inner wall of the casing 18 between the lower end 22 of the mandrel head 16 and the upper end 24 of the cone 26.

It will be appreciated by those skilled in the art that lead or other seal means can be used in lieu of the rubber ring 20. However, in many instances a rubber packing ring is preferred and for use in such instances I have provided an arrangement to prevent the natural resilience of the rubber packing ring from backing off the setting tool and mandrel after each impact of the weight of the running-in string 60 thereon.

This arrangement takes the form of a ratcheting action which comprises a plurality of vertically spaced-apart, circumferentially-extending grooves 76 formed in the outer surface of the mandrel 14 behind the packing ring 20. The grooves 76 are of substantially V-shaped section including a lower horizontal wall and an inclined upper wall adapted to matingly receive a complementary snap ring 78 seated in an annular groove 80 formed in the inner surface of the cone 26. The snap ring 78 in unstressed condition is of smaller internal diameter than the external diameter of the mandrel 14 so that when impacts are imparted to the setting tool 12 to force the mandrel 14 downwardly relative to the cone 26, the snap ring 78 engages the grooves 76 formed in mandrel 14 in succession. This is shown in the left hand portion of FIGURE 4 wherein the ring 78 is in engagement with the lowermost groove 76 thus preventing the natural resilience of the rubber packing ring 20 from expanding when the weight of the running-in string 60 is relieved from setting tool 12 between impacts.

After the packing ring 20 has been fully expanded an annulus pressure test can be made at once prior to retrieving the setting tool in order to determine whether the packing ring 20 has achieved an effective seal. In this connection it will be observed that the position of the O-ring seals 72 and 74 on opposite sides of the bores 44 in the mandrel 14 also provide a seal whereby such a test can be made. It will also be observed that the cup-shaped seal 66 on the lower end of the running-in string 60 will be forced into sealing engagement with the inner wall of the mandrel 14 during the annulus pressure test.

A successful test having been made, the setting tool 12 can be retrieved merely by rotating the running-in string 60 in a right hand direction until the threaded engagement 50 of the setting tool 12 and hanger assembly 10 is separated. Thereafter, upon raising of the running-in string 60, the upper end of the lower collar 64 engages the head 52 of the setting tool 12 to lift the setting tool out of the hole. It will be noted that the locking balls 46, which have been captured in the cup seal 66, are retrieved along with the setting tool 12.

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As is apparent, in the embodiment of my invention just described it is necessary to run in to the bottom of the hole as a preliminary step in setting the tool. This step is required so that the weight of the tool and the oil string or liner connected thereto can be utilized to prevent rotation thereof during rotation of the setting tool to release the slip jaws. However, in some circumstances it is desired to set the hanger at any point without running to bottom to first disengage the slips. For such uses I have provided the form of the invention illustrated in FIGURES 5 and 6.

With this form of the invention a setting tool, indicated generally by the numeral 12a, is used which differs in many respects from the setting tool 12 in the previously described embodiment. However, it will be understood that the setting tool 12a can be used in conjunction with the hanger assembly 10 already described or in conjunction with the hanger assembly 10a shown in FIGURES 5 and 6.

The hanger assembly 10a is substantially identical to the previously described hanger assembly 10 except that the former includes a lead seal ring 82 in lieu of the rubber packing ring 20. Inasmuch as the lead seal 82 does not have the inherent resilience of the rubber material of the packing ring 20, the ratcheting means described in connection with the hanger assembly 10 has been eliminated.

A cap member 88 on setting tool 12a is of the same external diameter as the head 16 of the hanger assembly 10a and has a reduced diameter lower end 90 having an external threaded engagement 50 with the mandrel 14a. The lower end portion 90 is also internally threaded, as indicated at 92, for engagement with the threaded upper end 94 of a tubular member 96. The threads 92 and 94 are left hand threads as is also the thread engagement 50 of the cap member 88 with the cap 16 of the hanger assembly 10a.

In order to prevent the cap member 88 from being turned out of threaded engagement with the tubular member 96, member 88 at its lower end has a fine right hand threaded engagement 98 with the upper end of a locking sleeve 100 that is slidable in mandrel 14a. The lower end of the locking sleeve 100 has a radially inwardly turned flange 102 adapted to abut the lower face of a radially outwardly directed flange 104 of the member 96.

The slip jaws 38 are held in retracted position on cone 26a against the force of the spring means by locking balls 46, as in the first described form of the invention. In order to maintain balls 46 in locking engagement with slip cage 36, the lower end of member 96 threadably mounts a collar 106 that is slidable in mandrel 14a. When the hanger assembly 10a and setting tool 12 are lowered into the hole, they are in the positions shown in FIGURE 5 wherein the tubular member 96 is threaded downwardly relative to the cap member 88 so that the collar 106 is positioned to hold the balls 46 in the desired locking engagement with the slip cage 36. Thus, in order to release the locking balls 46 to permit slip jaws 38 to be expanded into engagement with the casing 18, the tubular member 96 must be rotated in a right hand direction to move upwardly relative to the cap member 88 and hanger assembly 10a, the latter two elements being held rotationally immobile during such elevation of the tubular member 96. The lower end face 110 of the tubular member 96 will then be elevated above the aligned bores 42 and 44 to release the locking balls 46, which then drop into the cup seal 66 at the lower end of the setting tool 12a.

In order to permit such rotation of the tubular member 96 for releasing the locking balls 46, the running-in string 60 is modified by replacing the lower end continuation thereof shown in FIGURES 1 through 4, with another kelly stem section 112 to the lower end of which the cup seal 66 is affixed as before by a lock nut 68 and a threaded tubular adapter 114. Referring now to the left hand portion of FIGURE 5, it will be observed that the

running-in string 60 as before includes the kelly 58 with the lower coupling 64 from which the just mentioned kelly stem 112 depends. When the apparatus is being lowered into the casing 18, the oil string or liner is supported on the hanger assembly 19a and setting tool 12 by a thrust bearing 116 mounted in the upper end face of the cap member 88 which bears against the upper end of the lower coupling 64. The opening 118 in the thrust bearing 116 is larger than the kelly 58 so that rotation of the kelly 58 does not impart any rotation to the cap member 88 through bearing 116 which provides a frictionless bearing support for the cap member 88 on coupling 64. With this arrangement, rotation in a clockwise direction of the kelly 58 also turns the kelly stem 112 in the same direction.

Referring now to the right hand portion of FIGURE 5, it will be seen that the tubular member 96 at its lower end is provided with a rigidly mounted bottom plate 120 which is formed with a central polygonal or square opening 122 that is drivingly engaged by the kelly stem 112. Thus rotation of the running-in string 60 is imparted to the tubular member 96 whereby it is advanced upwardly on the cap member 88 until the flange 104 thereof contacts the lower end of the member 88 whereupon the member 96 and member 88 are coupled together. This coupling of the members 96 and 88 is achieved through a predetermined number of turns whereupon the lower end face 110 of the member 96 is elevated above the aligned bores 42, 44 to release the locking balls 46. The slip jaws 38 are then sprung into engagement with the casing wall 18 in the same manner as in the first described embodiment of the invention. The cap member 88 and hanger assembly 10 are held against rotation with the running-in string 60 by a plurality of vertically extending bow springs 86 rigidly mounted on cap member 88 that are biased into frictional engagement with casing 18. A top ring 84 supports the upper end of springs 86 and is formed with a central bore 124 through which kelly 58 and upper collar 62 can freely pass. The locking balls 46 having been released in the manner just described, the hanger assembly 10a can be set and sealed in the manner set forth in conjunction with the first described embodiment of the invention.

Various modifications and changes may be made with respect to the foregoing description without departing from the spirit of the invention or the scope of the following claims.

I claim:

1. In a hanger device including a mandrel, a slip cone on said mandrel, and a spring-loaded set of slips on said mandrel in operative association with said cone, a device for releasably locking said slips in a retracted position against the force of said spring loading, comprising: a substantially radially movable element on said mandrel and extending into the path of movement of said set of slips and having a cam engagement with said set of slips to translate upward movement of said set of slips into radially inward movement of said element; a tubular member in said mandrel contacted by the inner end of said element and normally holding said element against inward movement to retain said element in position to block upward movement of said set of slips and retain said slips in said retracted position; a cap member threadedly connected to both said tubular member and said mandrel, the number of turns connecting said tubular member and cap member being less than the number of turns connecting said cap member to said mandrel; means drivingly connecting said tubular member to a running-in string for threadedly advancing said tubular member out of engagement with said element and for threadedly coupling said tubular member to said cap member in response to rotation of said string through a predetermined number of turns, whereby said element is cammed out of engagement with said set of slips as said set rises into expanded position on said set of cone

to engage a casing; means on said cap member engageable with said casing to yieldably hold said cap member and mandrel rotationally immobile during rotation of said tubular member through said predetermined number of turns; means to suspend said hanger device from said string; and means in said string to impact the weight of said string on said cap member to set said slips after said slips have engaged said casing, rotation of said string beyond said predetermined number of turns after setting of said slips serving to threadedly uncouple said cap member from said mandrel whereby said cap member and tubular member can be lifted from said mandrel by said string and suspension means.

2. A hanger, comprising: a mandrel; a slip cone affixed to said mandrel; a slip cage including a ring slidably mounted on said mandrel and carrying a plurality of slips; spring means on said mandrel for moving said slip cage axially of said mandrel to radially expand said slips on said cone; lock means in said mandrel for releasably holding said ring against axial movement towards said cone against the force of said spring means; a tubular member in said mandrel in engagement with said lock means, said ring, lock means and tubular member being adapted to hold said ring when concurrently engaged and to release said lock means in response to axial movement of said tubular member; a support cap threadedly engaged to both said tubular member and said mandrel to support them on a running-in string, said string being freely rotatable in said cap and said tubular member being adapted to be rotated by said string, said cap being adapted for limited threading movement therein of said tubular member before said tubular member is fully threadedly engaged with said cap, said tubular member being adapted to release said lock means as a result of said limited movement, said tubular member and cap being adapted to threadedly disengage said cap from said mandrel, after being fully threadedly engaged, upon subsequent rotation of said tubular member; and a means adapted for contact with a well casing to hold said cap and mandrel against rotation only during said limited movement of said tubular member.

3. A hanger for use in a casing, comprising: a tubular mandrel formed with a through opening in its side wall; a slip cage mounted for axial movement on said mandrel having a ring formed with a through opening in the side wall thereof; a slip cone on said mandrel; spring means constantly urging said ring axially of said mandrel for moving said slip cage into engagement with said cone for wedging engagement with said casing; a lock ball disposed in the trough openings in the side walls of said ring and mandrel when said openings are coaxially aligned to thereby prevent movement of said slip cage into engagement with said cone; adjustable means in the through opening of said ring to position said ball such that the center thereof is within the through opening in said mandrel whereby axial relative movement of said cage and mandrel cams said ball radially inwardly out of engagement with said ring; and an elongated tubular setting tool insertable in said mandrel to prevent such displacement of said ball from within the opening in said ring, said tool having engagement with said mandrel and being movable with respect thereto for movement out of retaining engagement with said ball, whereby the force of said spring means cams said ball radially inwardly out of the opening in the side wall of said ring and urges said slip cage into wedging engagement with said casing.

4. A hanger for use in a casing according to claim 3 wherein said adjustable means comprises a headless screw threadedly positioned within the opening in said ring to prevent the center of said ball from entering the opening in said ring.

5. A hanger for use in a casing, comprising: a tubular mandrel formed with a through opening in its side wall; a slip cage mounted for axial movement on said mandrel having a ring formed with a through opening in the side

wall thereof; a slip cone on said mandrel; spring means constantly urging said ring axially of said mandrel for moving said slip cage into engagement with said cone for wedging engagement with said casing; a spherically shaped wedge disposed in the through openings in the side walls of said ring and mandrel when said openings are coaxially aligned to thereby prevent movement of said slip cage into engagement with said cone; adjustable means in the through opening of said ring to position said spherical wedge such that the center thereof is within the through opening in said mandrel whereby axial relative movement of said cage and mandrel cams said wedge radially inwardly out of engagement with said ring; and an elongated tubular setting tool insertable in said mandrel to prevent such displacement of said wedge from within the opening in said ring, said tool having engagement with said mandrel and being movable with respect thereto for movement out of retaining engagement with said wedge, whereby the force of said spring means cams said wedge radially inwardly out of the opening in the side wall of said ring and urges said slip cage into wedging engagement with said casing.

6. A hanger for use in a casing, comprising: a hanger assembly including a tubular mandrel formed with an opening in its side wall, a slip cone affixed to said mandrel and a slip cage having a set of spring loaded slips movably mounted on said mandrel in operative association with said cone, said slip cage being formed with an opening in its side wall; a tubular setting tool threadedly engaged with the upper end of said mandrel and having a body portion slidable in said mandrel; at least one spherically shaped lock element within the openings in the side walls of said mandrel and slip cage; means in the opening in the side wall of said slip cage to retain the center of said lock element within the opening in said mandrel to afford cam engagement of said element with said slip cage to translate upward movement thereof on said mandrel into radially inward movement of said element, said radial inward movement of said element being normally prevented by the body portion of said tool whereby said slips are maintained in a retracted position on said cone by said element; a running-in string having lost motion connection with said setting tool to rotate said tool in predetermined amount when said assembly is supported on a hole bottom whereby said tool can be rotated independently of said assembly to partially unthread said tool and mandrel to raise the body portion of said tool out of engagement with said element to permit said slips to rise into an expanded position on said cone as said element is cammed inwardly, said tool and assembly then being elevated with said string to a desired elevation in said casing; the lost motion connection between said string and said tool enabling the weight of said string to be impacted on said tool after said assembly and tool have been raised to said desired elevation to set said slips, after which said tool can be further turned by said string and guard means to be threadedly disengaged from said assembly, said string being raised to retrieve said tool.

7. A device as set forth in claim 6 in which said lock element comprises a ball of greater diameter than the wall thickness of said mandrel, and said string at a point below said bore mounting an upwardly opening cup-shaped seal into which said ball drops whereby said ball can be retrieved with said setting tool.

8. A device as set forth in claim 6 wherein said retaining means is a headless screw threadedly positioned within the opening in the side wall of said slip cage.

9. A device as set forth in claim 6 in which said hanger assembly is provided with a packer ring encircling said mandrel between the upper end of said cone and an enlarged diameter head portion of said mandrel whereby when the weight of said string is impacted on said setting tool to set said slips said packer ring is concurrently expanded into sealing engagement with said casing to define an annular seal between said casing and said mandrel.

10. A device as set forth in claim 9 in which said cone is affixed to said mandrel by a shear pin that is adapted to break upon impact of the weight of said string on said tool, and said cone and said mandrel are interconnected by ratchet means preventing downward movement of said cone on said mandrel, whereby when said packer is made of an elastomeric material said packer is prevented by said ratchet means from reflexion between successive impacts of said string.

11. A device as set forth in claim 10 in which said ratchet means comprises: a plurality of vertically spaced-apart, circumferentially extending external grooves in said mandrel opposite said packer ring, each of said grooves having a downwardly and inwardly inclined top face and a substantially horizontally disposed lower face, and said cone on its interior is formed with a circumferentially, extending groove which carries a snap ring whose inner edge is of a configuration complementary to said grooves.

12. A device for hanging a liner in a casing, comprising: a tubular setting tool having an enlarged diameter cap portion; a tubular mandrel having an enlarged diameter head portion of the same diameter as said cap and threadedly engaging said tool under said cap, said mandrel further having a body telescopically slidably receiving a body portion of said tool and adapted to support a liner from its lower end; a slip cone slidably mounted on said mandrel and downwardly spaced from the head of said mandrel; a shear pin initially holding said cone against movement on said mandrel; a packer of a resilient material encircling said mandrel and abuttingly interposed between confronting faces of the head of said mandrel and said cone; a slip cage having a set of slips slidably mounted on said mandrel; springs means on said mandrel urging said slip cage upwardly on said cone to expand said slips into engagement with said casing; a plurality of lock balls each of which is of a greater diameter than the wall thickness of said mandrel and each of which is disposed in one of a plurality of bores through the wall of said mandrel to be confined in said bores against radially inward movement by a wall portion of said tool, each of said balls engaging a recess formed in said cage to hold said slips in a retracted position on said cone against the force of said spring means; a kelly stem drivingly engaged with a central opening formed in the cap of said tool and axially slidable through said opening; a lower collar affixed to the lower end of said kelly and adapted to abut the lower face of the cap of said tool to gravitationally support said tool and mandrel until said mandrel and a liner suspended therefrom rest on a hole bottom independently of support of said lower collar whereby said tool can be rotated a predetermined number of turns independently of said mandrel to raise the body portion of said tool out of contact with said balls to release said set of slips, said predetermined number of turns being less than the total number of turns threadedly engaging said tool and mandrel, said tool, mandrel and liner then being elevated on said lower collar and running-in string to a desired elevation in said casing; a cup-seal mounted on said string at a point beneath said set of slips, said cup-seal opening upwardly to catch said balls after said balls have been cammed inwardly to said bores by the release of said set of slips, said cup-seal further defining a fluid seal with the inner surface of said mandrel; a collar affixed to the upper end of said kelly for coupling said kelly to a running-in string and by means of which the weight of said string can be dropped onto the upper face of said tool to set said slips against said casing, break said shear pin, and expand said packer into sealing engagement with said casing; a snap ring disposed in an internal circumferentially extending groove formed in said cone and having an inner edge defined by a downwardly and inwardly inclined top surface and a substantially horizontal bottom surface, said ring adapted to

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sequentially engage a plurality of vertically spaced-apart circumferentially extending complementary shaped external grooves formed in said mandrel opposite said packer to prevent reflexion of said packer between impacts of said string on said setting tool; and a pair of elastomeric O-ring seals seated in said cage, said seals being disposed on opposite sides of said bores in said mandrel when said slips are set to define a fluid seal between said cage and said mandrel, said setting tool and balls being retrieved after said hanger is set by further turning of said tool by said kelly to completely threadedly disengage said tool and mandrel and thereafter lifting said tool with said lower collar.

13. In a hanger device including a mandrel, a slip core on said mandrel, and a spring-loaded set of slips on said mandrel in operative association with said cone, a device for releasably locking said slips in a retracted position on said cone against the force of said spring loading, comprising: at least one lock ball movably mounted in a radially extending bore through the wall of said mandrel, the diameter of said ball being greater than the thickness of said wall; a member in said mandrel normally holding

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said ball against radially inward movement and retaining said ball in a position wherein it protrudes radially outwardly of said mandrel into a through opening formed in said slips; adjustable retaining means in the through opening of said slips to position said ball such that a major portion thereof is within the opening in said mandrel while a minor portion thereof is within the opening in said slips to block axial movement of said slips and retain said slips in said retracted position; and means drivingly connecting said member to a running-in string to move said member out of engagement with said ball in response to movement of said string whereby said ball is cammed radially inwardly out of engagement with said slips as said slips move into expanded position on said cone.

References Cited in the file of this patent

UNITED STATES PATENTS

1,604,771	Gill	Oct. 26, 1926
2,266,382	Quintrell et al.	Dec. 16, 1941
2,637,402	Baker et al.	May 5, 1953
2,693,859	Wright	Nov. 9, 1954