

Nov. 9, 1954

K. A. WRIGHT
LINER HANGER

2,693,859

Filed May 23, 1949

3 Sheets-Sheet 1

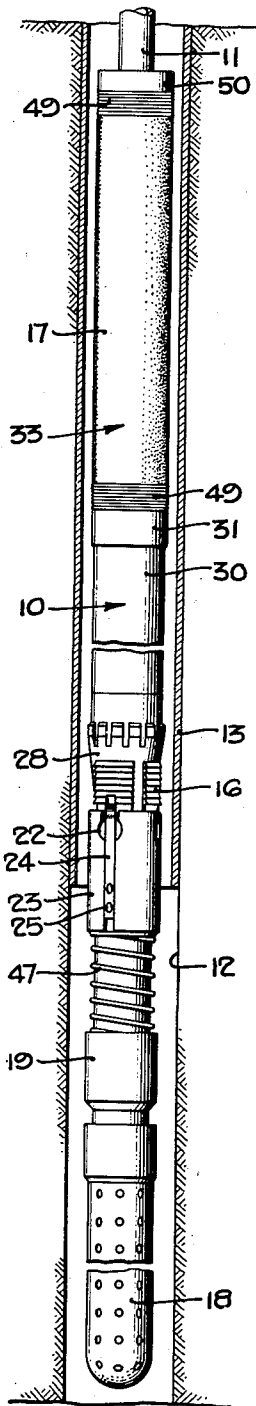


FIG. 1.

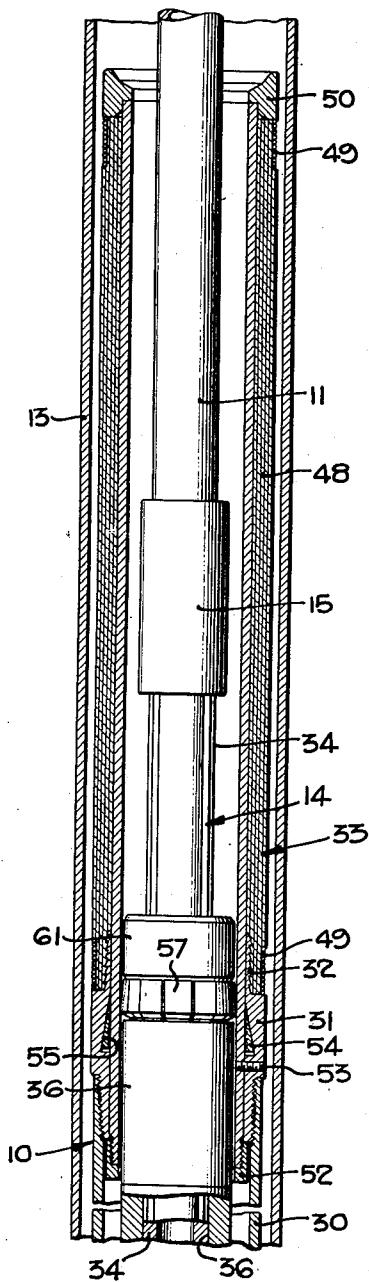


FIG. 2a.

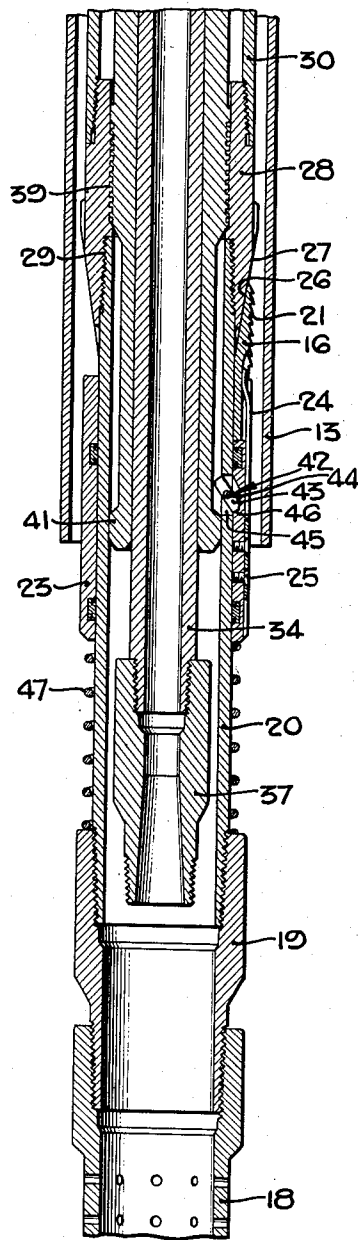


FIG. 2b.

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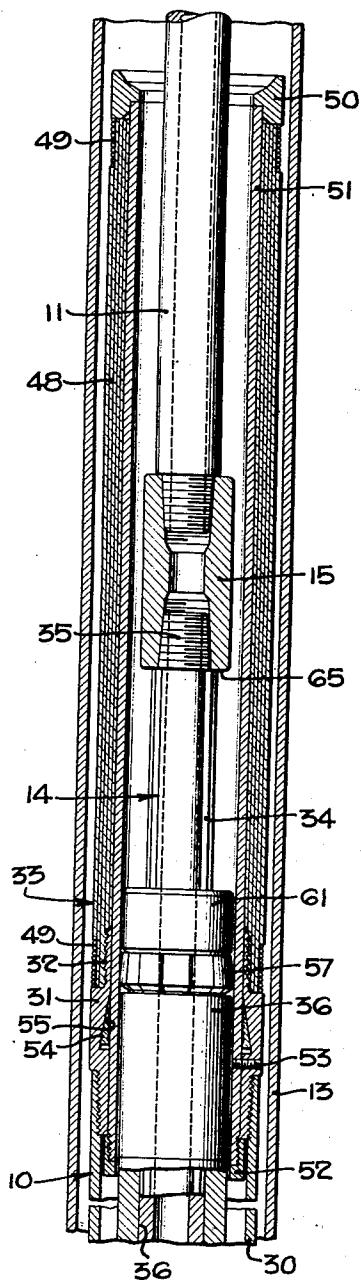


FIG. 3a.

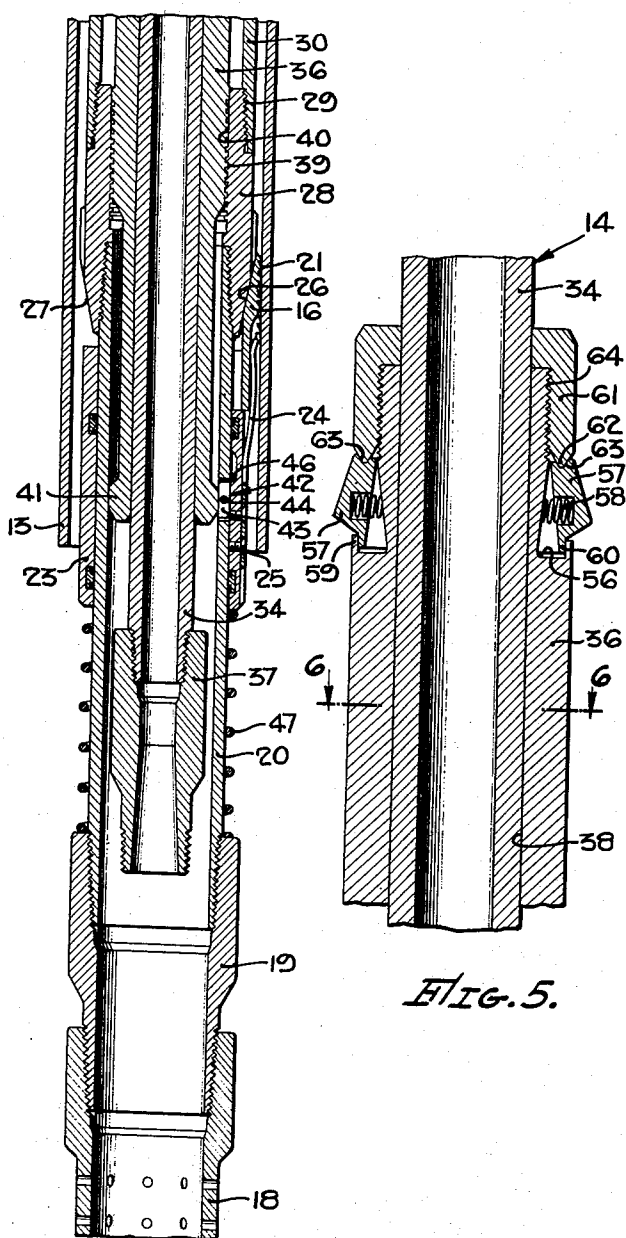


FIG. 3b.

FIG. 5.

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3 Sheets-Sheet 3

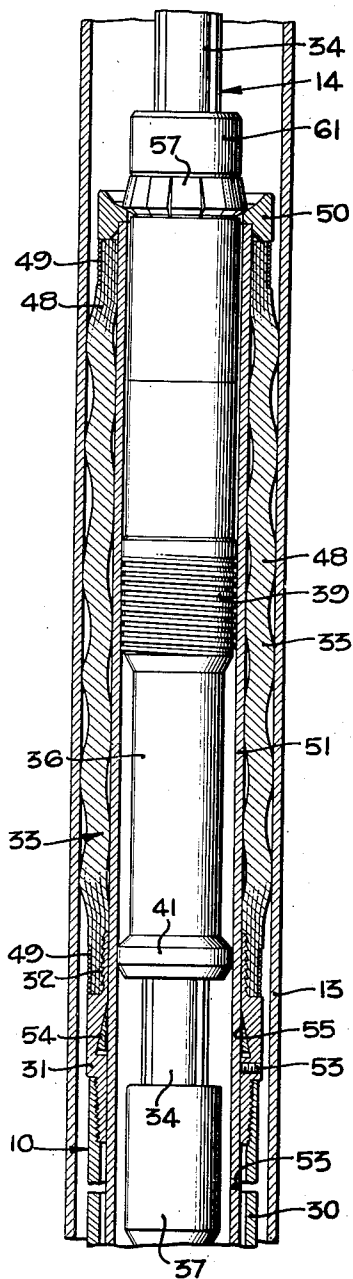


FIG. 4a.

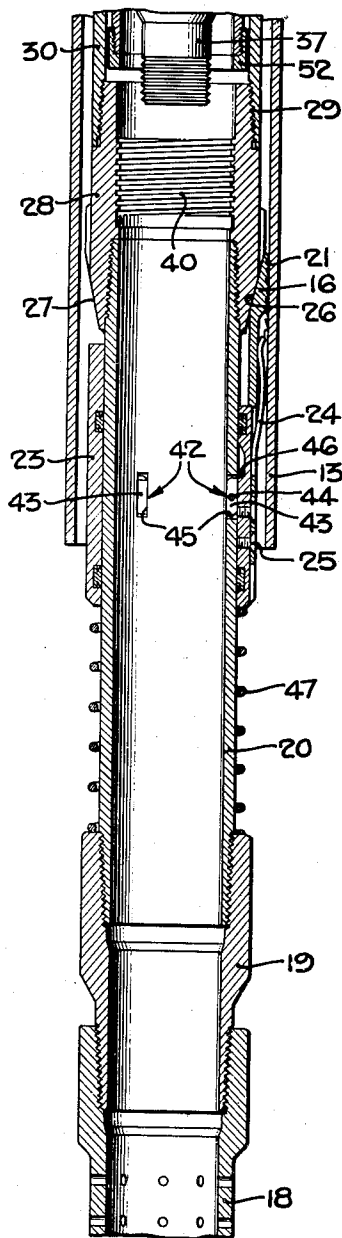


FIG. 4b.

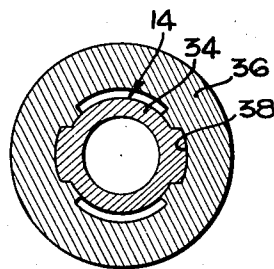


FIG. 6.

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2,693,859

LINER HANGER

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Application May 23, 1949, Serial No. 94,779

13 Claims. (Cl. 166—124)

This invention relates to oil well production equipment and is particularly directed to improvements in liner hangers.

The principal object of this invention is to provide a novel form of liner hanger and setting tool.

Another object is to provide a liner hanger and packer assembly of novel design in which the packer is positioned above supporting slips for the liner and which packer is held in operative position independently of the weight of the liner.

Another object is to provide a setting tool for a liner hanger which is effective to support the liner hanger and packer during insertion into a well bore and to engage the supporting slips at the proper elevation within the interior of the well casing.

A more detailed object is to provide a liner hanger and setting tool combination in which relative rotary movement between the tool and the hanger is first effective to release a slip holding latch without disconnecting the tool from the hanger so that the tool may be used to lift the liner within the well bore to a desired elevation, and so that continued relative rotary movement in the same direction acts to disconnect the tool from the hanger.

A further object is to provide a setting tool of this type having expandable means for use in setting the packer in operative position independently of the weight of the liner.

Other objects and advantages will appear hereinafter. In the drawings:

Figure 1 is a side elevation of a preferred embodiment of my invention illustrated in position within a bore hole.

Figures 2a and 2b are longitudinal sectional elevations showing the cooperative relationship between the setting tool and liner hanger assembly, the upper end of Figure 2b being a continuation of the lower end of Figure 2a.

Figures 3a and 3b are similar to Figures 2a and 2b respectively, but illustrate the working parts in position corresponding to setting of the supporting slips within the interior of the well casing.

Figures 4a and 4b are longitudinal sectional elevations similar to Figures 2a and 2b showing the packer in operative position and showing the setting tool ready for withdrawal from the well hole.

Figure 5 is a sectional elevation, partly broken away, showing the construction of the expandable elements for setting the packer.

Figure 6 is a transverse sectional view taken substantially on the line 6—6 as shown in Figure 5.

Referring to the drawings, the liner hanger assembly, generally designated 10, is supported on a vertically extending tube 11 and inserted into a well hole 12 through the usual casing 13. A liner setting tool, generally designated 14, is secured to the lower end of the tube 11 by means of a coupling 15. The function of the liner setting tool 14 is to lower the liner hanger assembly 10 into place near the lower end of the well bore 12 to cause the slips 16 to seat within the interior of the casing 13 at the proper elevation and then to expand the packer 17 into sealing relationship with the interior of the well casing 13. The setting tool 14 is then withdrawn from the well bore.

Considering the parts of the device in more detail, the liner hanger assembly 10 includes a liner pipe 18 at its lower end. This liner 18 may be made up of a number of sections if desired and may extend for a considerable distance. This liner 18 may be formed of perforated pipe or may comprise ordinary pipe which is later gun

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perforated in situ. A coupling 19 connects the perforated pipe 18 to the lower end of a tubular body 20. The slips 16 are normally carried on the outer periphery of the body 20; each of these slips 16 may comprise an annular segment having wicker teeth 21 formed on the outer surface thereof and adapted to engage the interior of the casing 13. Each of the slip segments is connected, as shown at 22, to an actuating collar 23 which is slidably mounted on the exterior of the tubular body 20. Spring fingers 24 are connected to the actuator collar 23 by means of suitable fastening elements 25. These spring fingers engage the slip segments to maintain them in contact with the outer cylindrical surface of the tubular body 20. Each of the slip segments is provided with a taper bore 26 adapted to engage the conical seat 27. This seat 27 is provided on the lower end of the ring 28. The ring 28 is connected to the tubular body 20 by means of the threaded connection 29 and is carried on the supporting pipe 30. The upper end of the supporting pipe 30 is threadedly connected to a slip bowl 31 which, in turn, is fastened at 32 to a suitable packer, generally designated 33.

The setting tool assembly 14 includes an elongated bar 34 of non-circular cross-section. This bar 34 is threadedly connected at 35 to the coupling 15 and extends downwardly within the packer 33 and through the actuating head or sleeve 36. The lower end of this bar 34 is threadedly connected to the support collar 37 which comprises the lower end of the setting tool, generally designated 14.

The actuating head 36 is provided with a non-circular bore 38 shaped to conform to the non-circular cross-section of the bar 34 so that it may have relative axial movement but is prevented from turning thereon. The sleeve 36 is provided with axially extending external left-hand threads 39 which screw into corresponding internal left-hand threads 40 provided on the ring 28. The lower end of the sleeve 36 is provided with an enlargement or knob 41 which fits closely within the interior bore of the tubular body 20. This knob 41 is adapted to release latch means upon predetermined extent of relative rotary movement between the sleeve 36 and the ring 28 along the helical left-hand threads 39 and 40. The latch means, generally designated 42, acts to retain the slips 16 in their retracted position while the liner hanger is being lowered into the bore hole and while it is being maneuvered to the proper elevation with respect to the casing 13. As shown in the drawings, this latch means includes a plurality of levers 43 pivoted upon pins 44 carried on the body 20. Lateral openings or recesses 45 are provided in the wall of the body 20 so that the levers 43 may have free pivotal movement with respect to the supporting pins 44. The slip actuator ring 23 is normally held in a retracted position on the body 20 because the lower ends of the latching levers 43 engage an abutment 46 provided within the ring 23. The collar 23 encircles the hanger body in the region of the lateral openings 45 to prevent flow of fluid through the openings. The positions of the parts in latching relationship are clearly shown in Figure 2b.

Rotary movement of the sleeve 36 with respect to the ring 28 causes the head 28 to move helically along the threads 39 and 40 and to bring the knob 41 into engagement with the upper, inwardly protruding ends of the latching levers 43. This action serves to swing the latching levers 43 from the engaged position shown in Figure 2b to the retracted position shown in Figure 3b. When the latching levers 43 assume the position shown in Figure 3b, the slip actuator collar 23 is free to move upwardly under the influence of the coil spring 47. This causes the slip segments to move upwardly and to coast with the seat 27 on the ring 28 to move them radially outwardly into engagement with the interior of the casing 13, as shown in Figure 4b.

The packer 33 preferably comprises a canvas tube 48 anchored at its opposed ends by means of wire coils 49. The upper end of the packer comprises an abutment piece 50 fixed to the upper end of a central sleeve 51 which extends within the canvas tube 48. The lower end of the sleeve 51 carries a stop collar 52 adapted to engage under the lower end of the slip bowl 31. Fran-

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gible pins 53 connect the slip bowl 31 to the sleeve 51. A plurality of wedge slips 54 are mounted in a recess 55 provided in the slip bowl 31, and these slips are positioned so that they prevent upward movement of the sleeve 51 with respect to the bowl 31.

The sleeve 36 is provided with an annular recess 56 encircling its upper end and a plurality of segmental striker elements 57 are mounted in this recess. A coil spring 58 is provided for urging each of the striker elements to move radially outwardly with respect to the sleeve 36. An upwardly directed retaining wall 59 is engaged by a downwardly extending lip 60 on each of the striker elements 57 to limit their outward movement. The upper ends of each of the striker elements 57 are pivotally mounted on the sleeve 36. While the pivotal mounting may take any convenient form, I prefer to employ a cap 61 having a downwardly extending rim 62. A recess 63 in the upper portion of each of the striker elements 57 receives the rim 62 and serves as a pivotal connection. The cap 61 may be connected to the actuating head 36 by means of threads 64.

The striker elements 57 are used for expanding the packer 33 into sealing engagement with the inner surface of the casing 13. As shown in Figure 4a, the striker elements 57 expand radially when the setting tool 14 is lifted with respect to the packer 33 until they overlie the inner portion of the abutment piece 50 at the upper end of the packer. In order to expand the packer, the setting tool 14 is raised until the striker elements 57 are above the abutment piece 50. The tube 11 and setting tool 14 are then allowed to descend by gravity so that the striker elements rest on the abutment piece 51. When the radial face 65 on the coupling 15 strikes the cap 61, a very severe blow is delivered through the striker elements to the abutment piece 50. This blow is severe enough to fracture the frangible pins 53, with the result that the inner sleeve 51 moves downwardly with respect to the canvas tube 48. Since the slips 16 prevent downward movement of the lower end of the packer 33, the canvas tube is distorted into sealing relationship with the interior of the casing 13, as shown in Figure 4a. Repeated blows may be struck in this manner in order that the packer may form a fluid-tight seal between the casing 13 and the liner hanger assembly.

In operation the liner hanger assembly 10 and setting tool 14 are run into the hole as a unit on the lower end of the tube 11. The lowering operation is continued until the lower end of the perforated pipe and liner 18 strikes the bottom of the hole. The tube 11 is then turned for a predetermined number of revolutions in order that the knob 41 may be moved axially for a sufficient distance to release the latch 43 but not to completely disengage the threads 39 and 40. The tube 11 is then raised to bring the liner hanger assembly to the desired vertical position within the casing 13. The slips 16 do not impede upward movement of the liner hanger assembly but only act to resist downward movement thereof relative to the casing 13. When the desired position is reached, the tube 11 is lowered which permits the freed slips to engage the casing. The tube is again rotated and the internal threads 39 are completely disengaged from the internal threads 40, with the result that the setting tool 14 is now free of the liner hanger assembly. The weight of the perforated pipe or liner 18 then acts to wedge the slips 16 tightly into engagement with the inner wall of the casing 13. The perforated pipe or liner 18 is thus supported by means of the slips 16 from the casing 13. The tool 14 is then raised to bring the striker elements 57 upwardly through the sleeve 51 and to a position above the abutment piece 50. Vertical reciprocation of the tube 11 then applies a series of blows to the abutment piece 50 through the striker elements 57 to distort the canvas tube 58 of the packer into sealing engagement with the interior of the casing. The setting tool 14 may then be withdrawn from the hole.

The threads 39 and 40 are made left-hand so that they may be disengaged through right-hand rotation of the tube 11. In this way the danger of unthreading tube couplings or other threads is eliminated.

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

I claim:

1. A liner hanger and setting tool assembly, compris-

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ing in combination: a hanger body adapted for connection to a liner, casing gripping slips on the hanger body for supporting it within a well casing, means on the hanger body for moving the slips to casing gripping position, latch means on the hanger body for releasably retaining the slips in retracted position, a setting tool assembly adapted to support the hanger body and liner, said assembly including a bar and a sleeve slidably but non-rotatably mounted for limited slidable movement on the bar, cooperating helical threads connecting the sleeve with the hanger body, a latch-releasing element on the sleeve operable to engage and release the latch means upon predetermined helical movement of the sleeve in one direction relative to the hanger body along said threads, the sleeve being disconnected from the hanger body upon continued helical movement of the sleeve in the same direction.

2. A liner hanger and setting tool assembly, comprising in combination: a hanger body adapted for connection to a liner, casing gripping slips on the hanger body for supporting it within a well casing, a spring for moving the slips toward casing gripping position, latch means on the hanger body for releasably retaining the slips in retracted position, a setting tool assembly adapted to support the hanger body and liner, said assembly including a bar and a sleeve slidably but nonrotatably mounted for limited slidable movement on the bar, cooperating helical threads connecting the sleeve with the hanger body, a latch-releasing element on the sleeve operable to engage and release the latch means upon predetermined helical movement of the sleeve in one direction relative to the hanger body along said threads to permit the spring to set the slips, the sleeve being disconnected from the hanger body upon continued helical movement of the sleeve in the same direction.

3. A liner hanger and setting tool assembly, comprising in combination: a hanger body adapted for connection to a liner, casing gripping slips on the hanger body for supporting it within a well casing, spring means for moving the slips upwardly toward casing gripping position, latch means on the hanger body for releasably retaining the slips in retracted position, a setting tool assembly adapted to support the hanger body and liner, said assembly including a bar and a sleeve and cooperating means nonrotatably connecting the bar with the sleeve for limited relative axial motion, an external helical thread on an element of the sleeve engageable with an internal helical thread on an element of the hanger body, a latch-releasing element on the sleeve operable to engage and release the latch means upon predetermined helical movement of the sleeve in one direction relative to the hanger body along said threads to permit the spring means to set the slips, the sleeve being disconnected from the hanger body upon continued helical movement of the sleeve in the same direction.

4. A liner hanger and setting tool assembly, comprising in combination: a hanger body, a liner suspended from the hanger body, casing gripping slips on the hanger body for supporting it within a well casing, means on the hanger body for moving the slips to casing gripping position, latch means on the hanger body for releasably retaining the slips in retracted position, a setting tool assembly insertable into the interior of the hanger body, said assembly including a bar and a sleeve slidably but nonrotatably mounted for limited slidable movement on the bar, helical thread means connecting the sleeve with the hanger body, and a latch-releasing element on the sleeve operable to engage and release the latch means upon predetermined helical movement of the sleeve relative to the hanger body along said threaded means.

5. A liner hanger and setting tool assembly, comprising in combination: a hanger body adapted for connection to a liner, movable gripping means on the hanger body for supporting it within a well casing, an annular packer secured to the hanger body above the gripping means, a setting tool assembly adapted to support the hanger body and liner, said assembly including a bar and a sleeve, cooperating parts nonrotatably connecting the sleeve with the bar for limited relative axial movement, engageable helical threads connecting the sleeve and hanger body, the sleeve being disconnected from the hanger body upon rotary movement of the sleeve relative to the hanger body; means on the sleeve engageable with the upper end of the packer for expanding it into sealing relationship with the well casing, and a shoul-

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der on the bar adapted to deliver an impact blow to the packer expanding means upon lowering the bar relative to the sleeve.

6. A liner hanger and a setting tool assembly, comprising in combination: a hanger body adapted for connection to a liner, casing gripping slips on the hanger body for supporting it within a well casing, means on the hanger body for moving the slips to casing gripping position, latch means on the hanger body for releasably retaining the slips in retracted position, an annular packer secured to the hanger body above the slips, a setting tool assembly insertable into the packer and adapted to support the hanger body and liner, said assembly including a bar and a sleeve slidably but nonrotatably mounted for limited slidable movement on the bar, cooperating helical threads connecting the sleeve with the hanger body, a latch-releasing element on the sleeve operable to engage and release the latch means upon predetermined helical movement of the sleeve in one direction relative to the hanger body along said threads, the sleeve being disconnected from the hanger body upon continued helical movement of the sleeve in the same direction, means on the sleeve engageable with the upper end of the packer for expanding it into sealing relationship with the well casing, and a shoulder on the bar adapted to deliver an impact blow to the packer expanding means upon lowering the bar relative to the sleeve.

7. A liner hanger and setting tool assembly, comprising in combination: an annular hanger body adapted for connection to a liner, the hanger body having a lateral opening extending therethrough, casing gripping slips on the hanger body for supporting it within a well casing, means on the hanger body for moving the slips to casing gripping position, latch means on the hanger body for releasably retaining the slips in retracted position, the latch means including a latch element movably mounted in said lateral opening, a setting tool assembly adapted to support the hanger body and liner, said assembly including a bar and a sleeve slidably but nonrotatably mounted for limited slidable movement on the bar, cooperating helical threads connecting the sleeve with the hanger body, a latch-releasing element on the sleeve operable to engage and actuate the latch element to release the latch means upon predetermined helical movement of the sleeve in one direction relative to the hanger body, the sleeve being disconnected from the hanger body upon continued helical movement of the setting tool in the same direction, and a collar encircling the hanger body in the region of said lateral opening to prevent flow of fluid therethrough.

8. A liner hanger and setting tool assembly, comprising in combination: an annular hanger body adapted for connection to a liner, the hanger body having a lateral opening extending therethrough, casing gripping slips on the hanger body for supporting it within a well casing, means on the hanger body for moving the slips to casing gripping position, latch means on the hanger body for releasably retaining the slips in retracted position, the latch means including a latch element movably mounted in said lateral opening, an annular packer secured to the hanger body above said lateral opening, a setting tool assembly adapted to support the hanger body and liner, said assembly including a bar and a sleeve slidably but nonrotatably mounted for limited slidable movement on the bar, cooperating helical threads connecting the sleeve with the hanger body, a latch-releasing element on the sleeve operable to engage and actuate the latch element to release the latch means upon predetermined helical movement of the sleeve in one direction relative to the hanger body, the sleeve being disconnected from the hanger body upon continued helical movement of the setting tool in the same direction, a collar encircling the hanger body in the region of said lateral opening to prevent flow of fluid therethrough, means on the sleeve engageable with the upper end of the packer for expanding it into sealing relationship with the well casing, and a shoulder on the bar adapted to deliver an impact blow to the packer expanding means upon lowering the bar relative to the sleeve.

9. A liner hanger and setting tool assembly, comprising in combination: an annular hanger body adapted for connection to a liner, the hanger body having a lateral opening extending therethrough, casing gripping slips movably mounted on the hanger body for supporting it within a well casing, a collar encircling and slidable on

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the hanger body in the region of said lateral opening to prevent flow of fluid therethrough, means connecting the slips to said collar, a spring on the hanger body engaging the collar for moving the slips to casing gripping position, latch means on the hanger body for retaining the slips in a disengaged position, the latch means including a latch element movably mounted in said lateral opening and engaging said collar to hold the slips out of engagement with the well casing, a sleeve within the hanger body, cooperating helical threads connecting the sleeve with the hanger body, a latch-releasing element on the sleeve operable to engage and actuate the latch element to release the latch means from said collar upon predetermined helical movement of the sleeve in one direction relative to the hanger body, the sleeve being disconnected from the hanger body upon continued helical movement of the sleeve in the same direction.

10. A liner hanger and setting tool assembly, comprising in combination: a hanger body adapted for connection to a liner, releasable casing gripping means for supporting the hanger body within a well casing, an annular expansible telescopic packer on the hanger body positioned above the gripping means, a setting tool adapted to support the hanger body and liner, the setting tool assembly including a longitudinally extending member and a sleeve, cooperating parts on the sleeve and member nonrotatably connecting them for relative axial movement, cooperating helical threads connecting the sleeve and the hanger body whereby the setting tool may be disconnected from the hanger body upon rotation of said member and sleeve relative to the body, stop shoulders on the longitudinally extending member limiting the extent of axial movement relative to the sleeve, a plurality of expansible striker elements on the sleeve, said elements being normally confined in retracted position within the interior of the packer, and means expanding said elements when the sleeve is lifted above the packer so that the elements may overhang the upper end of the packer.

11. A liner hanger and setting tool assembly, comprising in combination: a hanger body adapted for connection to a liner, releasable casing gripping means for supporting the hanger body within a well casing, an annular expansible telescopic packer on the hanger body positioned above the gripping means, a setting tool adapted to support the hanger body and liner and insertable into the packer, the setting tool assembly including a longitudinally extending member having a noncircular cross-section, the setting tool also including a sleeve having a corresponding noncircular bore slidably received on said member, stop shoulders on the longitudinally extending member limiting the extent of axial movement relative to the sleeve, cooperating helical threads connecting the sleeve with the hanger body whereby the sleeve may be disconnected from the hanger body upon rotation of said member and sleeve relative to the body, a plurality of radially expansible striker elements on the sleeve, said elements being confined in retracted position when positioned within the interior of the packer, and means expanding said elements when the sleeve is lifted above the packer so that the elements may overhang the upper end of the packer.

12. A liner hanger and setting tool assembly, comprising in combination: a hanger body adapted for connection to a liner, releasable casing gripping means for supporting the hanger body within a well casing, an annular expansible telescopic packer on the hanger body positioned above the gripping means, latch means on the body for releasably maintaining the gripping means in an inoperative retracted position, a setting tool assembly adapted to support the hanger body and liner, the setting tool including a longitudinally extending member and a sleeve, cooperating parts on the sleeve and member preventing relative rotation but permitting relative axial sliding movement, stop shoulders on the member limiting the extent of sliding movement, cooperating helical threads connecting the sleeve with the hanger body, a latch-releasing element on the sleeve arranged to engage and release the latch means upon predetermined helical movement of the sleeve in one direction relative to the hanger body along the helical threads, a plurality of expansible striker elements on the sleeve, said elements being confined in retracted position when positioned within the interior of the packer, and means expanding said elements when the sleeve is disconnected from the hanger

body and is lifted above the packer so that the elements may overhang the upper end of the packer.

13. A liner hanger and setting tool assembly, comprising in combination: a hanger body adapted for connection to a liner, releasable casing gripping means for supporting the hanger body within a well casing, an annular expansible telescopic packer on the hanger body positioned above the gripping means, latch means on the body for releasably maintaining the gripping means in an inoperative retracted position, a setting tool assembly adapted to support the hanger body and liner and insertable into the packer, the setting tool assembly including a longitudinally extending member having a noncircular cross-section and a sleeve having a corresponding non-circular bore slidably receiving the longitudinal member, stop shoulders on the longitudinally extending member limiting the extent of axial movement relative to the

sleeve, cooperating helical threads connecting the sleeve with the hanger body whereby the setting tool assembly may be disconnected from the hanger body upon rotation of said member and sleeve relative to the body, and a latch-releasing element on the sleeve arranged to engage and release the latch means upon predetermined helical movement of the sleeve in one direction relative to the hanger body along the helical threads.

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