

Feb. 23, 1954

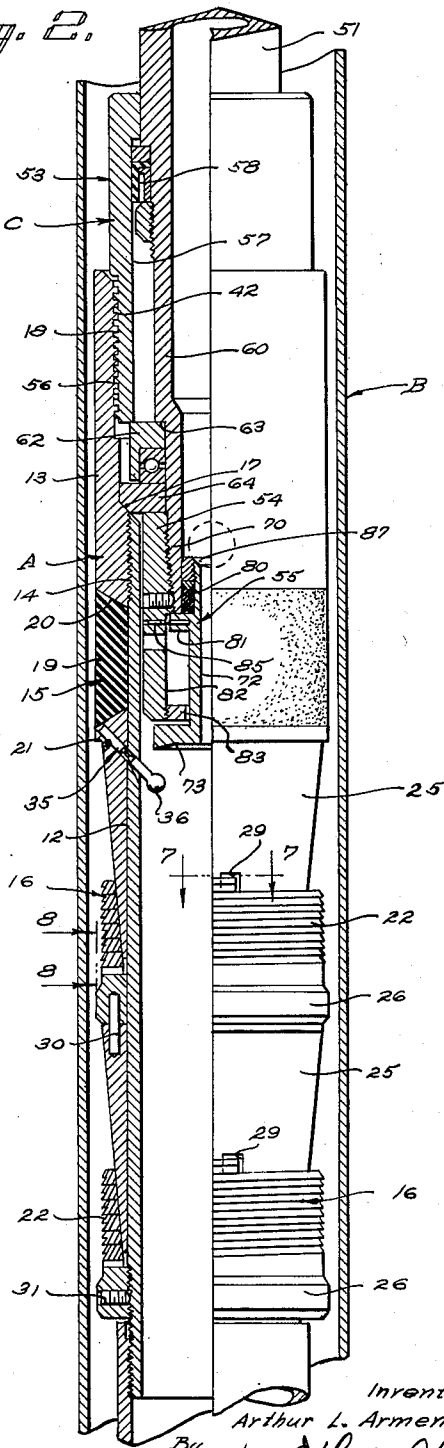
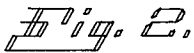
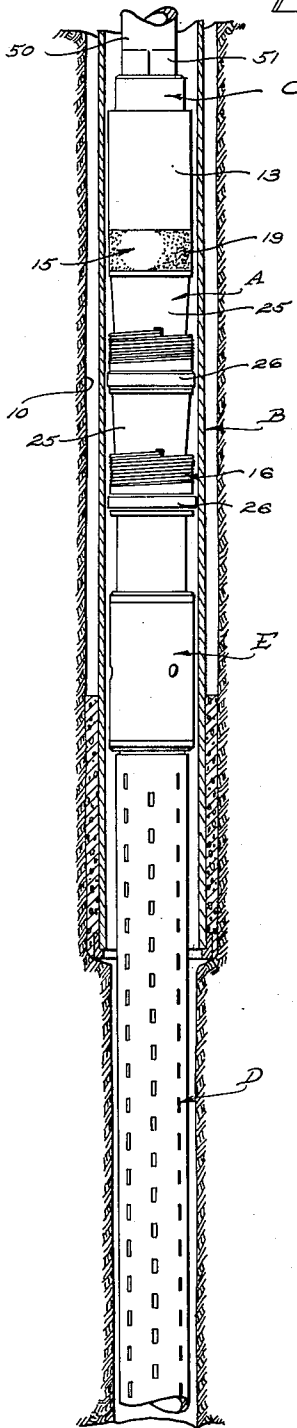
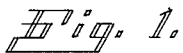
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2,670,045

LINER HANGER AND ACTUATOR THEREFOR

Filed Sept. 30, 1948

3 Sheets--Sheet 1



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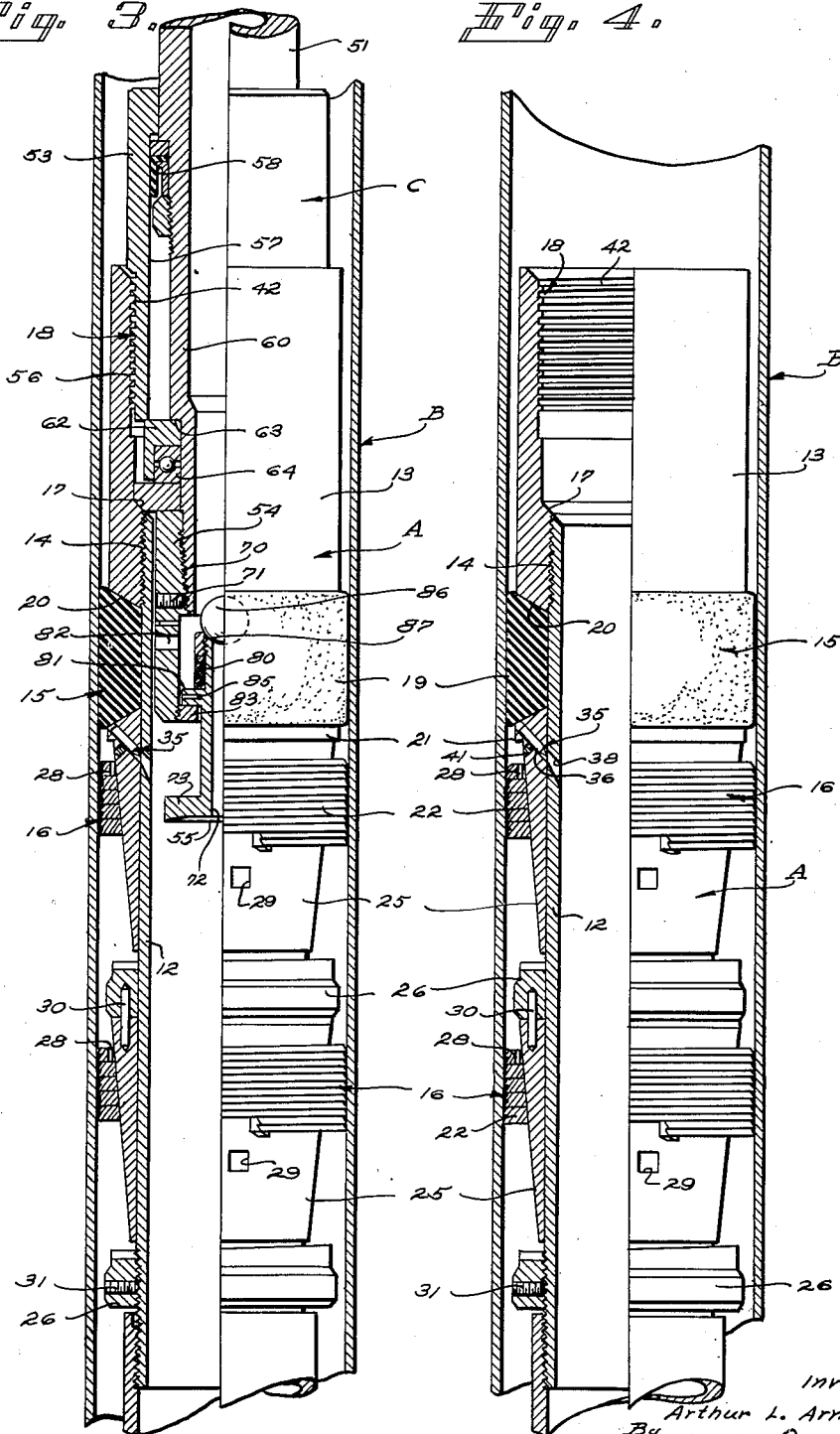
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Fig. 3.

Fig. 4.



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3 Sheets--Sheet 3

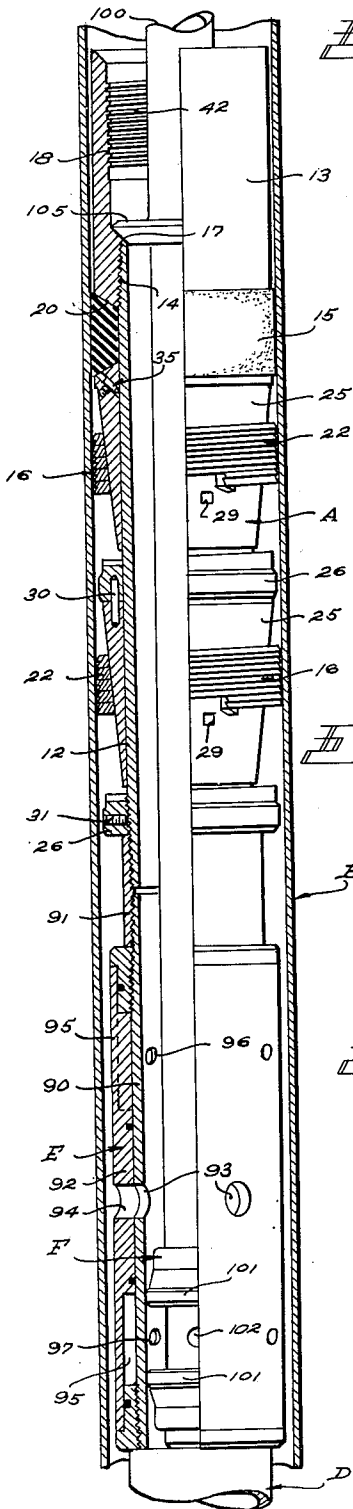


Fig. 5, Fig. 6.

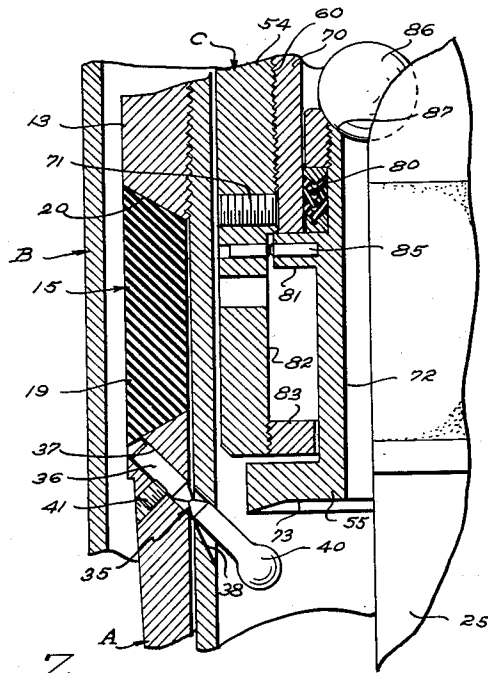


Fig. 7.

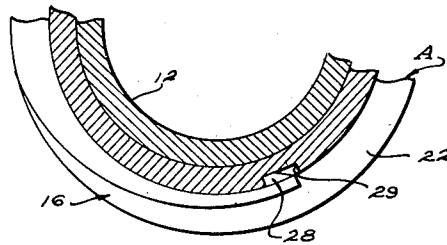
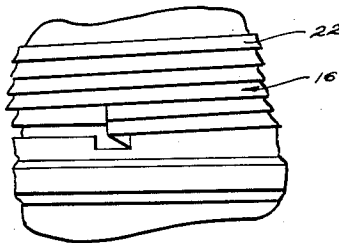


Fig. 8.



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UNITED STATES PATENT OFFICE

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LINER HANGER AND ACTUATOR THEREFOR

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Application September 30, 1948, Serial No. 52,037

8 Claims. (Cl. 166—12)

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This invention is concerned with a liner hanger and an actuator therefor, it being a general object of the invention to provide a hanger which is of simple, inexpensive, dependable construction and to provide an actuator for the hanger by which accurate and dependable operation of the hanger may be effected.

The present invention is concerned with a liner hanger that can be used to particular advantage in supporting a liner in a well from a point below the top thereof, as for instance, in the lower end portion of a well casing. In the following disclosure the hanger will be described in a situation where it is applied to a casing at the lower end portion thereof and the actuator described is of a form and type particularly practical in such a situation. It is to be understood, however, that the structure provided by the present invention may be employed to hang a liner at any point or in any location in a well and that the liner structure, per se, may be actuated in any desired manner.

It is a general object of the present invention to provide a liner hanger effective for supporting a liner in a well casing, or the like, and which involves few simple, inexpensive parts easily assembled and handled and dependable and effective in operation.

Another object of the invention is to provide a liner hanger which is of simple compact construction and is characterized by a tubular body to which the liner is attached and which affords a large access opening through which tools and equipment can be readily passed into the liner.

It is a further object of the invention to provide a liner hanger of the general character referred to having a stop shoulder therein for cooperation with auxiliary tools and equipment as a point of reference facilitating the location of such tools or equipment relative to the hanger.

A further object of the invention is to provide a liner hanger of the general character referred to provided at the upper end portion with a coarse or heavy thread serving as the means by which the hanger may be coupled to an actuator or other equipment. The structure of the present invention is free of bayonet slot constructions or other forms of catches, latches, or devices of limited strength and which are not always dependable in operation.

It is another object of the invention to provide an actuator for a liner hanger including means operable to actuate the hanger or to release the grippers of the hanger so that the hanger is set in operative position in a casing, or the like.

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The various objects and features of my invention will be fully understood from the following detailed description of a typical preferred form and application of the invention, throughout which description reference is made to the accompanying drawings, in which:

Fig. 1 is a vertical sectional view of a portion of a well bore showing a hanger embodying the present invention in elevation unactuated and located in the well casing and carrying a liner, the hanger being supported by an actuator also in the casing. Fig. 2 is an enlarged view of a portion of the structure shown in Fig. 1 showing the well casing in section and a part of the hanger actuator in section and unactuated. Fig. 3 is a view similar to Fig. 2 showing the hanger actuated or set to cooperatively engage the well casing. Fig. 4 is a view similar to Fig. 3 showing the actuator removed, leaving only the hanger in the casing supporting the liner. Fig. 5 is a reduced view similar to Fig. 4 and showing, in addition thereto, an auxiliary or supplemental device such as a flow control between the liner and hanger and showing a tool engaged in the circulation control and oriented therein by the shoulder in the hanger. Fig. 6 is an enlarged detailed sectional view of a portion of the structure shown in Fig. 2. Fig. 7 is an enlarged detailed sectional view taken as indicated by line 7—7 on Fig. 2, and Fig. 8 is an enlarged view taken as indicated by line 8—8 on Fig. 2.

The hanger A provided by the present invention is adapted to be engaged or set in a well casing B, or the like, and it is manipulated or controlled by means of an actuator C constructed in accordance with the present invention. The hanger A is intended to support a liner D, or the like, and the liner is particularly useful in a situation where a supplemental tool or device E, such as a circulation control, is employed in connection with the hanger and liner, for example between the hanger and liner.

The well casing B illustrated in Fig. 1 is shown located in a well bore 10 in which it is set in the usual manner, and the well bore is shown extending below the lower end of the casing to receive a portion of the liner D. The liner D is shown as a simple or conventional liner serving to admit flow from the well into the well casing through the liner hanger and through the flow control E when such an element is employed.

The flow control E is located between the upper end of the liner D and the lower end of the hanger A and is a valve mechanism acting when open to bypass well fluid into the hanger and out

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through the casing without flow through the liner. When the flow control E is closed any flow out through the hanger and casing must come from or be through the liner. The particular flow control device E illustrated in the drawings, merely for purpose of illustration, is of the form and construction more fully described and claimed in my copending application entitled "Circulating Unit and Actuator Therefor," filed on even date herewith and bearing Serial No. 53,337, now Patent 2,619,179. Further, the particular device or tool F shown cooperating with the circulation control is of the form and type disclosed in the said copending application.

The hanger A provided by the present is useful as a hanger for supporting a liner, or the like, in a well casing or other like element, and it may be used to advantage in any situation where a hanger is desired or it may be used in special situations as for instance in connection with other elements or equipment such as are disclosed and claimed in my copending application entitled "Method and Apparatus for Handling Fluid in a Well" filed on even date herewith and bearing Serial No. 52,038, now Patent 2,631,670.

The liner hanger, as shown in the drawings involves, generally, a tubular body that may be formed of a straight tubular main section 12 and a top or upper end section 13. In the case illustrated the two sections 12 and 13 of the hanger body are joined by a threaded connection 14. However, it is to be understood that the body may, if desired, be formed as a single or integral unit.

The body 12 of the hanger carries packing means 15 and one or more gripping units 16 and it is formed with a stop shoulder 17 and with a part 18 by which the hanger may be coupled with the actuator C.

The packing means 15 is preferably formed of or by an annular body 19 of packing which is normally in a contracted position on the upper end portion of the main body part 12 and which abuts a downwardly facing shoulder 20 on the lower end of the upper end portion 13 of the body. A ring or sleeve portion 21 surrounds the body portion 12 immediately below the packing 19 and upon being moved upwardly or toward shoulder 20 it actuates the packing to expand it outwardly into sealing engagement with the casing B as shown in Figs. 3 and 4 of the drawings.

In the particular form of the invention illustrated there are two gripping units 16 and they employ or include gripping parts such as are more fully described and which are claimed in my copending application entitled "Gripper and Method of Making the Same," filed on even date herewith, Serial No. 53,338.

The gripper hereinabove referred to and shown in the drawings is characterized by adjoining gripping parts 22 which are coils or convolutions of a spirally formed strip which is formed of resilient material and is normally in a contracted position such as is shown in Fig. 2 but which can be expanded to operating position such as is shown in Figs. 3 and 4.

The gripping parts 22 are preferably formed with teeth or other projections on their outer faces so that effective gripping engagement is established between the hanger and the interior of the casing B.

Where grippers of the form or type above referred to are employed and where more than one gripping unit 16 is employed, it is desirable

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that the gripping units be operatively coupled or arranged in series to operate together.

In the particular case illustrated each gripping unit 16 includes a tubular wedge 25 carried on the body part 12 to the shiftable relative thereto, an anchor ring 26 on the body at or immediately beyond the small end of the wedge, and a coiled gripping element on the wedge with one end anchored to the hanger element 26 and the other to the wedge. The desired anchoring engagement of the spring or helical gripping element is gained through lugs 23 projecting from the ends of the gripping element and engaged in sockets 29 in the parts to which the element is anchored or secured.

Where two elements 16 are employed, as shown in the drawings, the anchor ring 26 of the uppermost gripping element is keyed to the wedge 25 of the lower gripping unit by a key 30 which holds these parts against relative rotation. The anchor ring 26 of the lowermost gripping unit is set or fixed on the body part 12 as by a set screw 31 or the like, whereas the other anchor ring 26 and the wedges 25 are set to rotate and also to shift axially on the body part 12. In the case illustrated the ring or collar part 21 engaging the lower end of the packing ring 19 is formed integral with the uppermost wedge 25 with the result that upward shifting of the upper wedge 25 on the body part 12 causes actuation of the packing.

With the construction above described, that is, when the lowermost anchor ring 26 of the gripping units is fixed and the grippers or spirally wound elements of the gripping units tend to expand to the gripping position shown in Figs. 3 and 4, it is necessary to rotate the shiftable parts, as for instance, by rotating the uppermost wedge 25 to contract the gripping elements to a position such as is shown in Fig. 2. With the anchor ring 26 of the uppermost unit keyed to the wedge 25 of the lowermost unit both helical gripping members will be simultaneously contracted by rotation of the uppermost wedge. It will be apparent that when it is desired to ready the structure for operation rotation of the uppermost wedge tensions the structure so that it tends to spring to the operating or set position as soon as the uppermost wedge is released.

The present invention provides a control means 35 for the structure just described, which control means preferably involves a shear pin 36 carried in openings 37 and 38 which register when the units are fully contracted, as shown in Fig. 2 of the drawings. The opening 37 is in the upper end portion of the unit formed by the upper wedge 25 and the collar 21 while the opening 38 is in the wall of body 12. The particular construction illustrated involves openings 37 and 38 which support the shear pin at an angle clearly shown in Fig. 6, and the shear pin has an inner end portion or head 40 projecting into the interior of the body part 12 where it is exposed. A suitable setting means or set screw 41 is provided for setting the shear pin 36 in operating position.

The stop 17 provided in the hanger is preferably an upwardly facing shoulder formed in the upper end portion 13 of the hanger body. The shoulder is shown occurring where the upper end of the lower or main body section 12 terminates in the upper body section 13.

The part 18 of the hanger provided to facilitate connection with the actuator C or with like equipment occurs at the upper end of the upper body

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13 and is in the form of an extension of the body having a coarse internal thread 42.

The actuator C provided by the present invention is shown as including an elongate operating string 50 the lower end portion 51 of which is polygonal in cross sectional configuration. The actuator further includes a coupling member 53 carried by the lower end portion 51 of the string 50 and a head 54 carried on the lower end of portion 51 and supporting a striker 55 operable to actuate the shear pin 36.

The coupling member 53 is slidably keyed to the string 50 which is tubular and preferably extends to the top of the well, and it has an externally threaded lower end portion 56 engageable in the part 18 of the hanger body. The threads on part 56 are preferably coarse and cooperate with the threads on part 18 so that these parts are effectively connected when they are engaged, as shown in Fig. 2. To release the connection, assuming the string is made up of right hand joints, the coupling member 53 is rotated in a lefthanded direction, until the threaded part 56 is disengaged from the threaded part 18. In the form of the invention illustrating the coupling member 53 has an internal bore 57 and suitable packing 58 is carried by the operating string 50 to engage and operate in the bore to seal between the operating string and coupling member. Further, a bearing construction is carried by the stem portion 60 of the operating string which depends from the polygonal portion 51 and which supports the head 54. The bearing is shown as including an upper plate 62 engaged with the lower end of the coupling member 53 and a downwardly facing shoulder 63 on the stem 60 and a lower plate 64 which seats against or on the stop 17.

The head 54 of the actuator is fixed or secured on the lower end of the stem part 60 as by a threaded connection 70, and in practice it may be set in position on the stem by a set screw 71. The head 54 is in the nature of an enlargement on the lower end of stem 60 and is such as to enter the upper end portion of the body part 12 as shown throughout the drawings.

The striker 55 is provided to operate or fracture the shear pin 36 and in the case illustrated it is shown as involving a tubular core 72 operating in the head 54 and having a pin engaging part 73 at its lower end shaped and disposed to engage the head 40 of the shear pin 36. The core 72 is slidably engaged in the stem 60, it being preferred that there be packing 80 carried by the core and operating in the bore of the stem. In the case illustrated a flange 81 projects from the exterior of the core 72 near its upper end and operates in a counterbore 82 provided in the lower end portion of the head, downward movement of the core being limited by a stop member 83 threaded in the lower end portion of the counterbore. The core 72 is normally releasably held in an elevated position by a shear pin 85 engaged between the core and the head, preferably between the flange 81 of the core and the head, as shown in Fig. 6 of the drawings.

The upper end portion of the core is finished to present a seat 87 to receive a valve member such as a ball 86. The ball 86 is dropped into position through the operating string 50 when it is desired to actuate the hanger and when it engages the seat 87 it closes the opening through the core 72. With the structure thus closed by the ball 86 fluid pressure applied through the operating string 50 forces the striker 55 downward and as it moves down it engages and breaks

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the shear pin 36. When the shear pin 36 is broken the uppermost wedge 25 is released to shift relative to the body part 12. The wedge 25 may rotate about the body under the influence of the helical gripping members which expand to operating position. When the gripping members have engaged the casing the structure may be moved downward by lowering the operating string 50, causing the wedge members to enter behind the helical grippers to set them firmly in position and to cause the collar 21 to move upwardly toward shoulder 20 expanding the packer so that the desired seal is established.

The auxiliary or supplemental tool E shown in conjunction with the hanger, as above described, may, in practice, be any suitable structure or device such as circumstances may require. The particular tool illustrated involves a central tubular body 90 connected to the upper end of the liner and joined to the lower end of the hanger by a coupling 91. A sleeve valve 92 rotates on the body 90 and openings or ports 93 and 94 are provided in the body and valve to be moved into and out of register by rotation of the sleeve on the body. Vane type motor units 95 are provided at the ends of the valve sleeve and are such that when fluid under pressure is admitted to the port 96 of the upper motor unit the valve is moved in one direction, whereas when fluid under pressure is rotated in the opposite direction. The details of this particular tool are fully set forth in my above identified copending application Serial No. 53,337.

The particular device F shown for cooperation with the tool E involves a tubular operating string 100 extending through the hanger from the top of the well and spaced packers 101 on the lower end of the operating string and between which fluid under pressure is admitted from the string through a port 102. In Fig. 5 of the drawings the device F is shown in a down position where fluid pressure from the operating string 100 may be admitted to the port 97 of the lower motor unit of tool E whereas it will be apparent that if the string 100 is moved upwardly a suitable distance, which distance of course is known to the operator, then the pressure will be admitted to port 96 of the upper unit. The string 100 is shown provided with a stop shoulder 105 to engage and rest upon the stop 17 when the packers 101 are located to admit fluid under pressure to port 97. In operation the operator to position the parts as shown in Fig. 5 need only lower the operating string until the stop 17 is reached by the stop shoulder 105.

If he desires to admit pressure to the lower motor unit of tool E the parts are left in this position. If he desires to admit pressure to the upper motor unit he elevates the operating string a distance corresponding to the spacing of ports 96 and 97.

From the foregoing description it will be apparent that by my present invention I have provided a liner hanger which is simple, effective and dependably in operation and which may, if circumstances require, be used apart from any of the other equipment described. It is preferred, however, that the liner hanger be employed in connection with the actuator C hereinabove described, which actuator provides for effective, dependable releasable coupling of the hanger with a setting string and also carries the striker which is most effective for releasing or breaking the shear pin 36. Further, by providing the hanger with the stop shoulder 17 it effectively stops or limits engagement of the coupling member 53

with the hanger body and after the hanger has been set or is in operation it presents an abutment in a known position that can be dependently engaged by a supplemental tool such as that shown in Fig. 5 of the drawings, which tool may be used in connection with auxiliary equipment such as the tool E illustrated in Fig. 5.

Having described only a typical preferred form and application of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art and fall within the scope of the following claims.

Having described my invention, I claim:

1. A liner hanger including, a tubular body, two gripper units on the body one above the other and each including, an anchor, a resilient helical gripper around the body and normally expanded, and a conical wedge on the body and engaged in the gripper, the anchor of the lower unit being set on the body while the anchor of the upper unit is coupled to the wedge of the lower unit.

2. A liner hanger including, a tubular body, and two gripper units on the body one above the other and each including an anchor, a conical wedge rotatably mounted on the body and a resilient helical gripper around the wedge and normally expanded, one end of the gripper being secured to the anchor and the other to the wedge, the anchor of the upper unit being coupled to the wedge of the lower unit and the anchor of the lower unit being fixed on the body, and means releasably coupling the wedge of the upper unit to the body with the wedge rotated so the grippers are contracted.

3. A liner hanger including, a tubular body, and two gripper units on the body one above the other and each including an anchor, a conical wedge rotatably mounted on the body and a resilient helical gripper around the wedge and normally expanded, one end of the gripper being secured to the anchor and the other to the wedge, the anchor of the upper unit being coupled to the wedge of the lower unit and the anchor of the lower unit being fixed on the body, and a shear pin releasably coupling the wedge of the upper unit to the body with the wedges rotated so the grippers are contracted.

4. A liner hanger including, a tubular body, and two gripper units on the body one above the other and each including an anchor, a conical wedge surrounding the body and rotatable on the body and a resilient helical gripper around the wedge and normally expanded, one end of the gripper being secured to the anchor and the other to the wedge, the anchor of the upper unit being coupled to the wedge of the lower unit and the anchor of the lower unit being fixed on the body, means releasably coupling the wedge of the upper unit to the body with the wedges rotated so the grippers are contracted, and a packer on the body operable by one of said units.

5. A liner hanger including, a tubular body, and two gripper units on the body one above

the other and each including an anchor, a conical wedge rotatable relative to the body and a resilient helical gripper around the wedge and normally expanded, one end of the gripper being secured to the anchor and the other to the wedge, the anchor of the upper unit being coupled to the wedge of the lower unit and the anchor of the lower unit being fixed on the body, means releasably coupling the wedge of the upper unit to the body with the wedges rotated so the grippers are contracted, and a packer on the body above the units operated by the wedge of the uppermost unit.

6. In combination, a hanger having a tubular body, gripping means carried by the body and retaining means normally releasably retaining the gripping means against operation, and an operator including an operating string, a member slidably keyed to the string to shift longitudinally thereof, a threaded connection releasably coupling the string and body, and an element carried by the string to shift relative thereto and actuate the retaining means.

7. In combination, a hanger operable in a well casing and having a tubular body, a resilient casement gripping member carried by the body and retaining means normally releasably retaining the gripping means against operation, and an operator including, an operating string, a member releasably coupling the string and body for relative movement, and a fluid pressure actuated element carried by the string operable to effect release of the retaining means.

8. In combination a hanger operable in a casing and having a tubular body, a tubular casing gripper carried by the body and normally yieldingly tending to grip the casing, retaining means normally releasably retaining the gripping means against operation including a wedge carried on the body and engageable in the gripper, and an operator including an operating string insertable through the casing, a member releasably coupling the string and body, and a striker releasably carried by the string at the lower end thereof and shiftable relative to the string to actuate the retaining means, the retaining means including a shear pin coupling the body and wedge and engaged by the striker.

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