

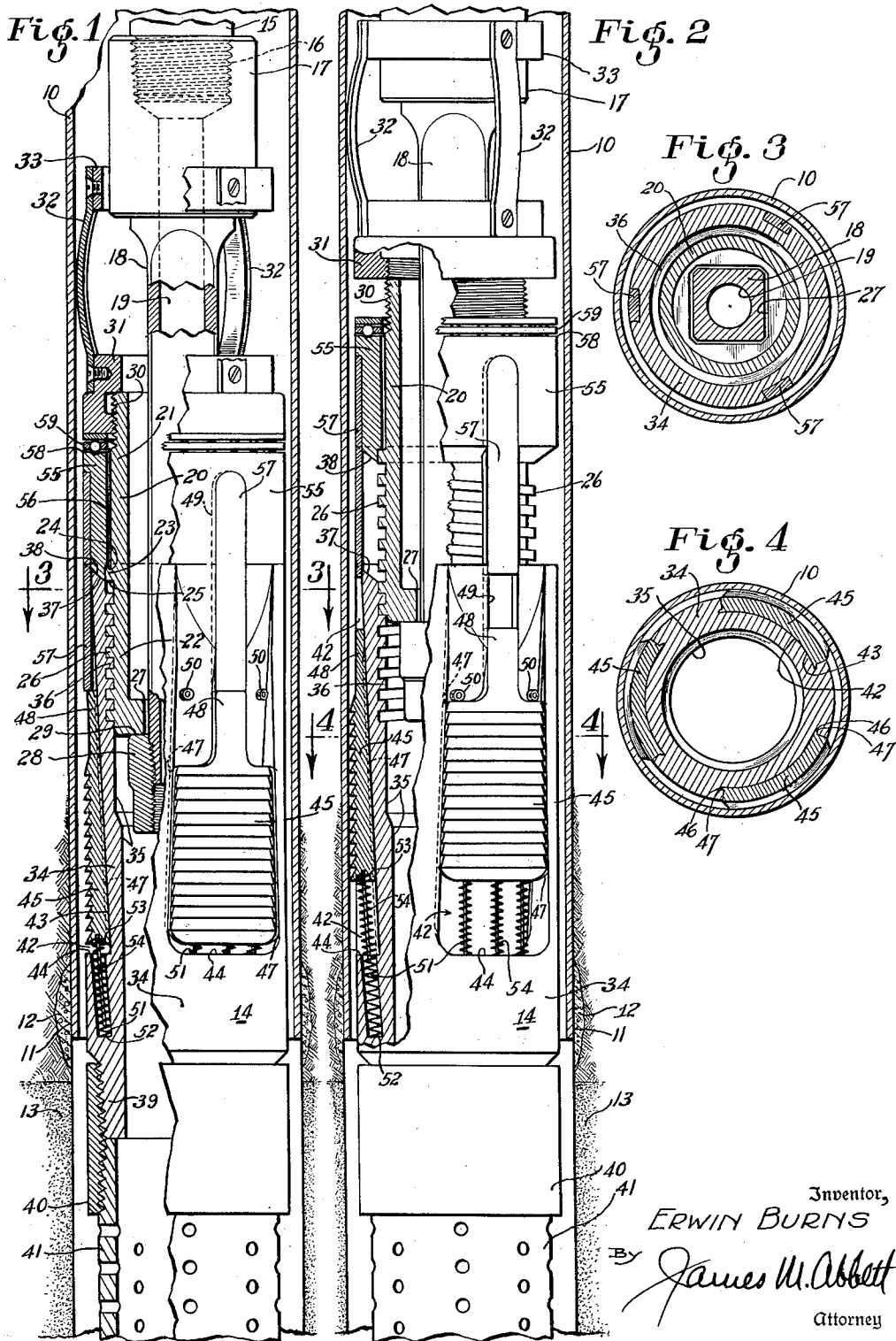
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E. BURNS

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LINER HANGER

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Inventor,  
ERWIN BURNS

By *James M. Abbott*  
Attorney

## UNITED STATES PATENT OFFICE

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## LINER HANGER

Erwin Burns, Los Angeles, Calif.

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1

This invention relates to oil well tools and particularly pertains to a liner hanger.

In oil well drilling operations and when preparing oil wells for production it is common practice to set a water string in the open hole and to thereafter drill into the formation and set well casing. In this latter operation it is usual to lower the casing through the water string and then to suspend the casing within the lower end of the water string by the use of a mechanical tool known as a liner hanger. Such hangers usually embody the use of serrated slips which are mounted to expand outwardly and to engage the wall of the water string in a manner to anchor and support the upper end of a string of casing. These devices employ various types of mechanisms to temporarily hold parts of the liner hanger against movement while other parts are manipulated to cause the slips to move outwardly and positively engage the walls of the water string. These mechanisms often are of a construction which causes parts to be broken and heretofore have made it necessary for the casing string to be set on the bottom of the hole in order to properly actuate the liner hanger. It is desirable of course to provide a liner hanger which may be actuated at any level in a well and which would make it possible for manipulation of the casing liner to be brought about without reference to the bottom of the well bore. It is the principal object of the present invention, therefore, to provide a liner hanger provided with slips which may be manipulated at any level in a string of pipe, and which makes it possible for the slips to be set and the supporting string detached from the liner hanger without reference to the bottom of the well bore.

The present invention contemplates the provision of a liner hanger including a body carrying slips adapted to be moved laterally into engagement with a set string of pipe, and which body may then be detached from a supporting string of pipe at any level therein.

The invention is illustrated by way of example in the accompanying drawing in which:

Figure 1 is a view in vertical elevation with parts broken away showing the complete liner hanger as disposed in a well and prior to the setting of the slips.

Fig. 2 is a view similar to Fig. 1 showing the liner hanger with the slips in their set position and with the operating tool removed therefrom while detaching the supporting string.

Fig. 3 is a view in transverse section through the body of the hanger as seen on the line 3—3 of Fig. 1 and shows the slip operating fingers.

2

Fig. 4 is a view in transverse section through the hanger body as seen on the line 4—4 of Fig. 2 and shows the manner in which the slips are mounted in their operative position.

Referring more particularly to the drawing, 10 indicates a well casing which is set in a well bore 11 by the use of setting material 12. The well bore 11 extends downwardly into the producing sand 13. A liner hanger 14 is provided and is designed to grip the wall of the casing 10 mechanically and to thereby hold the tool against longitudinal movement during the casing setting operation. The liner hanger is suspended from a string of drill pipe indicated at 15. The lower end of this string of pipe is formed with a threaded pin 16 which receives the threaded box 17 of a square tubular mandrel 18. The box 17 and the mandrel 18 are here shown as being formed integral. A central longitudinally extending passageway 19 is formed through the mandrel 18 and is open at both of its ends to allow unrestricted flow of fluid through the structure. Mounted upon the square mandrel 18 is a connecting nut structure 20. This nut has an upper cylindrical portion 21, a lower cylindrical portion 22, and an intermediate enlarged shoulder 23. This shoulder 23 has an upper square face 24 and a lower square face 25. The cylindrical portion 22 which occurs below the conical face 25 is formed with a coarse thread 26, here shown as being of the acme type and left-handed. Formed centrally of the connecting nut 20 is a square passageway 27 through which the square mandrel 18 may extend and reciprocate. The lower end of the mandrel 18 is fitted with a mandrel nut 28 which has a square upper face to abut against the end face 29 of the connecting nut 20. The opposite end of the mandrel nut 28 is threaded and may receive a tail pipe. The upper cylindrical portion 21 of the connecting nut 20 is formed with an external right-hand thread 30 which is of relatively fine pitch. This thread receives a slip releasing nut 31 which is fitted with a plurality of bow springs 32 which extend upwardly and are adapted to frictionally engage the walls of the casing 10 to prevent rotation of the releasing nut 31 under certain conditions to be explained hereinafter. The upper ends of the bow springs 32 are attached to a collar 33 which loosely surrounds a cylindrical extension of the box 17 carried at the lower end of the mandrel 18.

The connecting nut 20 is provided to temporarily support the cylindrical body member 34 of the structure. This body member is formed with a central cylindrical bore 35, the upper end

of which is internally threaded at 36 to receive the threaded length 26 of the connecting nut. The mouth of the bore 35 is formed with a tapered face 37 which is complementary to a tapered face 38 formed on the lower end of the compression ring 55. The lower end of the body member 34 is formed with a pin extension 39 to receive a coupling 40. The coupling 40 carries a length of perforated liner 41 which extends down into the open hole which penetrates the producing formation.

The body member 34 is formed on its external cylindrical surface with longitudinal slip ways 42 which are cut into the cylindrical face of the body portion and are shown in Fig. 4 as being three in number. The slip ways 42 have an inclined bottom face 43 which tapers upwardly and outwardly from a shoulder 44. The shoulder of each of the ways lies in a common plane normal to the longitudinal axis of the body member and is of a depth sufficient to accommodate the heel of a tapered slip member 45. The bottom face 43 of each of the ways is arcuate in cross-section and agrees in radius substantially with the radius of the outer circumference of the body member while being eccentric to the axis of the body member. The opposite edges of the ways 42, as indicated at 46, are undercut to form V-shaped guide grooves in which tapered edges 47 of the slips 45 may fit. It will be obvious that the slips will be free to move longitudinally of the ways but will be retained therein by the dove-tail connection between the edges of the slips and the opposite edges 46 of the ways. In order to provide a suitable gripping area for the slips the opposite undercut edges 46 taper with relation to each other so that the ways will be wider at their lower ends and so that the slips will provide a gripping surface which will conform to the inner face of the casing 10 which is to be gripped. The outer faces of the slips are wickered so that they will positively impinge against the surface of the casing and will hold the tool firmly in place. The upper end of each of the slips is formed with a tongue 48, which tongues extend upwardly along longitudinal recesses 49. These recesses are open at their upper ends and the thickness of the tongues is such as to cause their outer surfaces to conform to the outer circumference of the cylindrical body member 34 at all times. Stop members 50 are positioned in the ways 42 at a suitable point near their upper ends so that the upward movement of the slips will be limited. The slips are urged upwardly by a plurality of helical springs 51, the lower ends of which are fitted within seats 52 formed in the shoulders 44 of the body member 34, and the upper ends of which fit into seats 53 formed in the heels of the slips 45. Extending downwardly from each of the seats 53 is a guide pin 54. These pins extend into the helical springs 51 and tend to maintain them in a straight condition so that they will not buckle. The longitudinal axes of the springs are parallel to the taper of the faces 43 of the ways 42.

As previously explained the connecting nut 20 is free to slide upon the square mandrel 18 and is limited in its downward movement by the mandrel nut 28. The connecting nut 20 which is formed with the shoulder 23 is provided to receive a compression ring 55. This ring is formed with a central bore 56 through which the upper cylindrical portion 21 of the nut 20 extends. The outer circumference of the ring agrees with that of the body 34. Extending downwardly from

the lower face of the ring is a plurality of thrust fingers 57. These fingers agree in number with the longitudinal recesses 49 formed in the outer face of the body member 34 and are of sectional dimensions to permit them to lie within the recesses 49 so that their free ends abut against the ends of the fingers 48 which are carried by the slips 45. The length of the thrust fingers 57 is such as to insure that when the compression ring 55 abuts against the shoulder 37 of the body member 34 the slips 45 will be in a retracted position with their wickered faces conforming to the circumference of the body portion 34.

The compression ring 55 is provided with an upper end face 58 which is formed with a ball race. An anti-friction thrust bearing 59 is disposed upon this race and is held in position by the nut 31 which is threaded onto the cylindrical extension 21 of the connecting nut 20.

In operation of the present invention the liner hanger 14 is assembled as shown in Fig. 1 of the drawing preparatory to being lowered into the wall. At this time the connecting nut 20 is screwed firmly into the threaded end of the body member 34 with the tapered faces 37 and 38 of the body member and the compression ring being set up firmly against each other by the releasing nut 31 being tightened on the threads 30 formed on the extension 21 of the connecting nut 20. The hanger structure is then fastened to the supporting string of pipe 15 and is lowered into the wall. During the lowering operation the bow springs 32 will be compressed while in frictional engagement with the side walls of the casing 10. When the tool has reached a level at which it is desired to set the slips the string of pipe 15 may be rotated clockwise. This will rotate the entire hanger structure with the exception of the releasing nut 31 which is held against rotation since the square mandrel 18 is extending through the square passageway 27 in the connecting nut 20, and the connecting nut is set up within the body member 34. As rotation of the drill string to the right continues while the releasing nut 31 is being held against rotation by the bow springs 32 the threaded portion 30 of the connecting nut 20 will be screwed out of the releasing nut 31. As this operation proceeds the helical springs 51 at the lower ends of the slips 45 will force the slips upwardly and outwardly. After the threaded portion 30 of the connecting nut 20 has been screwed out of the releasing nut 31 the connecting nut 20 and the supporting string may be detached from the body portion 34 which is now held in a set position by the slips 45. This detaching action is accomplished by rotating the supporting string and the connecting nut 20 in a right-hand direction. This will act to unscrew the connecting nut 20 from within the body member 34 and allow the connecting nut 20 to move upwardly on the square mandrel 18 until the connecting nut 20 has been completely unscrewed from the left-hand threads 36 within the body member 34. The supporting string 15 may then be removed and as it is lifted the mandrel nut 28 will engage the lower end of the connecting nut 20 to remove the connecting nut 20, the releasing nut 31, and the bow spring structure 32.

It will thus be seen that the liner hanger here disclosed is compact and rugged in construction, simple in operation, and may be easily actuated to optionally set the tool at any level in the well and to thereafter optionally release the supporting string from the tool so that it will remain in a set position.

5

While I have shown the preferred form of my invention as now known to me, it will be understood that various changes may be made in combination, construction and arrangement of parts by those skilled in the art, without departing from the spirit of the invention as claimed.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. A liner hanger or the like comprising a cylindrical body member having a central bore therethrough, means at the lower end of said bore for attaching to said member an article to be supported by said member, a coarse female screw thread formed in the upper end of the bore through said body member, a male-threaded connecting nut screwed into said female thread and being formed with a shoulder abutting against the upper end of said body member, a plurality of wickered retractable slips mounted around the outer circumference of said body member, spring members tending to urge said slips to their gripping positions, an upper cylindrical extension formed as a part of said connecting nut, a compression ring removably mounted on said cylindrical extension and freely rotatable around the axis thereof, means carried by said compression ring for engaging said slips to urge the slips to their retracted positions, said engaging means interlocking with said body member to hold the said compression ring against rotation relative to said body while permitting the connecting nut to rotate therein, a relatively fine male thread provided on the outer surface of said cylindrical extension above said compression ring, said fine male thread being pitched oppositely from said coarse female thread aforesaid, a releasing nut screwed onto said last named male thread against said compression ring to force the compression ring toward a slip retracting position, friction means carried by the releasing nut to engage the interior wall of a casing into which the structure is lowered to hold the releasing nut against rotation relative to the connecting nut, and a square tubular mandrel extending downwardly through a square passageway in the connecting nut and movable longitudinally with relation thereto said mandrel carrying a mandrel nut for supporting said connecting nut, said mandrel engaging the square passageway in said connecting nut to impart positive rotation to said connecting nut.

2. A liner hanger or the like comprising a cylindrical body member having a central bore therethrough, means at the lower end thereof for

6

attaching to said member a liner to be supported thereby, the upper end of said bore being formed with a coarse internal left-hand thread, the outer circumference of said body member being formed with a plurality of longitudinally tapered guideways extending upwardly and outwardly along the sides of said body member, wickered slips, one slidably mounted within each of said guideways, spring members interposed between the lower ends of said slips and the lower end faces of said guideways tending to urge the slips upwardly and outwardly along said guideways, longitudinal grooves in said body member, one of said grooves extending upwardly from each of said guideways and being open at the upper end of said body member, a connecting nut screwed into said upper threaded portion of the body member and being formed with a shoulder to limit downward movement of the nut with the body member, said nut having an externally threaded upper cylindrical extension, a compression ring slidably mounted upon said upper cylindrical extension and being formed with fingers fitted within said longitudinal grooves and movable therealong to engage the upper ends of the slips and to force said slips toward their retracted positions against the action of said springs, a releasing nut screwed onto the upper extension of said connecting nut with a right-hand thread and tending to hold the compression ring in a seated position upon said connecting nut, a plurality of bow springs secured by their lower ends to the releasing nut and extending upwardly to frictionally engage a well casing into which the structure is lowered, a ring member carrying the upper ends of said bow springs, and a mandrel extending downwardly through the ring member, the releasing nut and the connecting nut, said mandrel being longitudinally movable relative thereto and being in splined engagement with the connecting nut, the lower end of said mandrel carrying a retaining nut by which said connecting nut is supported on said mandrel.

ERWIN BURNS.

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