

Dec. 28, 1943.

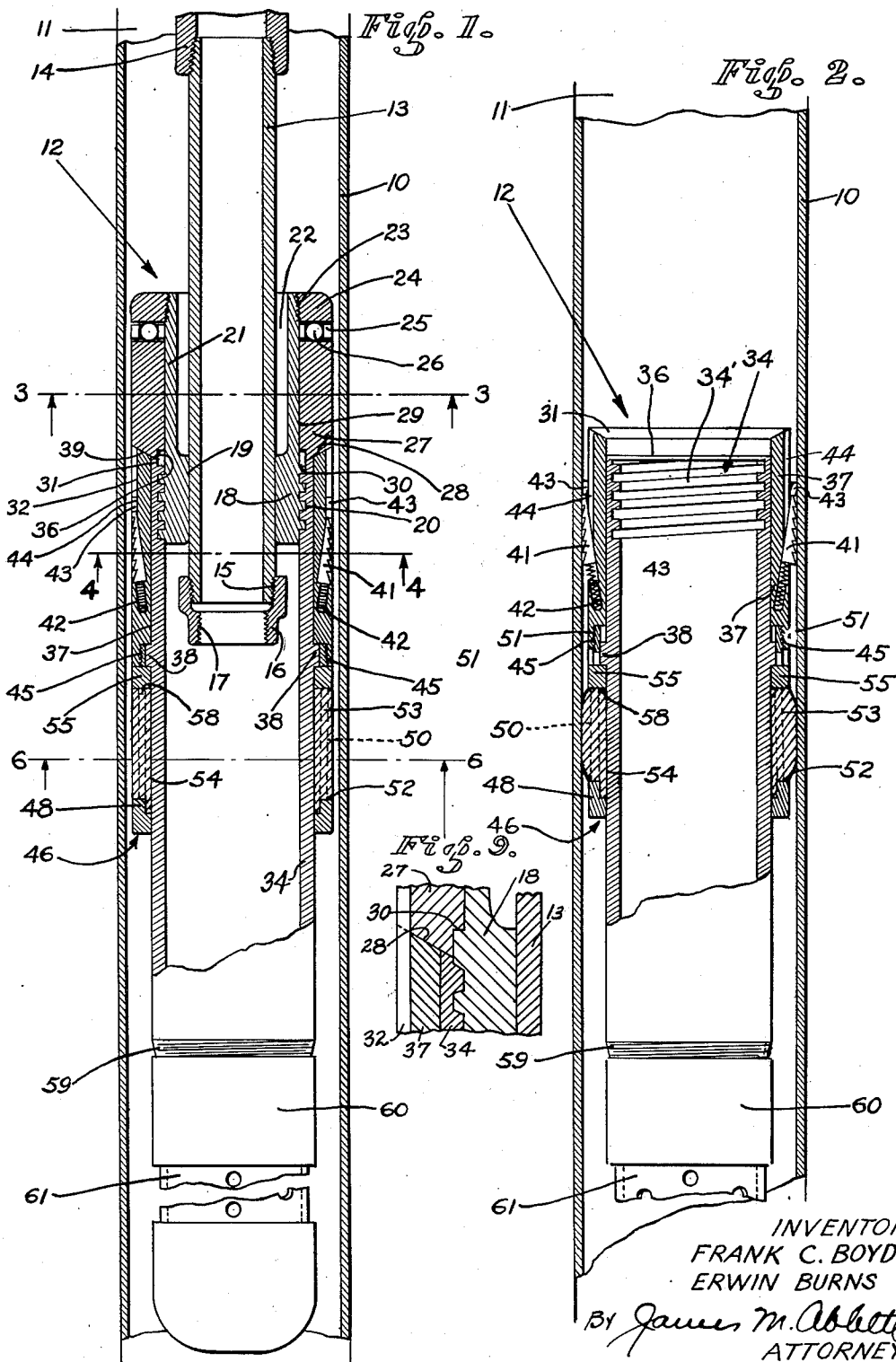
E. BURNS ET AL

2,337,733

LINER HANGER

Filed Oct. 22, 1940

2 Sheets-Sheet 1



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Fig. 3

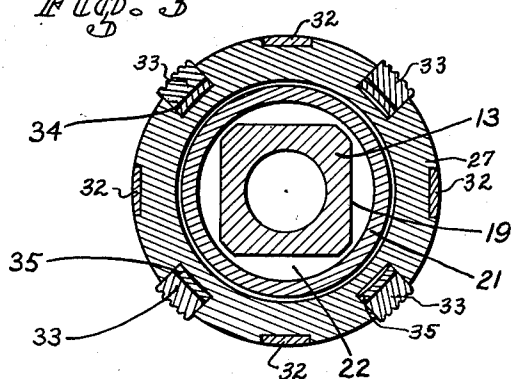


Fig. 4

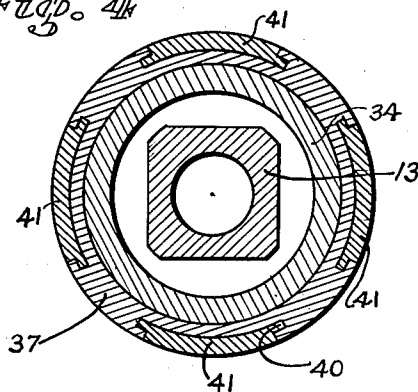


Fig. 5

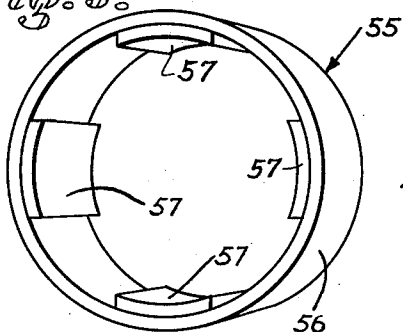


Fig. 6

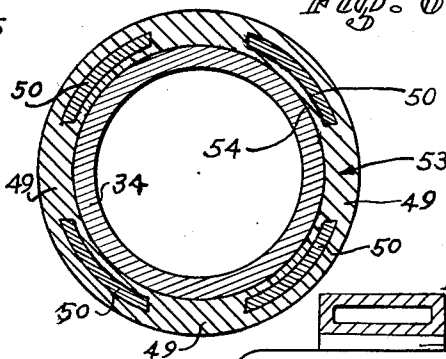


Fig. 7

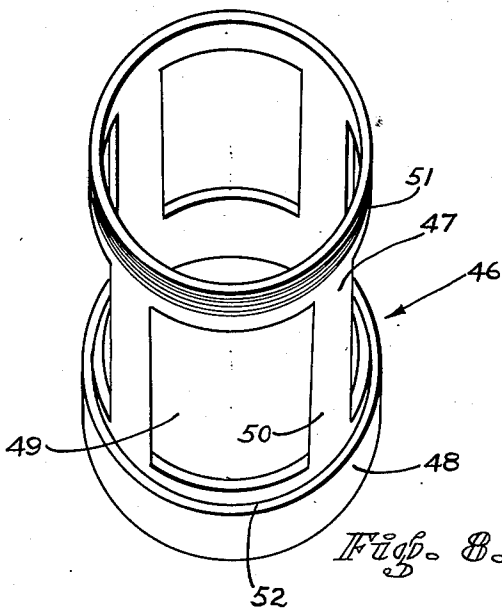
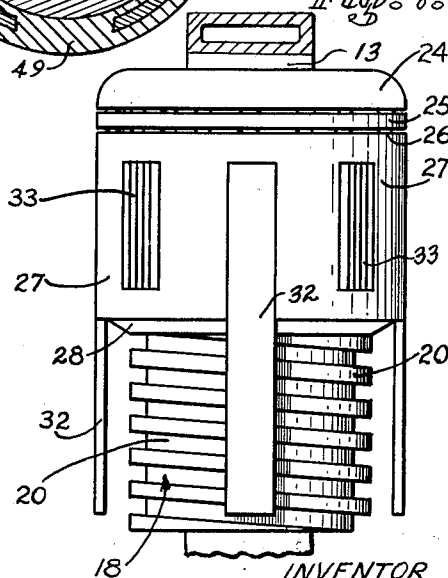


Fig. 8

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2,337,733

LINER HANGER

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Application October 22, 1940, Serial No. 362,198

9 Claims. (Cl. 166—12)

This invention relates to oil well production tools and particularly pertains to tools for setting pipe, tubing or casing within a cased well bore, and commonly known as a liner hanger.

In the practice of completing oil wells it is customary to suspend a liner within the casing. This liner consists of a length of perforated pipe supported at its upper end in the lower end of the casing by means of a device commonly known as a liner hanger. The length of perforated pipe extends below the casing and into the uncased well bore. In present day practice it is also common practice to employ a type of liner commonly known as the "pre-gravel packed" liner. This type of liner is delicate in construction and will not withstand the severe handling to which ordinary liners are subjected such particularly as rotation of the liner in contact with the well formation. It is, therefore, desirable to provide a liner hanger which is simple in its construction, positive in operation, and may be easily manipulated to set the slips in holding position with a minimum of manipulation or movement of the liner and without any rotation thereof. It is the object of the present invention, therefore, to provide a liner hanger by which a liner may be readily lowered into a well bore in a simple and effective manner and in the operation of which the liner may be supported without necessity of rotation while the slips of the hanger are set and without imposing any weight on the setting tool or the liner.

It is a further object of the present invention to provide a liner hanger carrying a packing element which cannot be accidentally disturbed or distended until the tool which is used to set the liner hanger has been released and the weight of the liner is imposed directly upon the slips of the hanger.

Additional objects and features of this invention will be disclosed as the description of the invention is made.

The present invention contemplates the provision of a setting tool having a barrel, a removable stem associated therewith, slips carried by the barrel and normally held in retracted positions but capable of being released by manipulation of the stem to set against the casing, and a deformable packer carried by the barrel and adapted to be distended into a sealing position when the weight of the liner is imposed upon the structure after the slips have set.

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

Figure 1 is an enlarged view in longitudinal

section showing the liner hanger in its original position before setting.

Fig. 2 is a view similar to Fig. 1 in section and elevation showing the liner hanger set and the packing element distended to its packing position.

Fig. 3 is a view in transverse section through the liner hanger as seen on the line 3—3 of Fig. 1.

Fig. 4 is a view in transverse section showing the liner hanger as seen on the line 4—4 of Fig. 1 and disclosing the slip mounting.

Fig. 5 is an isometric view showing the packing actuating ring.

Fig. 6 is a view in transverse section through the packing disclosing it and the packing cage.

Fig. 7 is a fragmentary view in elevation showing the head of the setting tool.

Fig. 8 is an isometric view showing the packing cage.

Fig. 9 is an enlarged fragmentary view in vertical section showing details of the structure.

Referring more particularly to the drawings, it is to be pointed out that certain parts and features of the present invention have been shown and described in an application for U. S. Letters Patent entitled "Liner hanger," filed April 25, 1939, in the name of Frank C. Boyd, Erwin Burns, and Ford A. Pilgrim, and bearing Serial No. 269,884, now Patent #2,228,503, granted January 14, 1941.

Referring particularly to Figs. 1 and 2 of the drawings, 10 indicates a well casing which is set within a well bore 11 and within which a liner hanger 12 is mounted, the liner hanger including a square mandrel or stem 13 which is threaded into the lower end of a drill pipe joint 14. This stem is of square cross section and has a lower threaded end 15 which receives a nut 16. The nut 16 is internally threaded at 17 and may receive the threaded end of a length of tubing through which circulation of fluid or cement may be forced downwardly into the liner. The square stem 13 extends through a liner nut 18 of the setting tool. This nut has a central bore therethrough of square cross section, as indicated at 19, through which the stem 13 may slide while positively engaging the nut to impart rotation thereto. The exterior surface of the lower cylindrical portion of the liner nut is formed with threads 20. These threads are square left-hand threads. The upper length of the nut is cylindrical, as indicated at 21, and has a cylindrical counterbore 22 above the squared stem opening 19. This cylindrical portion is exteriorly thread-

ed at 23 to receive an annular bearing nut 24. The bearing nut has a lower shoulder forming a ball race 25 which rests upon an anti-friction bearing 26, here shown as being of the ball bearing type. The anti-friction bearing 26 rests upon the upper end face of a sleeve 27 of the setting tool. This sleeve is cylindrical and is formed at its lower end with a frustoconical face 28. A cylindrical bore 29 is formed in the sleeve and the sleeve has a running fit with the upper cylindrical portion 21 of the nut 18. The lower end of this bore is counterbored and forms a square shoulder 30 which rests against a shoulder 31 at the upper end of the threaded section 20 of the nut 18. This restrains the sleeve 27 from longitudinal movement upon the extension 21 of the nut 18. Extending downwardly from the sleeve 27 are a plurality of separate slip engaging fingers 32 which are mounted on the outer circumference of the sleeve 27 and overhang the screw portion 20 of the nut 18, as shown in Fig. 7 of the drawings. Four of these fingers are here shown and their purpose in the structure will be hereinafter described.

Mounted in the outer circumferential face of the sleeve 27 and spaced between the fingers 32 are a plurality of radially yieldable dogs 33 which are shown in Fig. 3 of the drawings as being disposed in recesses 33'. In the rear of each of these dogs is a spring 35 which acts to yieldably urge the dogs to their outermost position. The outer faces of the dogs are formed with longitudinal serrations so that they may frictionally engage the surface of the casing 10 and prevent rotation of the sleeve 27, as will be hereinafter described.

The liner hanger includes a tubular body 34 which is internally threaded at its upper end as indicated at 34', the threads being complementary to threads 20 on the nut 18. The upper end of the body 34 is formed with an internally and downwardly tapered seat 36 which is complementary to the end face 28 of the sleeve 27. Slidably mounted upon the tubular body member 34 is a slip barrel 37 which fits over the body member 34 and rests against the upper face of an annular shoulder 38 formed around the body member 34 at a point intermediate its length. The upper face of the shoulder 38 provides a rest for the slip barrel 37 and holds the upper tapered end face 39 of the slip barrel in oblique alignment with the end face 36 of the body member 34. Formed within the cylindrical outer face of the slip barrel body 37 are guideways 40 which receive wickered slips 41. These slips are designed to move upwardly and outwardly in the guideways 40 as urged by a plurality of springs 42 mounted at the heel of the slips. The upper end of each slip is formed with a finger 43 which extends along a longitudinal slot 44 and into which slot the fingers 32 of the sleeve 27 extends. The fingers 32 and 43 are in longitudinal alignment therefor and when the sleeve 27 is in its lowermost position force the slips downwardly and hold them retracted so that they will not grip the wall of the casing 10 until released.

The lower end of the slip barrel 37 is internally threaded as indicated at 45. This receives the upper threaded end of a packer cage 46. This cage is shown particularly in Fig. 8 of the drawings, where it will be seen to have a substantially cylindrical body portion 47, at the lower end of which an enlarged collar 48 occurs. The body portion 47 is cut away at intervals in its circumference as indicated at 49, and has longitudinal

wall portions 50 between the cutaway portions. The upper end of the cylindrical portion 49 is threaded, as indicated at 51, and is threaded into the threaded bore 45 of the slip barrel 37. It will be seen that due to the fact that the enlarged lower collar 48 is of a diameter somewhat greater than the diameter of the cylindrical body 47 a square shoulder 52 will be formed in a plane at right angles to the longitudinal axis of the packer cage. Cast around the portions 50 of the cage and filling the openings 49 is a sleeve type packer 53. This packer may be of any desired design or construction and any suitable deformable material, such for example as lead or rubber. By reference to Fig. 6 it will be seen that the packer sleeve is cylindrical and of an outside diameter agreeing with that of the enlarged collar 48 on the cage. The inside diameter of the packer sleeve, indicated at 54, fits snugly around the circumferential face of the packer body 34, as clearly shown in Figs. 1 and 6. The length of the packer is such as to insure space for a packer actuating ring 55. The actuating ring 55 is shown in detail in Fig. 5 of the drawings. Here it will be seen to comprise an annular wall section 56. The outer diameter of this section agrees with the normal outside diameter of the packer sleeve and the outside diameter of the slip barrel 37. Arcuate lugs 57 extend inwardly from the annular portion 56 of the ring and are spaced at equal intervals therearound. These lugs fit into the upper ends of the slotted openings 49 in the packer cage, it being understood that the packer sleeve 53 is of a length shorter than the upper edges of the openings 49 sufficient to permit the lugs 57 to assume a position in the ends of the openings 49 and resting against the upper end face of the packer sleeve 53. Attention is directed to the fact, as shown in Fig. 1 of the drawings, that the inside diameter of the ring 55, as indicated at 58, is less than the outside diameter of the shoulder 38 on the liner hanger body 34 so that the shoulder 38 will rest against the ring 55 for a purpose to be hereinafter described.

The lower end of the body 34 extends downwardly below the cage 46 a desired distance and is externally threaded at 59 to receive a coupling collar 60 into which is threaded the upper end of a perforated liner 61. Before use the structure is assembled as shown in the drawings by placing the packer cage (reference #46) on the body member 34 with the ring 55 disposed above the sleeve 53. It will be understood that when thus assembled the shoulder 38 will hang on the ring 55 and that the portions 57 of the ring 55 will protrude through the openings 49 in the packer cage 46. Thus the underface of the ring 55 will extend entirely across the upper face of the packing sleeve 53. The slip barrel 37 is then attached to the top of the packer cage 46 by threading the portion 51 of the packer cage into the threaded section 45 of the barrel 37. When thus threaded the shoulder 38 of the body member 34 will limit the downward movement of the slip barrel 37. The liner nut 18 carrying the sleeve 27 is then threaded into position within the upper end of the body member 34 and by engagement of the threads 20 on the nut with the threads 34' of the body member. When the nut is tightened into position the tapered face 28 of the sleeve 27 will rest against the upwardly presented tapered faces 36 and 31 on the tubular body and slip barrel respectively. It will be understood that when this assembly operation

is made the sleeve 37 does not rotate since the fingers 32 extend into longitudinal recesses 44 in the slip barrel 37. While thus held the nut 18 is tightened and will move the fingers 32 downwardly to engage fingers 43 on the ends of the wickered slips 41. These slips will be held in their retracted positions so long as the nut is tightened to its seated position. Attention is directed to the fact that while the nut 18 is rotated as controlled by the mandrel 13, the tubular body 34 is stationary and produces an advantage to be more clearly set forth hereinafter. When the structure is assembled as directed, a perforate liner 61 is attached to the lower end of the tubular body 34 by a coupling collar 60. The structure is then ready to be lowered into the bore of an oil well and to be set with relation to the casing 10.

In operation of the present invention the liner hanger is assembled and set as shown in Fig. 1 of the drawings and is ready to be run into the well bore. It is to be pointed out that in the event the lower end of the packer cage 46 should strike an obstruction or meet resistance while being lowered into the casing that this will have no effect on the tool and the entire tool will remain in its set assembled position, since the packer cage 46 is directly connected to the slip body through the threaded connection 45, and the slip body in turn being held against longitudinal movement by bearing against the sleeve 27 which is held by the hanger nut 18. It will therefore be seen that no amount of end thrust on the lower end of the cage 46 will ever deform the packer sleeve 53. When the structure is lowered into the well it will be understood that the liner 61 is in place on the lower end of the liner hanger body 34. Due to the length of the stem 13 it is possible for the hanger to have considerable longitudinal movement on the stem so that the hanger and the liner may be manipulated sufficiently to facilitate the handling of the table slips or other means used at the surface level. When the liner has reached the desired point of setting in the well rotation of the drill pipe 14 to the right will impart similar rotation to the square stem 13 and will result in positive rotation of the hanger nut 18. The nut will then advance longitudinally upwardly. This movement will correspondingly move the sleeve 27 upwardly due to the abutting engagement of the shoulders 30 and 31. As previously explained, the sleeve 27 carries the fingers 32. These will move upwardly and away from their abutting engagement with the extension fingers 43 carried at the upper ends of the slips. This will permit the springs 42 to force the slips upwardly and outwardly into engagement with the inner face of the casing 10. Attention is also directed to the fact that during this operation the dogs 33 frictionally engage the inner face of the casing to prevent relative rotation of the liner and hanger. At this time the sleeve 27 is held against rotation due to the fact that the fingers 32 on the sleeve extend into longitudinal grooves 32' formed in the outer face of the slip barrel 37. When relative rotation takes place between the nut 18 and the sleeve 27 the anti-friction bearing 26 serves to reduce frictional resistance. When the slips 41 engage the wall of the casing with sufficient force to hold the hanger in position the weight of the liner is transmitted from the shoulder 38 of the body member 34 directly onto the actuating ring 55. Thus, this weight will be imposed by the ring 55 and its lugs 57

upon the packer sleeve 53 to deform the same and to force it outwardly to a sealing position, as shown in Fig. 4 of the drawings. Thus, the hanger with the liner suspended thereon will be set and sealed in position within the casing. After the sleeve 27 has been elevated to a point where the fingers 32 are retracted from the grooves 32' further rotation of the stem 13 will completely disengage the sleeve and nut from the hanger body 34 and will permit it to be removed from the well with the drill string 14.

From the foregoing description it will be seen that under no circumstances can the packer be set until the setting tool has been at least partially removed and that prior to such a time the packing elements will be held positively against any longitudinal movement.

Another feature of importance in the present invention is that the liner which is to be set does not rotate when the setting tool is manipulated. This is due to the fact that the dogs 33 which are carried by the sleeve 27 engage the innerface of the casing 10 and hold the sleeve against rotation. At the same time the fingers 32 act as external keys within the longitudinal grooves 44 of the slip barrel 37 and hold the slip barrel and packer against rotation. Since the tubular body member 34 which carries the liner 61 is supported entirely within the slip barrel and by the packer and its cage, the liner will not rotate even though the nut 18 is rotated in either direction. Thus the liner may be set at any point in the length of the well casing without its rotating or without the necessity that it shall rest upon the bottom of the well bore before setting may be effected.

The present design of liner setting tool does not require the use of special separate tools or the use of more than one string of pipe since the liner is directly carried on the liner setting tool and a tool is directly carried upon a single string of pipe. The invention also involves the novel feature of insuring that the slips are disposed above the packer and that they are directly actuated by the application of the weight of the liner to the deformable packing independently of the slips.

It will thus be seen that by the arrangement here disclosed it is possible to provide a liner hanger of the type shown in the aforementioned co-pending application for U. S. Letters Patent, Serial No. 269,884, now Pat. #2,228,503, with the additional advantages that the slips of the liner hanger when set carry the entire weight of the liner, and that in turn the weight of the liner then automatically expands the packer sleeve to form a seal, and that furthermore, obstructions encountered in lowering the tool into the well will have no effect to either set the slips or deform the packer.

While we have here shown the preferred form of our invention as now known to us, 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 our invention as claimed.

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

1. A liner hanger, comprising an elongated cylindrical body portion from which a liner may be suspended, a slip structure including a sleeve slidably mounted on said body portion and carrying a plurality of slips adapted to engage a circumscribing casing wall, an expansible packer

structure carried on said body and rigidly secured to said slip sleeve, means releasably holding the slips in their retracted positions and releasably holding said cylindrical body portion, and means between said packer and the cylindrical body whereby the weight of the liner will be imposed upon the packing structure to expand the same only when the slips and the cylindrical body have been released.

2. A liner hanger structure including an elongated tubular body member suspended in a well bore from its upper end and carrying a liner at its lower end, a slip barrel mounted upon said body member and carrying a plurality of slips, releasable means supporting the tubular body member and holding the slip barrel against relative movement with the body member and holding the slips in a retracted position, an expandible packer carried on the lower end of the slip barrel independent of and below the slips and slip actuating means and means between said tubular body member and the packer whereby when the slip barrel is released for relative longitudinal movement with relation to the body member and the slips are released so that the weight of the liner will be imposed upon the packer to set the same.

3. A liner hanger structure, comprising a supporting string of pipe, an elongated tubular hanger carrying a liner at its lower end, a detachable connection between the upper end of the supporting string and the liner hanger member, a slip barrel through which the liner hanger telescopes, said slip barrel carrying a plurality of slips normally held in their retracted position by said detachable connection, a packer structure through which the body member extends and which structure includes a rigid cage mounted upon the slip barrel, a deformable packer sleeve carried by the cage, and cooperating means between the body member and the deformable packer structure whereby when the detachable connection is released from the liner hanger the slips will be set and the packer will be expanded by having the weight of the liner imposed on said cooperating means.

4. A combined liner hanger and packer, comprising a suspending string of pipe, a tubular body member, detachable means disposed at the upper end of said body member and by which it is supported from the string of pipe, the lower end of said body member carrying a liner, a slip barrel through which the liner hanger extends, means limiting longitudinal movement of the barrel upon the body member in either direction, said detachable supporting means cooperating therewith to prevent longitudinal movement of the body and barrel in either direction when set, slips carried on the slip barrel to engage the wall of a casing through which the hanger extends, a rigid packer cage secured to the lower end of the slip barrel and carrying a deformable packer, a cooperating means between the body and the deformable packer whereby when the detachable supporting member is detached the slips are set, the hanger body move downwardly with relation to the slip barrel and impose the weight of the liner upon the upper end of the deformable packer to deform the same.

5. A combined liner hanger and packer comprising an elongated tubular body adapted to support a liner at its lower end, a tubular slip barrel through which the body extends and upon which it has limited longitudinal movement, said slip barrel carrying casing engaging slips mov-

able longitudinally of its outer face, stop means carried by the body for limiting downward movement of the barrel on the body, a rigid packer cage secured to the lower end of the barrel and through which the barrel extends, a deformable packer sleeve carried by the packer cage and downwardly against which the stop means of the hanger body bears, a support for the hanger, detachable means carried thereby for engaging the hanger body and temporarily cooperating with the stop means on the hanger body to hold the hanger body and the slip barrel against longitudinal movement with relation to each other, and means carried by the detachable means for holding the slips in retracted position until the releasing action of the detachable means is made by the supporting member and permits the slips to set, whereby the slip barrel will be fixed against rotation and the hanger body will be released to impose its weight and the weight of the liner upon the deformable packer sleeve to set the same.

6. A combined liner hanger and packer, comprising a tubular body member adapted to support a liner at its lower end, a rotatable threaded nut disposed at the upper end of the body member and detachably engaging the same, a supporting stem slidably mounted through said nut for longitudinal movement and positively engaging the nut for rotation therewith, the upper end of said stem engaging a supporting string of pipe, a slip barrel slidably mounted upon the body, cooperating means between the hanger body and the slip barrel for preventing downward movement of the slip barrel upon the hanger body while permitting downward movement of the hanger body with relation to the slip barrel, a packer structure rigidly supported upon the slip barrel, engaging means between the hanger body and the packer structure whereby downward movement of the hanger body as produced by the weight of the liner carried thereby will set the packer, slips mounted upon the slip barrel and urged toward a set position, and a sleeve carried upon the nut and movable therewith to releasably hold the hanger body and the slip barrel against relative longitudinal movement and the slips against setting movement, whereby when the nut and supporting means are manipulated to disengage the nut from the hanger body the slips will be released to set and the support of the hanger body will be released from the nut and sleeve and imposed upon the packer structure to set the same.

7. A combined liner hanger and packer, comprising a tubular body member adapted to support a liner at its lower end, a rotatable threaded nut disposed at the upper end of the body member and detachably engaging the same, a supporting stem slidably mounted through said nut for longitudinal movement and positively engaging the nut for rotation therewith, the upper end of said stem engaging a supporting string of pipe, a slip barrel slidably mounted upon the body, cooperating means between the hanger body and the slip barrel for preventing downward movement of the slip barrel upon the hanger body while permitting downward movement of the hanger body with relation to the slip barrel, a packer structure rigidly supported upon the slip barrel, engaging means between the hanger body and the packer structure whereby downward movement of the hanger body as produced by the weight of the liner carried thereby will set the packer, slips mounted upon the slip barrel

and urged toward a set position, a sleeve carried upon the nut and movable therewith to releasably hold the hanger body and the slip barrel against relative longitudinal movement and the slips against setting movement, whereby when the nut and supporting means are manipulated to disengage the nut from the hanger body the slips will be released to set and the support of the hanger body will be released from the nut and sleeve and imposed upon the packer structure to set the same, and an actuating ring included within the packer structure and through which the hanger body extends, said actuating ring engaging the hanger body and the packer to impose the weight of the hanger body and the liner upon the packer.

8. A packer assembly, comprising a tubular body member, a packer cage disposed therearound and being substantially cylindrical and tubular in shape and adapted to engage a supporting member at its upper end, the lower end of said cage being formed with a shoulder in a plane transversely of the longitudinal axis of the cage and extending outwardly therefrom, the wall of the cage being formed with a plurality of longitudinally extending and circumferentially arranged slotted openings, the central passageway through the cage being reduced in diameter at each end and agreeing substantially with the outside diameter of the body member, a deformable packer sleeve carried by the cage and being of a thickness as represented by the outside diameter of the shoulder on the cage to the inside diameter of the restricted passageway, whereby the longitudinal slots in the wall of the cage will be occupied by the sleeve and the cage wall portions occurring between said slots will be incorporated in the walls of the sleeve, and an actuating ring at the upper end of said cage having an

outside diameter agreeing with the outside diameter of the packer sleeve in its normal position, an inside diameter agreeing with the diameter of the body of the cage and carrying arcuate lugs which extend into the slots through the wall of the cage and conforming to a circle as represented by the inside diameter of the packing sleeve, said ring being engaged by the body member, whereby downward pressure upon the ring will act against the upper end of the sleeve to deform the same.

9. A combination liner, hanger and packer comprising a tubular body member at the lower end of which a liner is attached; a packer on said tubular body member, cooperating means between the tubular body member and the packer whereby the weight of the tubular body member and the liner will be imposed upon the packer to deform the same; a detachable supporting structure engaging the upper end of the tubular body member and from which the tubular body member may be disconnected by rotation; a slip barrel mounted on the tubular body member and carrying wickered slips adapted to engage a well casing and be anchored; a positive connection between said slip barrel and the packer structure and means carried by the detachable supporting structure and engaging the slip barrel for longitudinal movement relative thereto without rotation and whereby the wickered slips will be held in retracted positions when the detachable supporting means is in engagement with the body members, and means carried by said positive connection for engaging the well casing and preventing rotation of the positive connection, slip barrel, the packer and the tubular body member with relation to the casing.

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