March 17, 1959 E. BURNS 2,877,850

LINER HANGER AND PACKER

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Fig. 1.

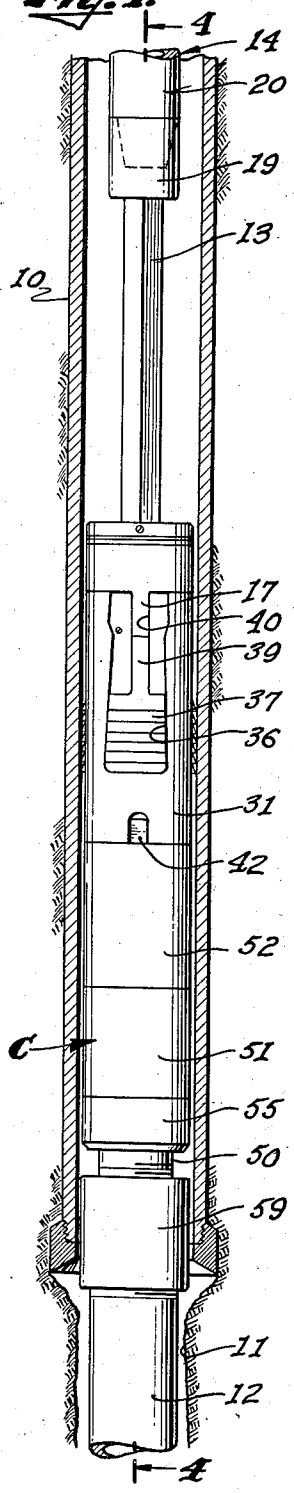


Fig. 2.

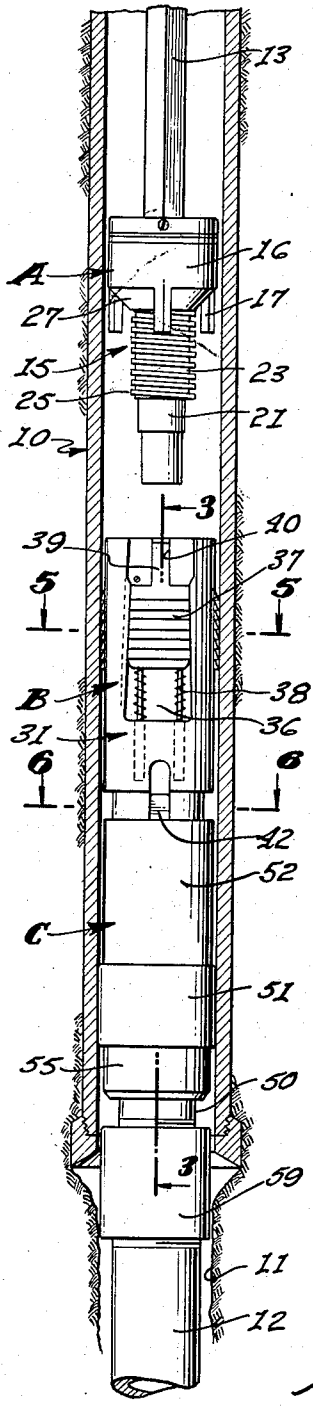
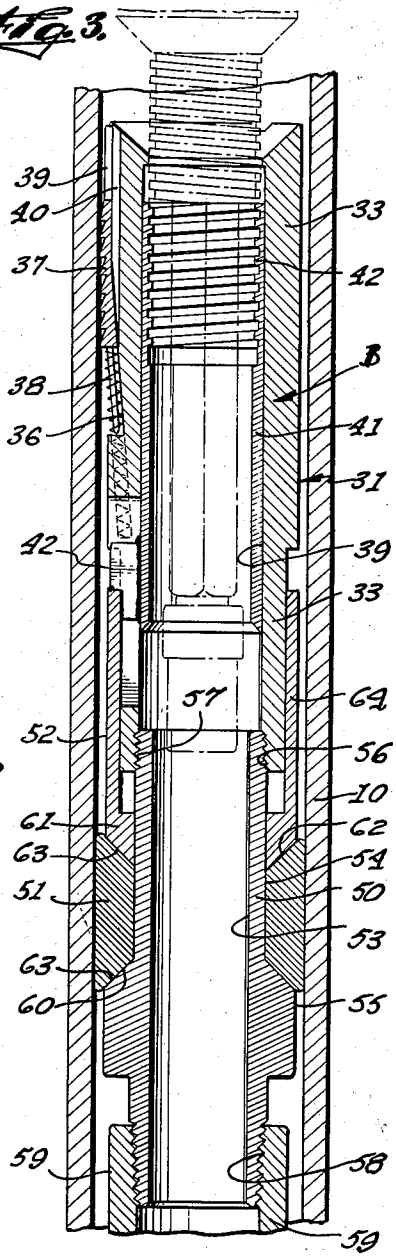


Fig. 3.



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Fig. 4.

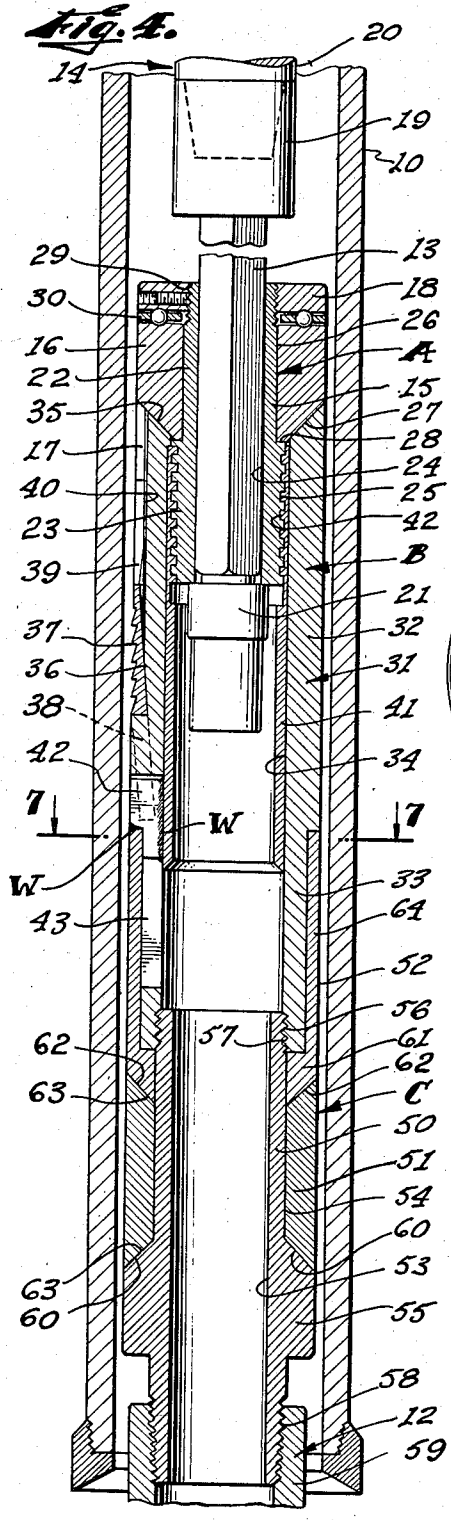


Fig. 5.

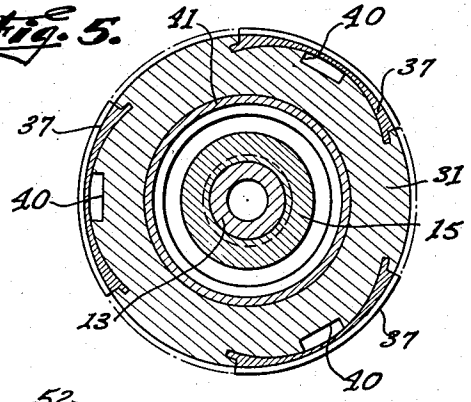


Fig. 6.

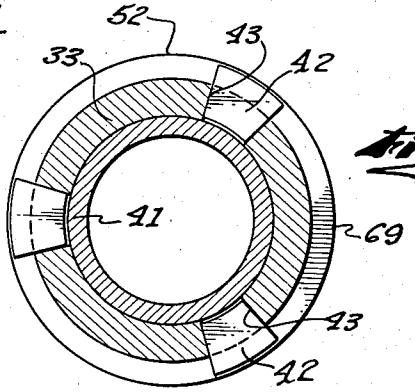
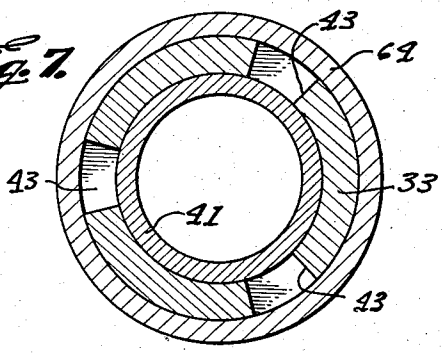


Fig. 7.



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LINER HANGER AND PACKER

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This invention is related to an oil well tool and is more particularly concerned with a liner hanger and packer construction, adapted to suspend a liner in a well casing and to seal off the annulus between the liner and the well casing in which the tool is engaged.

Heretofore, liner hanger constructions of the general character referred to, that is, liner hanger constructions which include packing means, have involved constructions which are both complicated and costly of construction and which have inherent weaknesses.

In the ordinary tool of the character referred to, the liner is related to and suspended from an element of the packing means, which element is generally a thin-walled, apertured, cage-like part in and about which elements and/or parts of the packing means are arranged. Due to the thin and light construction of these cage-like parts, they are subject to becoming damaged easily and thereby rendering the entire tool with which they are related, inoperative.

Further, in the ordinary tool of the character referred to, the liner is related to the packing means in such a manner that when the hanger mechanism is set, and the setting tool which is employed to orient and set the hanger in the well casing, is disengaged from the construction, the weight of the liner is exerted upon or through the packing means in such a manner as to actuate the packing means and in such a manner that the liner is, in effect, supported and carried by the packing.

Still further, in the ordinary packing means for tools of the character herein referred to, the supporting and actuating elements thereof are so arranged as to occupy a considerable amount of space radially of the constructions and thereby materially limit the quantity of deformable packing material that can be employed.

It is an object of the present invention to provide an improved liner hanger construction including a deformable packing means, which construction involves but a few sturdy and easy to manufacture parts, and a construction which is both easy and economical of manufacture.

A further object of my invention is to provide a construction of the general character referred to wherein the liner is coupled directly to the hanger construction by a sturdy, easy to make, imperforate element or part of the packing means and is such that it is not subject to becoming damaged and rendered inoperative in normal use.

A further object of my invention is to provide a packing means which is operated independently of the hanger and which is in no way effected by the weight of the liner related thereto.

Still another object of the present invention is to provide an actuating means for the packing which is spaced above the packing and which in no way restricts the quantity of packing material that can be employed.

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 my invention, throughout which description reference is made to the accompanying drawings, in which:

Fig. 1 is an elevational view of the well tool provided by the present invention and showing it engaged in a well structure in an unactuated position.

Fig. 2 is a view similar to Fig. 1 and showing the tool in an actuated or set position in the well structure.

Fig. 3 is a longitudinal sectional view taken as indicated by line 3—3 on Fig. 2, and showing the construction in an actuated position.

Fig. 4 is a longitudinal sectional view taken as indicated by line 4—4 on Fig. 1 and showing the construction in an unactuated position.

Fig. 5 is a transverse sectional view taken as indicated by line 5—5 on Fig. 2.

Fig. 6 is a transverse sectional view taken as indicated by line 6—6 on Fig. 2.

Fig. 7 is a transverse sectional view taken as indicated by line 7—7 on Fig. 4.

The well tool that I provide is adapted to be engaged in a casing 10 in a well bore 11 to suspend a liner 12 therein and to pack off the annulus between the tool and the casing in which it is engaged. The tool is shown as an elongate assemblage and involves generally, a setting tool A, a liner hanger B releasably carried by the setting tool, and a packer C related to the hanger and carrying the liner 12.

The setting tool A that I provide includes a mandrel 13 adapted to be engaged with the lower end of a run-in string of tubing 14, an elongate coupler 15 carried by the mandrel and adapted to releasably engage the hanger B, a sleeve 16 rotatably carried by the coupler and carrying a plurality of slip-engaging fingers 17, and a bearing nut 18 on the coupler and retaining the sleeve.

The mandrel 13 is an elongate vertically disposed member, polygonal in cross-section and is provided at its upper end with an internally threaded enlargement 19 which receives the male member of a drill pipe joint 20 at the lower end of the run-in string 14. The lower end of the mandrel is threaded to receive a suitable stop nut 21.

The coupler 15 carried by the mandrel 13 is an elongate member having upper and lower portions 22 and 23 and a central, longitudinally disposed, polygonal opening 24 through which the mandrel 13 is engaged for free longitudinal movement and for positive rotational drive. The exterior surface of the lower portion 23 of the coupler is formed with left-hand square threads 25. The upper portion 22 of the coupler is of reduced diameter with respect to the lower portion 23 and has a straight, cylindrical outer wall 26, adapted to rotatably carry the sleeve 16.

The coupler 13 is free to shift longitudinally relative to the mandrel 13 and is retained from displacement on the mandrel by the enlargement 19 and the stop nut 21 at the upper and lower ends of the mandrel.

The sleeve 16 is an elongate cylindrical member and is formed at its lower end with a frusto-conical face 27. The sleeve 16 is engaged about the upper portion 22 of the coupler to have a running fit therewith and so that its lower terminal end engages and rests on the shoulder 28 established on the coupler where the upper section 22 joins with the lower section 23.

The bearing nut 18 is a simple, internally threaded annular part, screw-threaded on an externally threaded extension 29 at the upper terminal end of the coupler, and projects radially outwardly from the coupler to overlie the top of the sleeve 16, to maintain the sleeve engaged on the coupler. In practice, a suitable anti-friction ball bearing 30 is engaged between the bearing nut and the sleeve to assure free relative rotation therebetween.

The slip engaging fingers 17 carried by the sleeve of the setting tool A are simple, straight vertically disposed members secured to the sleeve about its outer periphery in spaced relationship to each other and de-

pend from the sleeve to overlie or occur in spaced parallel relationship with the lower screw portion 23 of the coupler 15. The fingers 17 are adapted to cooperate with longitudinally shiftable slips of the hanger construction in a manner that will hereinafter be described.

The hanger B that I provide and which is releasably carried by the setting tool A is shown as including a tubular body 31 having upper and lower portions 32 and 33 and an elongate cylindrical bore 34.

The top of the upper portion 32 of the body is provided with a downwardly tapered annular seat 35 which is complementary to the bottom face 27 of the sleeve 16 of the setting tool A. The body is further provided with a plurality of circumferentially spaced tapered guideways 36 formed in its outer wall which guideways slidably receive wickered casing engaging slips 37. The slips 37 are adapted to be urged upwardly and outwardly in the tapered guideways 36 by a plurality of springs 38 mounted at the heel of the slips.

The upper end of each slip 37 is provided with an upwardly projecting finger 39 which enters and extends along a longitudinal slot 40 in the outer wall of the body and into which the fingers 17 of the setting tool extend. The fingers 39 and 17 are in longitudinal alignment with the result that when the sleeve 16 of the setting tool is seated on the upper end of the body 31, the fingers 17 extend into the slots 40 to engage the fingers 39 engaged therein and force the slips 37 downwardly in the guideways 36 and hold them retracted so that they will not grip the wall of the casing 10 until released.

Slidably engaged within the bore 34 of the body 31 is an actuating sleeve 41. The sleeve 41 is internally threaded at its upper end, as indicated at 42, to receive the threads on the lower portion 23 of the coupler 15 of the setting tool A. The actuating sleeve 41 is keyed against rotation and against longitudinal displacement from the body 31 by a plurality of circumferentially spaced, radially outwardly projecting lugs 42 at its lower end portion, which lugs project through elongate vertically disposed and circumferentially spaced slots 43 in the body.

The slots 43 in the body 31 of the hanger B are formed as by cutting or milling and establish open communication between the interior and the exterior of the body. The lugs 42 on the actuating sleeve 41 are shown as simple, block-like elements and are fixed to the outer wall of the sleeve as by welding W and are of sufficient radial extent so that they terminate substantially flush with the exterior of the upper or top portion of the body.

The upper ends of the slots 42 terminate in the body 31 at a point spaced from the upper end of the body so that when the upper terminal end of the actuating sleeve 41 occurs adjacent the inner peripheral edge of the tapered seat 35 at the upper end of the body, the lugs 42 on the sleeve engage and seat in the upper ends of the slots. With this relationship of parts, it will be apparent that the sleeve is positively held against displacement from the body and that when the coupler 15 of the setting tool A is engaged therein, the sleeve supports and carries the body 31 and the other parts of the tool construction carried by the body.

The actuating sleeve 41 is operatively related or coupled to the packing means C and is adapted to be shifted downwardly relative to the body 31 in which it is engaged, to actuate the packing means in a manner that will hereinafter be described.

The packing means C of the tool provided by the present invention is shown as including, a barrel 50 threadedly engaged in the lower terminal end of the hanger body 31 to depend therefrom, an annular body of deformable packing material 51 carried by the barrel about the exterior thereof and a sleeve-like follower 52 slidably carried by the barrel and the body.

The follower 52 is operatively connected with the actuating sleeve 41 in the body 31 of the hanger and is adapted to be shifted longitudinally of the barrel 50 and the body of packing material 51 to urge the said body of packing material radially outward and into sealing engagement with the inner wall of the well casing 10 in which the tool is engaged.

The barrel 50 of the packer is an elongate vertically disposed tubular member having a central longitudinal bore 53, a cylindrical outer wall 54 and a radially outwardly projecting flange-like enlargement 55 at a point spaced intermediate its ends.

The upper terminal end of the barrel is externally threaded as at 56 and is engaged in complimentary threads 57 provided at the lower end of the bore 34 in the hanger body 31. The lower terminal end of the barrel is externally threaded as at 58 and is threadedly engaged in a suitable pipe joint 59 provided at the upper end of the liner 12. With the above relationship of parts it will be apparent that the barrel 50 is rigidly coupled to the hanger body 31 and the liner 12 is in turn rigidly coupled to the packer barrel, with the end result that the hanger body, packer barrel and liner establish a rigid assembly.

The flange-like enlargement 55 on the packer barrel 50 is spaced a substantial distance below the lower end of the body 31 of the hanger and is provided with an upwardly and radially inwardly inclined top face 60.

The follower 52 of the packing means C is shown as including an annular body portion 61 slidably engaged on the packer barrel 50 and having a downwardly and radially inwardly inclined bottom face 62, opposing the top face 60 of the enlargement 55 on the barrel. The follower 52 is shown as further including an annular skirt 62 projecting upwardly from its outer periphery and slidably engaged around the lower portion 33 of the hanger body 31, which lower portion of the body is of slightly less diametric extent than the upper portion 34 thereof.

The body of packing material 51 is a simple annular body of lead or other suitable malleable material and is engaged around the barrel between the opposed faces 60 and 62 on the enlargement 55 of the barrel 50 and the follower 52. The ends of the body of the packing material are provided with radially inclined faces 63 adapted to cooperatively receive the faces 60 and 62 on the enlargement 55 and the follower 52 related thereto.

The upper end of the skirt 63 on the follower 52 is fixed to the outer ends of the lugs 42 on the actuating sleeve 41 as by welding W, with the result that the follower and the sleeve are rigidly fixed to each other to establish a unitary actuating means for the packing.

With the above relationship of parts, it will be apparent that when the sleeve 41 is urged downwardly in the body 31 of the hanger B, the follower 52, connected therewith, is urged downwardly towards the enlargement 55 on the barrel 50, of the means C, with the result that the body of packing material 51 between the enlargement 55 and the follower 52 is compressed and is forced to distend or flow radially outwardly into the tight sealing engagement with the well casing 10.

In operation, the tool provided by the present invention is assembled in the manner shown in Figs. 1 and 4 of the drawings, wherein the coupler 15 of the setting tool A is threaded into the actuating sleeve 41 in the hanger body 31 and so that the bottom face 27 of the sleeve 16 of the setting tool is seated on the inclined seat 35 of the body 31. When the sleeve of the setting tool is in its lowermost position, the fingers 17 carried thereby are registered with and project into the longitudinal slots 40 in the body 31 and engage the upper ends of the fingers 39 on the wickered slips 37 and hold the slips in their down or unactuated position in the recesses 36 and against the action of the springs 38.

The sleeve 16 of the setting tool A is held in its lowermost position by the coupler 15 which is screwed into the actuating sleeve 41 in the hanger body. When the

coupler 15 is fully threaded into the actuating sleeve 41 in the hanger body 31, and so that the sleeve 16 of the setting tool is seated with the body in the manner set forth above, the actuating sleeve 41 and the follower 52 of the packing means C related thereto, are held and maintained in their uppermost or unactuated position by the setting tool.

When it is desired to set the liner 12, the tool, with the liner, is lowered into the well casing 10 to the desired depth, after which the run-in string 14 and mandrel 13 are rotated a sufficient amount to unscrew and elevate the coupler 15 and the sleeve 16 of the setting tool A, to a point where the fingers 17 on the sleeve 16 are moved out of engagement with the slots 40 in the hanger body 31 and so as to allow the slips 37 to be urged upwardly and outwardly into engagement with the wall of the well casing 10 by the action of the springs 38, as clearly illustrated in Figs. 2 and 3 of the drawings.

After the hanger B is set in the manner set forth above, and the coupler 15 of the setting tool A is unscrewed and retracted from the actuating sleeve 41 a sufficient distance to allow for free relative shifting between the sleeve 16 of the setting tool and the hanger body 31, as indicated in phantom lines in Fig. 3 of the drawnigs, the weight of the run-in string 14 is placed onto the actuating sleeve 41, through the setting tool A, thereby forcing the actuating sleeve 41 and the packer follower 52, related thereto, downwardly relative to the hanger body 31 and the packer barrel 56, which have already been set in the well casing by the action of the wickered slips 37. Upon downward movement of the packer follower 52 in the manner set forth above, the annular body of packing material 51 is squeezed or distended radially outwardly to form a fluid tight seal with the well casing in the manner previously set forth above.

After the liner hanger B has been set and the packing 51 has been actuated into sealing engagement with the well casing 10, the setting tool A is completely unscrewed from the actuating sleeve 41 by further rotation of the run-in string 14 and the mandrel 13 of the setting tool, and the run-in string and the setting tool are withdrawn from engagement with the tool and thereafter from the well, as clearly illustrated in Fig. 2 of the drawings.

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 well tool of the character referred to including, a setting tool at the lower end of a run-in string of tubing, a liner hanger and packer releasably carried by the setting tool and including, an elongate vertically disposed tubular body having circumferentially spaced longitudinally disposed slots in its lower end portion, an elongate tubular barrel with a radially outwardly projecting enlargement fixed to and depending from the body, a liner fixed to and depending from the barrel, a plurality of circumferentially spaced vertically shiftable slips carried by the body and adapted to shift upwardly and outwardly relative to the body and engage a casing in which the tool is engaged, an annular body of deformable packing material around the barrel and engaging the top of the enlargement, a follower slidably carried by the barrel and engaging the top of said packing material and having an upwardly projecting annular skirt overlying the lower slotted portion of the body, an elongate actuating sleeve slidably engaged in the body, blocks on the sleeve to project through the slots in the body and fixed to the skirt on the follower, said setting tool including an elongate mandrel fixed to and depending from the run-in string, a coupler carried by the mandrel and threaded into the actuating sleeve, a sleeve carried by the coupler, and fingers depending from the sleeve and engaging the slips to hold them down in an unactuated position, said setting tool being operable to release the slips and to thereafter shift the actuating sleeve downwardly in the body and thereby shift the follower downwardly into pressure engagement with the packing material and thereby expand the material into sealing engagement with the casing.

2. A well tool of the character referred to including, a setting tool at the lower end of a run-in string of tubing, a liner hanger and packer releasably carried by the setting tool and including, an elongate vertically disposed body with a central longitudinally disposed bore and having circumferentially spaced longitudinally disposed slots in its lower end portion, an elongate cylindrical barrel with a radially outwardly projecting enlargement fixed to and depending from the body and, a liner fixed to and depending from the barrel, a plurality of circumferentially spaced wickered slips carried by the upper portion of the body at the exterior thereof, spring means normally yieldingly urging the slips upwardly and outwardly relative to the body, an annular body of deformable packing material around the barrel and engaging the top of the enlargement, a follower slidably carried by the barrel and engaging the top of said packing material and having an upwardly projecting annular skirt overlying the lower slotted portion of the body, an elongate actuating sleeve slidably engaged in the body, blocks on the sleeve to project through the slots in the body and fixed to the skirt on the follower, said setting tool including an elongate mandrel fixed to and depending from the lower end of the run-in string, a coupler carried by the mandrel and threaded into the actuating sleeve, a sleeve carried by the coupler, and fingers depending from the sleeve and engaging and holding the slips down against the resistance of the spring means in an unactuated position, said setting tool being operable upon rotation of the run-in string to release the slips to engage a casing in which the tool is engaged and to thereafter shift the actuating sleeve downwardly in the body by the application of the weight of the run-in string on the setting tool and thereby shift the follower downwardly into pressure engagement with the packing material and thereby expand the material into sealing engagement with the spring.

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