

April 17, 1945.

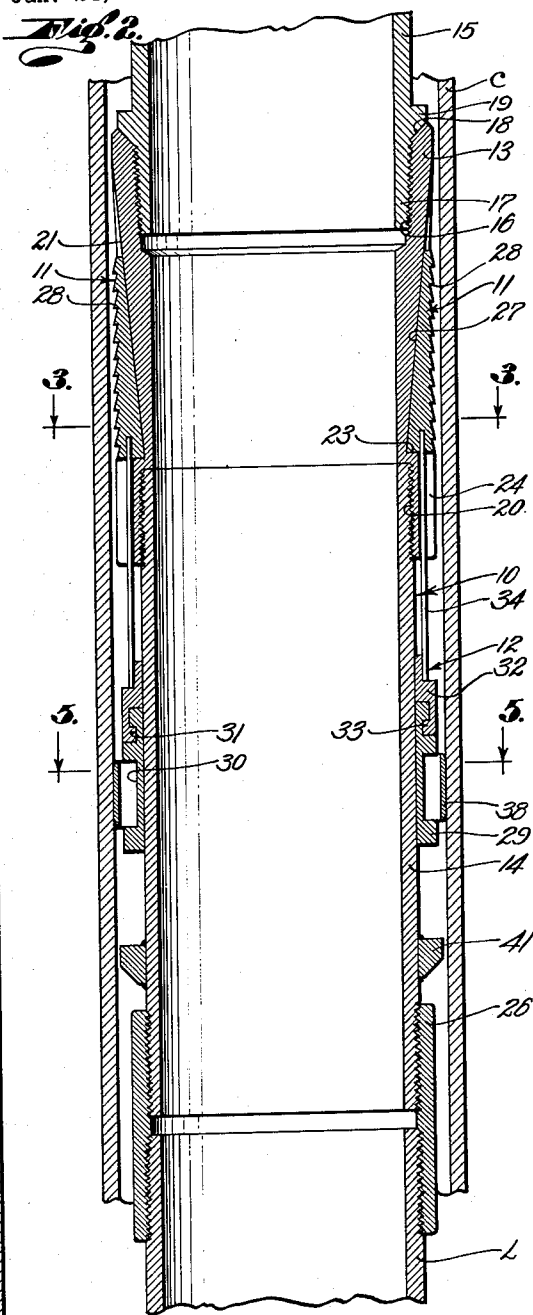
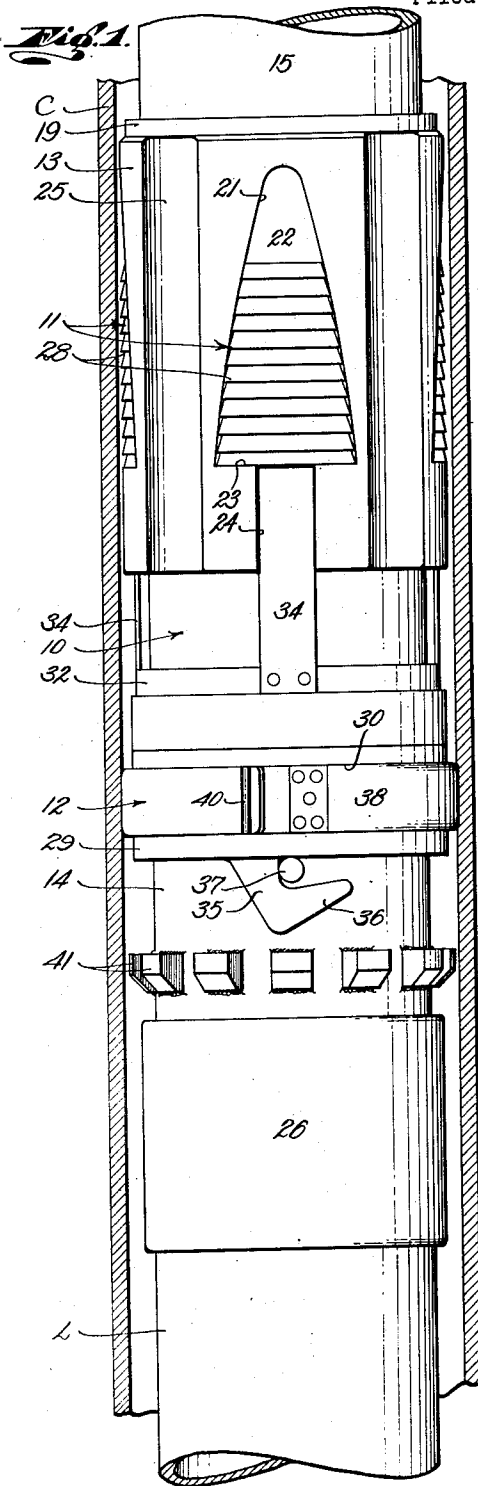
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2,373,880

LINER HANGER

Filed Jan. 24, 1942

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 3.

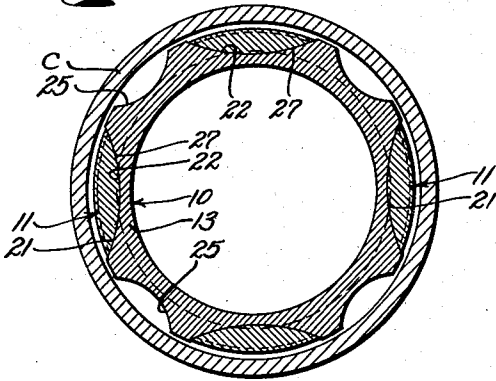


Fig. 4.

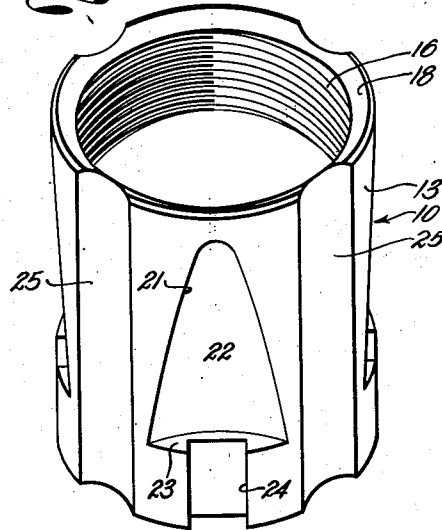


Fig. 5.

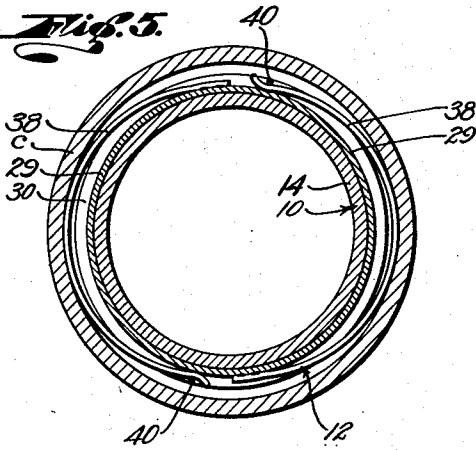


Fig. 6.

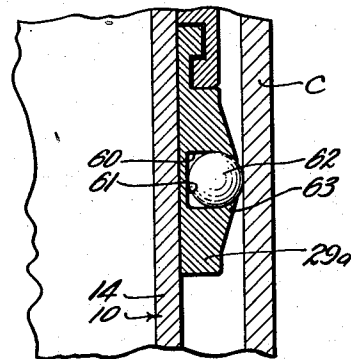
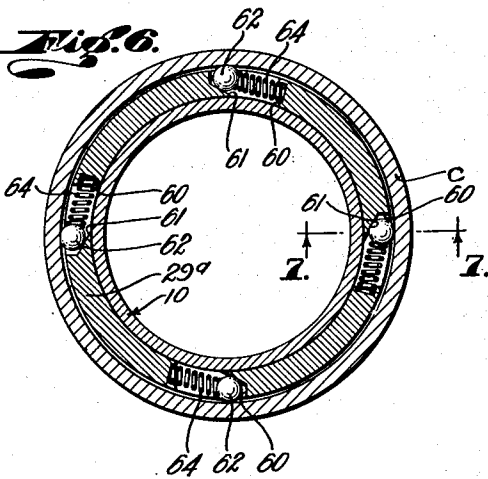


Fig. 7.

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LINER HANGER

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6 Claims. (Cl. 166—1)

This invention relates to well tools and relates more particularly to liner hangers for securing or suspending liners in wells, such as oil wells and gas wells. A general object of this invention is to provide a simple, practical and highly effective liner hanger.

Another object of this invention is to provide a liner hanger embodying a novel gripping means occupying a minimum peripheral or external area of the body and yet maintaining extensive and ample bearing contact with the hanger body in all operating positions. Liner hangers are usually equipped with slips which are operated or expanded by a conical surface of the body. The conical surface usually occupies all or the major portion of the body's circumference. Further, the conventional slips have full cooperation with the conical surface in only one operating position and in all other positions bear along their edges only. The gripping parts or slips of the present invention do not require the full conical body surface and have full bearing cooperation with their concave seats at all times in any position.

Another and important object of this invention is to provide a liner hanger in which the slips may be sufficiently thick and strong to withstand the hardest usage even though there is but very little clearance between the interior of the casing and the exterior of the tool body.

Another object of this invention is to provide a well tool such as a liner hanger embodying slips having cylindrical convex surfaces on both their inner and outer sides to be of maximum thickness where there is a minimum of clearance between the tool body and casing and to have full uniform bearing engagement with the cylindrical body surfaces or seats. In addition to the advantages already enumerated the formation of the slips with cylindrically curved convex surfaces on both their inner and outer faces allows a greater taper per foot than previously employed, thus providing for greater outward movement or expansion of the slips and preventing wedging and sticking of the slips when it becomes necessary to remove the tool from the well.

Another object of this invention is to provide a liner hanger of the character referred to in which the slips are housed in seats or recesses in the tool body to be protected against mud, fluid and projecting parts of the casing when the hanger is run into the well, thus facilitating the rapid lowering of the hanger and assuring the successful operation of the slips.

Another object of this invention is to provide a liner hanger in which the body may be of simple

inexpensive construction and the slip seats may be readily milled or cored in the body to receive the slips.

Another object of this invention is to provide a well tool, such as a liner hanger, embodying a novel effective and very compact means for releasing and resetting the slips or gripping means. The releasing and resetting means of the present invention is extremely short, materially reducing the over all length of the tool.

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

Fig. 1 is a side elevation of the liner hanger of this invention in the unactuated condition showing the well casing in longitudinal cross section. Fig. 2 is a longitudinal detailed sectional view of the liner hanger. Fig. 3 is a transverse detailed sectional view taken as indicated by line 3—3 on Fig. 2. Fig. 4 is a perspective view of the upper body section shown in Fig. 2, disconnected from the other parts and with the slips removed. Fig. 5 is a transverse detailed sectional view taken as indicated by line 5—5 on Fig. 2. Fig. 6 is a view similar to Fig. 5 illustrating another form of means for frictionally engaging the interior of the well casing and Fig. 7 is an enlarged fragmentary vertical detailed sectional view taken as indicated by line 7—7 on Fig. 6.

The features of the present invention may be embodied in tools varying considerably in design, proportions and application. In the drawings I have shown the invention embodied in a preferred form of liner hanger, it being understood that the invention is not to be construed as limited or restricted to the specific forms or applications of the invention herein disclosed but is to be taken as including any features or modifications that fall within the scope of the claims.

The liner hanger of the invention illustrated in Figs. 1 to 5, inclusive, may be said to comprise, generally, a tubular body 10 to be secured to a liner L or other object to be installed in the well, slips 11 carried by the body 10 for gripping the well casing C, and means 12 for controlling the slips 11.

The body 10 is an elongate tubular structure or assembly for carrying the other elements of the tool and is adapted to be secured to the liner L or other tool or object to be suspended in the well. In the plain circulating type of liner hanger the body 10 may comprise an upper sec-

tion 13 for carrying the slips 11 and a lower section 14 for carrying the means 12. The upper section 13 of the body 10 is of special design or construction and is best illustrated in Fig. 4. The upper end of the section 13 is formed for connection with the adaptor 15 of a setting tool, while the lower end of the section is constructed for connection with the lower section 14. A socket 16 is formed in the upper end of the section 13 and has either right hand or left hand threads for mating with corresponding threads on a pin 17 provided on the lower end of the adaptor 15. An outwardly and upwardly tapered surface 18 is provided on the section 13 at the upper end of its socket 16 to be engaged by a correspondingly tapered surface on a flange 19 formed on the adaptor 15. It is to be understood that the adaptor 15 forms the lower element of a releasable coupling device known in the art as a "setting tool" for releasably connecting a tubular setting string with the liner hanger. Such setting tools are well known in the art and the setting tool herein referred to is not an element of the present invention and does not require detailed description. In the construction illustrated, the lower end of the upper body section 13 has a threaded socket 20 for receiving the threaded upper end of the lower body section 10.

It is preferred to make the upper body section 13 of substantial wall thickness as shown, it being understood that the section 13 is provided with recesses or seats 21 for the slips 11. As illustrated, the exterior of the section 13 is cylindrical and there is a plurality of circumferentially spaced seats 21. In the particular case illustrated there are four equally spaced seats 21. In accordance with the invention the seats 21 have vertically or longitudinally extending cylindrically curved walls 22. The seat walls 22 are cylindrically concaved and are of uniform curvature throughout. The concave walls 22 slope or pitch, sloping downwardly and inwardly with respect to the central longitudinal axis of the tool. The seats 21 start adjacent the upper end of the upper body section 13 and because of the pitch of their walls 22 the seats widen as they extend downwardly. The slip seats 21 terminate in a plane spaced above the lower end of the section 13 and have horizontal upwardly facing lower walls 23. Flat walled grooves 24 are formed in the exterior of the body section 13 and extend downwardly from the lower ends of the seats 21 to the lower end of the section 13. The grooves 24 are centrally disposed with respect to the seats 21 and are considerably shallower than the lower portions of the seats. The grooves 24 receive elements of the slip controlling means, as will be later described.

In employing the liner hanger it may be desired to flush out or wash the lower portion of the well and the body section 13 may be constructed to allow for the upward flow or return flow of the flushing fluid. Vertical or longitudinal grooves 25 are shown in the exterior of the upper body section 13 to handle the return flushing fluid. The grooves 25 are spaced between the seats 21 and extend between the upper and lower ends of the upper body section 13. There is a plurality of spaced grooves 25 and the grooves may be of ample depth and capacity to carry the returning fluid. In the case illustrated, the grooves 25 have cylindrically concaved walls, it being understood that the grooves may have flat walls if desired.

The lower section 14 of the body 10 may be a simple tubular member whose upper end is di-

rectly threaded in the socket 20 of the section 13. A collar or coupling 26 may connect the lower end of the section 14 with the upper end of the liner L. The lower body section 14 may have the same internal diameter as the upper section 13 and the adaptor 15 and the section 14 may be of uniform external diameter. The external diameter of the lower section 14 may be considerably less than that of the upper section 13.

The slips 11 are operable to grip the well casing C to support or suspend the body 10 and the liner L, being expansible or movable outwardly through cooperation with their seats 21. The design or construction of the slip 11 is an important feature of the invention. The slips 11 are formed or shaped to move vertically or longitudinally in their seats 21 and to conform to and grip the internal surface of the casing C. Thus, in accordance with the invention the slips 11 have cylindrical convex inner surfaces 27 for conforming to and riding on the seat walls 22 and have cylindrical convex outer surfaces for cooperating with the internal surface of the cylindrical casing C. The convex cylindrical inner surfaces 27 of the slips 11 are formed to evenly bear and ride on the seat walls 22. Because the seat walls 22 and the inner slip surfaces 27 are cylindrical the surfaces 27 have full uniform and unbroken bearing engagement with the seat walls with the slips in any position. This is of great importance as it provides greater resistance to fracture and failure, gives a full distribution of force and friction and reduces the possibility of the slips becoming sanded up. The outer cylindrical surfaces of the slips 11 are roughened or toothed to grip the cylindrical concave internal wall of the well casing C. It is preferred to provide downwardly and outwardly sloping gripping teeth or wickers 28 for gripping the interior of the casing C. Teeth or wickers formed in this manner are effective in resisting and preventing downward movement relative to the casing C.

The gripping slips 11 provided with cylindrically curved convex surfaces on both their inner and outer sides may be of ample thickness even where there is a minimum of clearance between the exterior of the body 10 and the internal surface of the casing C. As seen in Fig. 3 the slips 11 are of a great thickness especially in their medial portions. The slips 11 fitting the cylindrically curved seats 21 are housed and protected when retracted so that their outer surfaces are in a circle of lesser diameter than the external surface of the body section 13 and the slips do not collect mud, do not contact the well casing or interfere with the running of the tool into the well. In this connection it should be noted that the tool has gripping parts spaced or spotted about its circumference so that there is less likelihood of catching or fouling on projections or slivers on the casing. The walls 22 of the seats 21 and the inner convex surfaces 27 of the slips 11 may be given a substantial pitch or taper to provide for a maximum outward movement or expansion of the slips. As illustrated in Fig. 2 of the drawings the longitudinal edges of the slips 11 curve or converge upwardly or inwardly. This formation results from the pitch of the inner slip surfaces 27 relative to the toothed external slip surfaces. The inner convex surfaces 27 of the slips 11 slope upwardly and outwardly to conform to the seat walls 22, giving the slips their required wedge configuration. The slips 11 are considerably shorter than the seats 21 so that they may have the required vertical move-

ment in the seats. The upper and lower ends of the slips 11 may be flat and horizontal. The lower ends of the slips 11 are adapted to rest or engage on the lower walls 23 of the seats 21 when the slips are in their fully retracted positions, shown in Fig. 2.

The means 12 normally or initially holds the slips 11 in the retracted positions so that the liner L may be run into the well and manipulated as required without interference by the slips, and the means 12 is releasable to allow actuation of the slips. It is a feature of the invention that the means 12 is small and compact so that the body 10 may be of minimum length. The means 12 is carried by the lower body section 14 and comprises a sleeve or ring 29 freely shiftable and turnable on the body section 14. The ring 29 has a wide annular external groove 30 and a narrow annular external groove 31 spaced above the groove 30. A rotatable or swivel connection is provided between the several slips 11 and the ring 29. This swivel connection includes a ring 32 surrounding the body section 14 above the ring 29. The ring 32 is freely turnable and shiftable on the body and has a lower portion overlapping or engaging around the ring 29. This lower portion of the ring 32 has an internal flange or ridge 33 which rotatably fits the groove 31. The engagement of the ridge 33 in the groove 31 connects the rings 29 and 32 for relative turning, that is, it permits free turning of the ring 32 with respect to the ring 29. The connection between the ring 29 and the slips 11 further includes links or reins 34 connecting the slips 11 with the swivel ring 32. The reins 34 have their upper ends fixed in the lower ends of the slips 11 and the lower ends of the reins are secured to the ring 32 as by riveting or the like. The reins 34 are flexible and resilient to allow free expansion and contraction of the slips and the reins pass through the grooves 24 with clearance. The slots or grooves 24 allow the reins 34 to pass directly from the ring 32 to the slips 11. The engagement of the reins 34 in the grooves 24 guides the slips 11 and holds the slips against lateral movement and turning.

The means 12 further includes a releasable latch mechanism for holding the ring 29 in the position where the slips 11 are retracted. This latch means comprises one or more latches 35 on the ring 29. As shown, the latch 35 depends from the ring 29 and has a lateral or horizontal finger 36 on its lower portion. In the case illustrated the finger 36 projects rearwardly relative to the right hand direction of rotation of the tool, it being understood that the finger 36 may project in the other direction if desired. The latch means further includes a pin 37 projecting from the body section 14 and engageable by the latch 35. With the pin 37 engaged in the latch 35, as shown in Fig. 2, the ring 29 is held in the lower position where the slips 11 are retracted or in the lower portions of the seats 21.

The means 12 further includes a novel friction means or movement resisting means for holding the ring 29 against movement when the body 10 is manipulated to release the pin 37 from the latch 35 and to actuate the slips. In the form of the invention illustrated in Figs. 2 to 5, this movement resisting means comprises two or more circumferentially arranged springs 38 on the ring 29. In the typical case illustrated there are two like springs 38 arranged in the wide groove 30 of the ring 29. The springs 38 are bowed or curved leaf springs and where two springs are

employed each spring extends through slightly less than 180° so that the two springs have their ends in adjacent spaced relation. One end of each spring 38 is anchored to the bottom or inner wall of the groove 39 as by welding, or the like. The opposite ends of the springs 38 are loosely tied or connected to the ring 29 so that the springs may bow or flex. The free or unattached ends of the springs 38 are bent inwardly to bear on the bottom wall of the groove 30 and pins 40 pass vertically through the groove 30 to engage over the end portions of these springs 38 to prevent the springs from passing out of the groove while allowing free circumferential working or flexing of the springs. The ring 29 forms an effective housing for the springs 38. The springs 38 are bowed outwardly between their ends, having a radius of curvature considerably less than the ring 29 and the springs are formed and constructed so that their intermediate portions bear against the internal surface of the casing C. In practice the springs 38 may be constructed to bear against the interior of the casing C with substantial force to offer considerable resistance to movement of the ring 29 with respect to the casing. As illustrated in Fig. 5 of the drawings, the springs 38 may have extensive engagement with the inner wall of the casing C. Guide and protector lugs 41 may be secured on the body 10 below the ring 29. The lugs 42 may be welded on the body section 14 to be spaced below the ring 29 and are spaced apart to allow for a free circulation of fluid.

In the use or operation of the liner hanger illustrated in Figs. 1 to 5, inclusive, the body 10 is connected with the upper end of the liner L by the coupling 26 and the adaptor 15 of the setting tool is threadedly connected with the upper end of the body 10. The latch 35 is engaged with the pin 37 so that the slips 11 are held in their retracted positions in the seats 21. In this connection it is to be understood that the reins 34 may exert inward force on the slips 11 to yieldingly hold them against the seat walls 22. The hanger carrying the liner is secured to the lower end of a tubular setting string, not shown, by means of a suitable setting tool and the assembly is run into the well on the setting string.

When the liner has been lowered to the selected point in the well, water or other fluid may be pumped down the setting string to discharge from the liner. This flushing fluid washes the open portion of the well in which the liner is to be disposed and the fluid returns upwardly around the liner and liner hanger. The slots or grooves 25 permit the free upward passage of the fluid around the thickened body section 13 and the fluid is free to return upwardly around the setting string. When the flushing operation is completed and when the liner is in the selected position the setting string is manipulated to turn the body 10 a short distance to the left. This moves the pin or pins 37 out of engagement with the latches 35 and the string is then lowered a short distance to actuate the slips. During these movements of the body 10 the springs 38 frictionally bearing against the inner wall of the casing 10 resist movement of the ring 29 so that the latches remain substantially stationary when the pins 37 are moved from them and so that the slips 11 are held against downward movement when the body is moved down to expand the slips. The springs 38 offer substantial resistance to downward move-

ment of the slips 11 to assure the proper expansion or actuation of the slips. Upon downward movement of the body 10 the seat walls 22 slidably cooperate with the pitched cylindrical inner surfaces 27 of the slips 11 to force the slips outwardly into effective biting or gripping engagement with the casing C. The slips 11 gripping the interior of the casing C dependably support the body 10 and the liner L in the well. The setting tool may be released to permit removal of the setting string from the liner. If, at any time, it becomes desirable or necessary to release the liner hanger to permit withdrawal of the liner the setting string may be reengaged with the hanger body 10 by means of the setting tool. When this has been done the string may be moved upwardly to free the slips 11 or to permit the release of the slips and to bring the pins into position for engagement with the latches 35 in the string, then turning a short distance to the right to engage the pins 37 in the latches 35. This latches the slips 11 in their retracted positions and the liner hanger is free to be withdrawn from the well.

Figs. 6 and 7 of the drawings illustrate an alternative form of friction means for resisting movement of the ring 29^a and the slips 11 when the slips are to be released for expansion and are to be retracted. In this form of construction the ring 29^a, corresponding to the ring 29, has a series of circumferentially spaced windows or openings 60. The openings 60 are elongated circumferentially of the ring 29^a. One end of each opening 60 has a sloping or pitched surface 61. In the case illustrated, the surfaces 61 occur on the walls of the opening 60 which are the rear walls relative to the right hand direction of rotation. The surfaces 61 are pitched outwardly and in the rearward or left hand direction.

Each opening 60 carries a casing engaging member 62. In the case illustrated, the members 62 are in the nature of spheres or balls. The mouths of the openings 60 have restrictions or lips 63 to prevent the loss or displacement of the members 62. The members 62 project from the mouths of the openings 60 to have cooperation with the internal surface of the casing C. Coiled springs 64 are arranged under compression between the forward walls of the openings 60 and the members 62 to urge the members 62 against the pitched walls 61. The pitched walls 61 direct the spring urged members 62 outwardly so that the spring urged members have frictional cooperation with the interior of the casing C. The strength of the springs 64 and the pitch of the surfaces 61 are such that the members 62 engage with the casing C to offer substantial resistance to movement of the ring 29^a. The members 62 engage with the casing C to resist both turning movement and longitudinal movement of the ring 29^a and the parts connected therewith. It is believed that it will be understood how the spring urged members 62 may be substituted for the springs 38 of the above described structures.

Having described typical preferred forms and applications 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 or fall within the scope of the following claims.

Having described my invention, I claim:

1. A liner hanger comprising a body part hav-

ing external recesses presenting concave cylindrically curved walls pitched with respect to the longitudinal axis of the body part, slips in the recesses for gripping the well casing, the slips having toothed cylindrically curved convex outer surfaces for engaging the well casing and cylindrically curved convex inner surfaces pitched with respect to said outer surfaces and slidably bearing on said walls so that the slips are actuated upon relative longitudinal movement between the body part and slips, and means for controlling operation of the slips comprising a member supported on the body part for free movement, spring means on said member having movement-resisting frictional engagement with the well casing, connections between the slips and said member, and latch means connecting the member with the body part releasable to allow movement of the body part relative to said member and slips.

2. A liner hanger comprising a solid walled tubular body part having external recesses presenting concave cylindrically curved walls pitched with respect to the longitudinal axis of the body part, slips in the recesses for gripping the well casing, the slips having toothed cylindrically curved convex outer surfaces for engaging the well casing and cylindrically curved convex inner surfaces pitched with respect to said outer surfaces and slidably bearing on said walls so that the slips are actuated upon relative longitudinal movement between the body part and slips, and means for controlling operation of the slips comprising a member carried by the body part for free movement, circumferentially extending springs on the member having frictional engagement with the well casing to resist movement of the member, and means for connecting the slips with said member.

3. A liner hanger comprising a body part having external recesses presenting concave cylindrically curved walls pitched with respect to the longitudinal axis of the body part, slips in the recesses for gripping the well casing, the slips having toothed cylindrically curved convex outer surfaces for engaging the well casing and cylindrically curved convex inner surfaces pitched with respect to said outer surfaces and slidably bearing on said walls so that the slips are actuated upon relative longitudinal movement between the body part and slips, and means for controlling operation of the slips comprising a ring carried by the body part for free movement, circumferentially disposed leaf springs on the rings bowed outwardly between their ends to have frictional engagement with the interior of the well casing, reins on the slips, and means for swivelly connecting the reins with the ring.

4. In a well tool, a body having an inclined surface, a slip engaged on said surface to be actuated thereby, and means for governing actuation of the slip comprising a ring carried by the body for free movement, the ring having an external annular groove, one or more circumferentially extending leaf springs housed in the groove and bowed outwardly between their ends to project from the groove for frictional engagement with the well wall, and an operative connection between the ring and slips.

5. In a well tool, a body having an inclined surface, a slip engaged on said surface to be actuated thereby, and means for governing actuation of the slip comprising a ring carried by the body for free movement, the ring having an external annular groove, one or more circumferentially extending leaf springs housed in the groove and

bowed outwardly between their ends to project from the groove for frictional engagement with the well wall, and an operative connection between the ring and slips including a swivel ring rotatably connected with the first named ring, and a rein connecting the slip and swivel ring.

6. In a well tool, a body having an inclined surface, a slip engaged on said surface to be actu-

ated thereby, and means for governing actuation of the slip comprising a ring carried by the body for free movement, a circumferentially extending leaf spring on the ring for frictionally engaging the well wall, a swivel ring rotatably connected with the first named ring, and a rein connecting the slip and swivel ring.

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