

June 1, 1948.

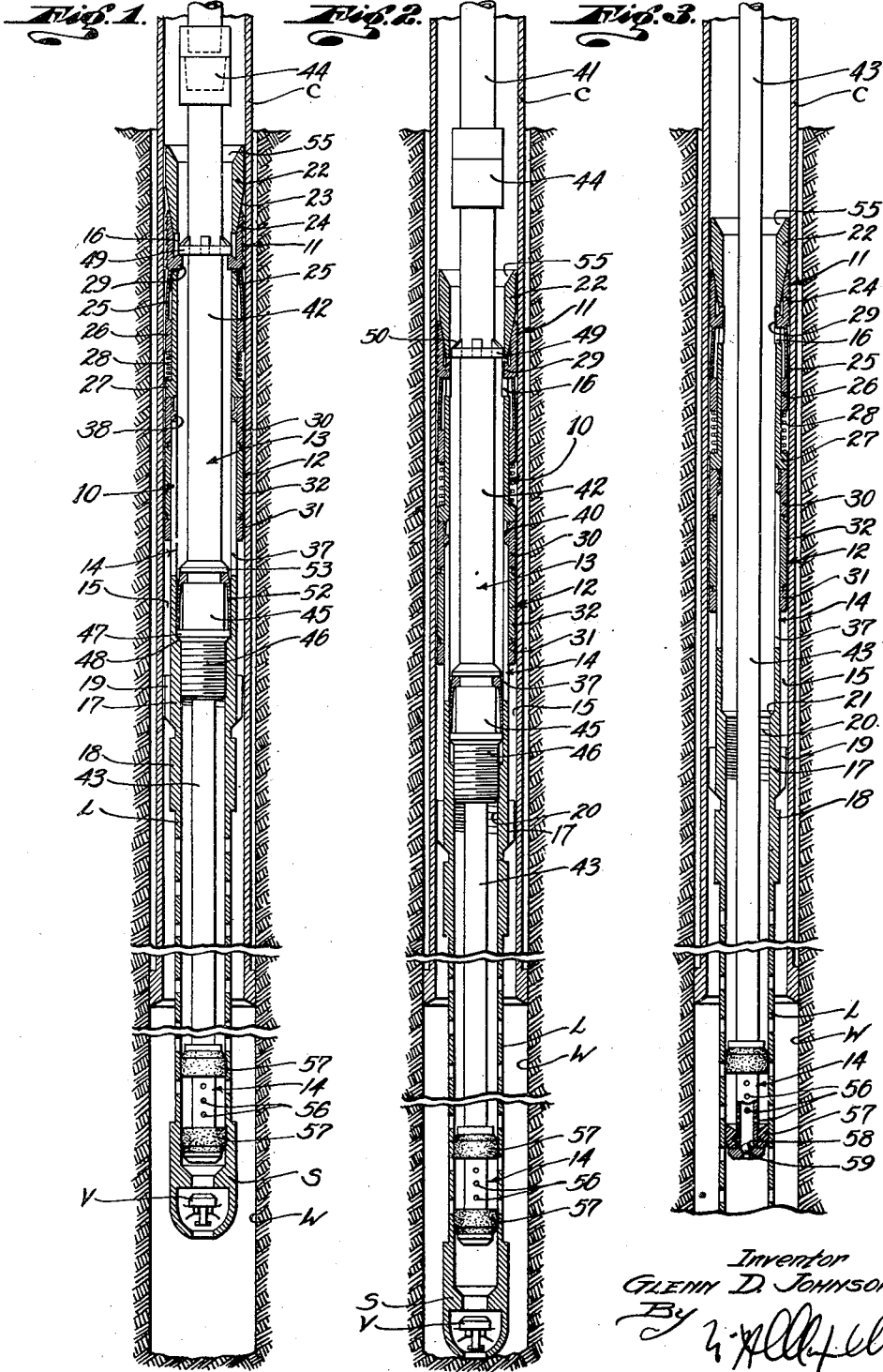
G. D. JOHNSON

2,442,544

LINER HANGER

Original Filed Jan. 7, 1941

3 Sheets-Sheet 1



Inventor
GLENN D. JOHNSON
By *[Signature]*
His Attorney

June 1, 1948.

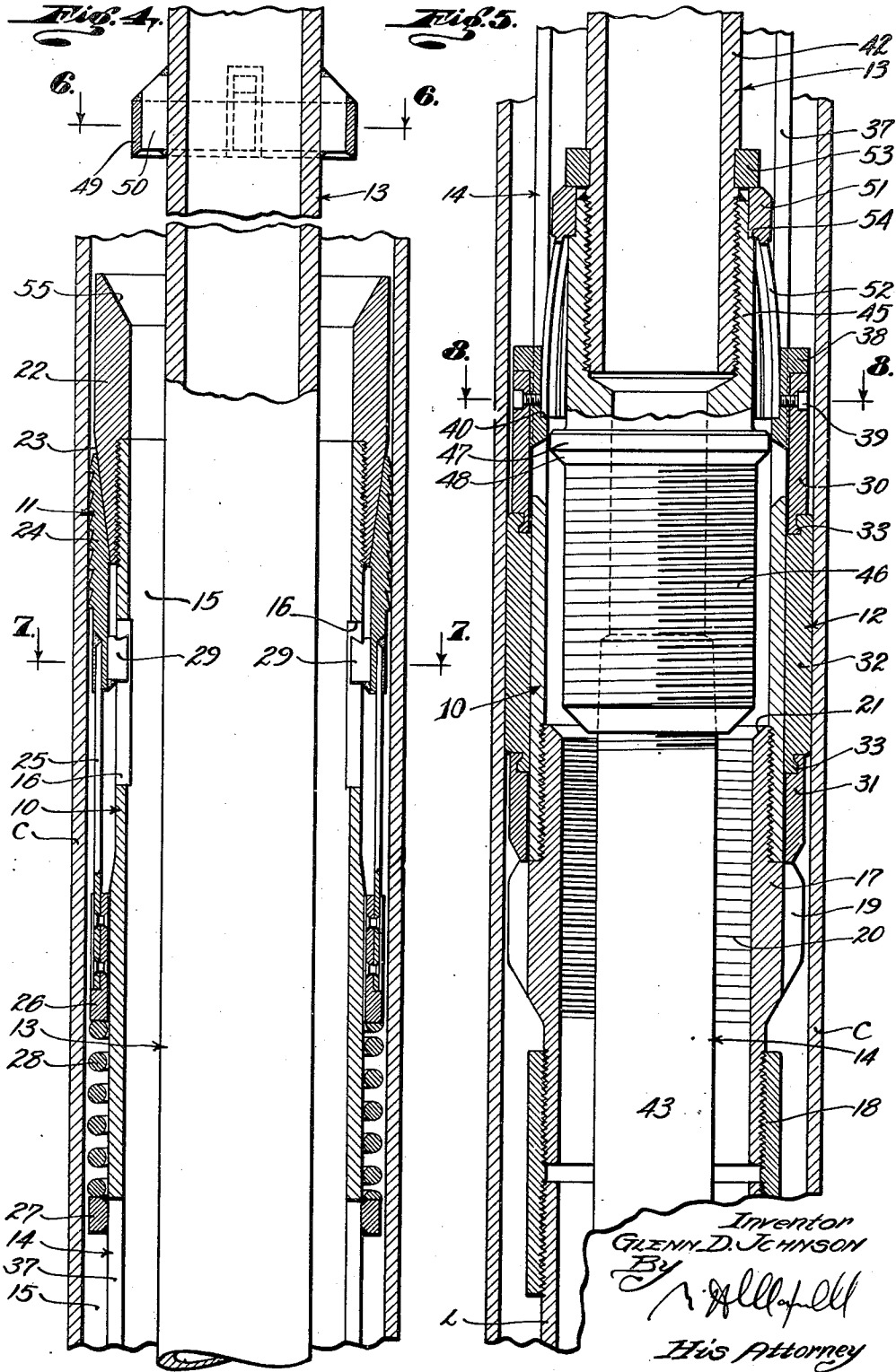
G. D. JOHNSON

2,442,544

LINER HANGER

Original Filed Jan. 7, 1941

3 Sheets-Sheet 2



June 1, 1948.

G. D. JOHNSON

2,442,544

LINER HANGER

Original Filed Jan. 7, 1941

3 Sheets-Sheet 3

Fig. 6.

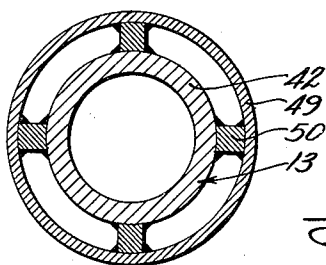


Fig. 10.

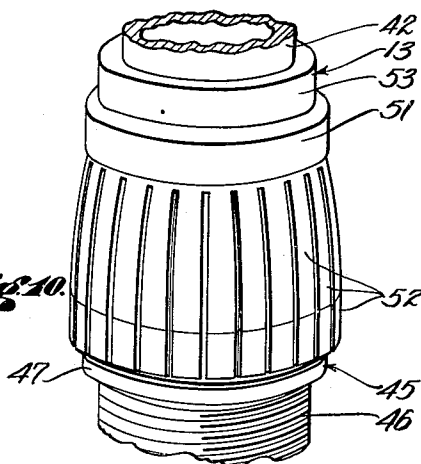


Fig. 7.

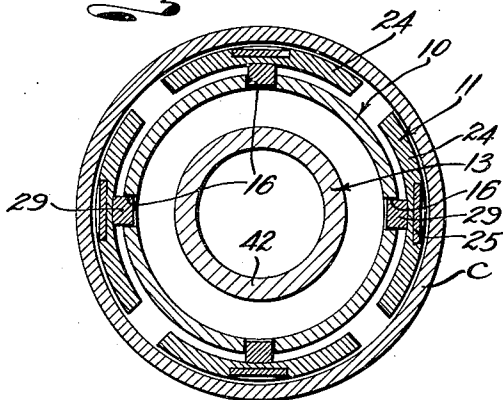


Fig. 9.

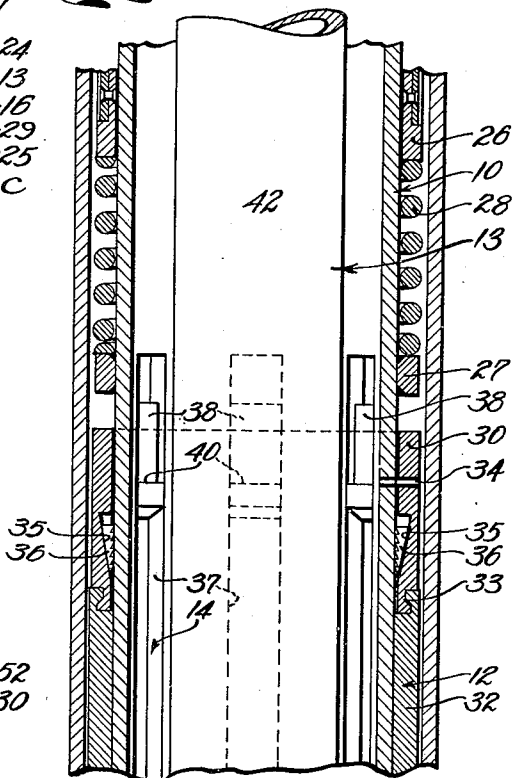
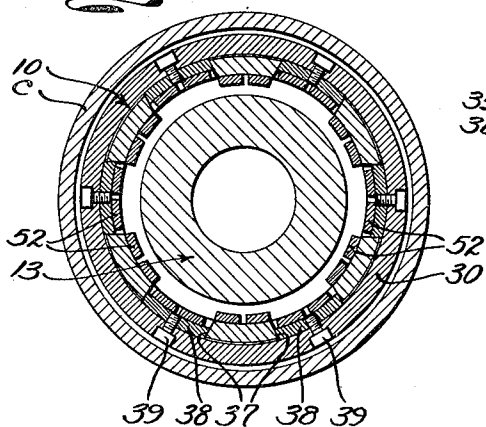


Fig. 8.



Inventor
GLENN D. JOHNSON

By *R. H. Hall*
His Attorney

UNITED STATES PATENT OFFICE

2,442,544

LINER HANGER

Glenn D. Johnson, Compton, Calif., assignor to
Baash-Ross Tool Company, Los Angeles, Calif.,
a corporation of California

Continuation of application Serial No. 373,428,
January 7, 1941. This application May 24, 1943,
Serial No. 488,259

19 Claims. (Cl. 166—20)

1

This invention relates to well tools and equipment and has particular reference to liner hangers for supporting or suspending liners in wells. A general object of the invention is to provide a practical, dependable and readily controlled liner hanger.

This application is a continuation of my application Serial No. 373,428, filed January 7, 1941 now abandoned.

Another object of this invention is to provide a liner formed and equipped to permit a thorough and effective washing or flushing of the liner and the open productive portion of the well bore.

Another object of the invention is to provide a liner hanger of the character referred to embodying means whereby the flushing fluid is bypassed around the packer and slip assembly to allow for a free upward flow of the flushing fluid and to prevent the packer and slip means from becoming mudded up. When setting or actuating a liner hanger it is usually desirable to flush the liner and the open portion of the well. The flushing fluid is discharged through the perforations of the liner and returns upwardly through the restricted annular space between the liner and casing. The unactuated packer and the slip means of the hanger restrict this already limited fluid passage and in most prior devices the packer and slip means have interfered with the return flow of the flushing fluid and have prevented an efficient washing action. Further, the flushing fluid flowing over or past the packer and slip means deposits some of its solid matter and the slip means and packer may become mudded up. The liner hanger of the present invention provides for the free passage of the flushing fluid around or past the packer and slip means, thus overcoming the difficulties encountered in employing prior liner hangers.

Another object of this invention is to provide a liner hanger of the character referred to in which the by-pass ports or slots for the flushing fluid are sealed off or made inoperative for the passage of the well fluid when the packer is actuated.

Another object of this invention is to provide a liner hanger of the character mentioned which is easily controlled and operated to provide for a thorough washing of the liner and open part of the well bore.

A further object of this invention is to provide a liner hanger of the character mentioned in which the gripping means may be tested to determine its effectiveness before actuating the packer, to insure the dependable supporting or suspension of the liner.

The various objects and features of my in-

2

vention will be fully understood from the following detailed description of a typical preferred manner of carrying out the method and typical form of apparatus of the invention, throughout which description reference is made to the accompanying drawings, in which:

Figs. 1, 2 and 3 are diagrammatic views illustrating different stages of operation of the liner, Fig. 1 showing the equipment in position in the well and conditioned for the initial flushing operation, Fig. 2 showing the setting tool partially raised with the liner resting on the well bottom, and Fig. 3 showing the slips set and the tool conditioned for the final washing operation. Fig. 4 is an enlarged, vertical, detailed, sectional view of the upper portion of the liner hanger showing the slips set or actuated. Fig. 5 is an enlarged, vertical, detailed, sectional view of the lower portion of the hanger showing the packer being actuated. Figs. 6 and 7 are transverse, detailed, sectional views taken as indicated by lines 6-6 and 7-7, respectively, on Fig. 4. Fig. 8 is a transverse, detailed, sectional view taken as indicated by line 8-8 on Fig. 5. Fig. 9 is a fragmentary, vertical, detailed, sectional view of the intermediate portion of the hanger taken in a vertical plane different from the plane of sectioning of Figs. 4 and 5, and Fig. 10 is a fragmentary, perspective view illustrating the spring clutch member for actuating the packing.

The liner hanger which is one element of the present invention and which may be termed the well section may be employed to set or support different types of well liners and may be used under varying operating conditions. In the drawings I have shown a typical form of the invention used to suspend a conventional perforated or slotted liner L in a well bore equipped with a casing C which forms the wall of the well. The casing C terminates some distance above the well bottom to leave the lower portion of the well W open for the production of the well fluid. The lower end of the liner L is equipped with a shoe S having a downwardly opening valve V. It is to be understood that the invention is not to be construed as limited or restricted to the particular form and application herein disclosed but it is to be taken as including any features or modifications that may fall within the scope of the claims.

The liner hanger or well section of the structure I have provided may be said to comprise, generally, a body 10 to be secured to the liner L, gripping means 11 on the body 10 for engaging in the well casing C and packing means 12 on the body 10 for sealing with the interior of the casing C. A setting tool or mandrel 13, which is

3

part of a setting element or section of the structure, is provided for lowering the liner L and body 10 into the well and for controlling the means 11 and 12, and means 14 for handling the flushing fluid. The setting section is separable from the well section to be removable from the well as will be hereinafter described.

The body 10 of the hanger is an elongate tubular structure received in the casing C with substantial clearance to leave an annular passage 15 for the flushing fluid, as will be later described. A series of spaced longitudinally extending slots 16 is provided in the upper portion of the body 10. The body 10 is formed or equipped for ready connection with the upper end of the liner L and to be releasably engaged by the setting tool or mandrel 13. In the form of the invention illustrated a sub or connecting member 17 is threaded in the lower end of the body 10 and the lower end of the member 17 is in turn threaded into a collar 18 on the upper end of the liner L. The member 17 may shoulder against the lower end of the body 10 and is provided with spaced longitudinally extending external ribs 19 with abrupt upper ends to form abutments for the packing means 12, as will be later described. The upper portion of the member 17 is provided with a rather heavy internal thread 20 and the upper end 21 of the member 17 slopes downwardly and inwardly.

The gripping means 11 is provided to connect the hanger body 10 with the casing C to suspend the liner L from the casing so that it occupies the desired position in the open part of the well W. The gripping means 11 is preferably arranged on the upper part of the body 10 and comprises a cone member 22 threaded on the upper end of the body. The lower end of the member 22 presents a downwardly and inwardly sloping surface 23. The means 11 further includes a plurality of gripping members or slips 24. The slips 24 are segmental wedge-like elements having sloping inner sides which conform to the cone surface 23 and having toothed outer surfaces for gripping the inner surface of the casing C. The slips 24 are movable on the surface 23 between retracted positions, where they are clear of the casing C, and expanded or actuated positions where they grip the inner surface of the casing.

In accordance with the invention the slips 24 are spring loaded or spring urged. Somewhat flexible fingers or reins 25 are secured to the lower ends of the slips 24. In the drawings I have shown the reins 25 welded in recesses or grooves in the lower parts of the slips 24. A ring 26 is shiftable engaged on the body 10 some distance below the slips 24. The lower ends of the slip reins 25 are riveted or otherwise fixed to this ring 26. A collar 27 is fixed to the exterior of the hanger body 10 where it is spaced below the ring 26. In the drawings the collar 27 is shown welded to the body 10, it being understood that it may be secured in other manners. A coiled spring 28 surrounds the body 10 and is arranged under compression between the ring 26 and the collar 27. The spring 28 urges the ring 26 and slips 24 upwardly so that the slips have gripping engagement with the casing C but the spring is normally held inactive by the setting tool 13 as will be later described.

Blocks or lugs 29 are secured to the lower parts of the slips 24 to extend inwardly therefrom. The lugs 29 may be formed integral with the slips 24 or may be welded to the slips. The

4

lugs 29 extend into and operate in the slots 16 in the body 10. In accordance with the invention the lugs 29 are proportioned to project into the interior of the body 10 when the slips 24 are in their retracted positions and to be clear of the interior of the body 10 when the slips 24 are in their active positions. The upper ends of the lugs 29 may be notched or grooved for more dependable cooperation with the setting tool 13.

The sealing or packing means 12 is arranged on the body 10 below the gripping means 11 and is provided to seal or pack between the body 10 and the casing C. The packing means 12 is a tubular or annular assembly engaged around the body 10 and comprises an upper ring or gland 30, a lower gland 31 and a sleeve-like body of packing 32 engaged between the glands 30 and 31. The packing 32 may be lead or similar material capable of distortion and expansion when subjected to compression. The engaging ends of the glands 30 and 31 and the packing 32 have interlocking tongues 33 which connect the glands and packing to form a continuous unit. The glands 30 and 31 are proportioned to be freely received in the casing C and the packing 32 is initially of about the same external diameter as the glands to freely enter the casing.

When the packing means 12 is in the idle or unactuated condition the upper gland 30 is immediately below or adjacent the collar 27 and the lower gland 31 is spaced a substantial distance above the ribs 19. Releasable or frangible means is provided for holding the packing means 12 in this unactuated position. A shear pin 34 is engaged in openings in the body 10 and the gland 30 to releasably retain the packing means 12 in the unactuated position. The shear pin 34 is illustrated in Fig. 9.

Gripping means may be provided to retain or hold the packing 32 in its expanded or actuated condition. The interior of the gland 30 may be formed with spaced vertical recesses 35 having downwardly and inwardly inclined walls and grippers 36 may be shiftable engaged in these recesses, see Fig. 9. The grippers 36 have sloping backs engaged on the recess walls and have toothed forward sides for gripping the external surface of the body 10. The grippers 36 allow free downward movement of the gland 30 but automatically grip the body 10 to prevent upward or return movement of the gland.

The packing means 12 embodies parts engageable by parts on the setting tool or mandrel 13 to bring about the fracture of the pin 34 and the expansion of the packing 32. In accordance with the invention the hanger body 10 has a plurality of spaced longitudinal slots 37 of substantial length spaced between its upper and lower ends. The slots 37 serve as by-pass ports of the flushing means 14 to be later described. Blocks 38 are engaged or fitted on the upper end of the upper packing gland 30 and slidably or shiftable engage in the slots 37. Screws 39 may secure the blocks 38 to the follower or gland 30. The parts of the blocks 38 which operate in the slots 37 have upwardly facing generally horizontal shoulders 40 engageable by elements on the setting tool 13 for the fracture of the pin 34 and the compression of the packing 32. It will be observed that the shear pin 34 serves to initially retain the packing means 12 in an elevated position adjacent the gripping means 11 where substantial portions of the slots 37 are uncovered or unobstructed for the free flow of the flushing fluid.

The setting tool or setting mandrel 13 which

is an element of the invention and may be termed the setting section serves to releasably attach the body 10 to a setting string 41, to be run into the well thereon, and is employed to control or operate the gripping means 11 and the packing means 12. The setting string 41 is a well string of pipe or tubing and the mandrel 13 is connected to the lower end of this tubular string.

The setting mandrel 13 comprises an upper section 42 and a lower section 43. The upper section 42 is a length of pipe or tubing received in the hanger body 10 with substantial clearance, leaving ample space for the passage of fluid through the body. A suitable threaded connection 44 secures the upper end of the section 42 to the lower end of the setting string 41. A sub or connecting member 45 connects the upper and lower sections 42 and 43. The lower section 43 is an elongate tubular member or extension and is preferably of less diameter than the upper section 42. The lower section 43 may be quite long, its length depending to a large extent upon the length of the liner L. The connecting member 45 may be threaded on the adjacent ends of the sections 42 and 43 and is larger in external diameter than said sections.

The lower portion of the member 45 has an external thread 46 for cooperating with the thread 20 to releasably connect the body 10 and the mandrel 13. The threads 20 and 46 are preferably straight lefthand threads to be easily unthreaded without loosening or endangering the threaded connections of the setting string 41. A flange 47 is provided on the member 45 above its thread 46 and has a sloping lower face 48 which engages and seals with the sloping end 21 of the member 17 when the threads 20 and 46 are fully engaged. When the threads 20 and 46 are fully engaged the setting tool or mandrel 13 is in what I will term its initial position. This initial position of the mandrel 13 is illustrated in Fig. 1 where it will be observed that the section 42 extends upwardly beyond the top of the body 10 and the section 43 extends downwardly to adjacent the lower end of the liner L.

The mandrel 13 is provided with an actuating part for cooperating with the lugs 29 for the control of the gripping means 11. This part is preferably in the nature of a ring 49 surrounding the upper section 42 and proportioned to be received in the body 10 to engage downwardly against the lugs 29. The ring 49 surrounds the section 42 with considerable clearance and is secured to the section by spaced welded webs 50, leaving ample spaces for the free flow of fluid upwardly through the ring. When the mandrel 13 is in its initial position the ring 49 bears downwardly on or cooperates with the lugs 29 to hold the slips 24 in their retracted positions. The lower end of the ring 49 may be pitched or beveled to better cooperate with the grooved upper ends of the lugs 29 and to positively lock the slips 24 against outward movement. When the thread 46 of the mandrel 13 is partially unthreaded upwardly from the thread 20 a given distance the ring 49 is raised sufficiently to allow the slips 24 to assume their gripping positions. As the slips 24 move upwardly under the action of the spring 23 the lugs 29 move outwardly in the slots 16 and are fully retracted from the interior of the body 10 so that they are no longer engageable by the ring 49. Fig. 2 of the drawings illustrates the intermediate position of the mandrel 13 where the member 45 is partially unthreaded from the member 17 so

that the slips 24 are moved up on the cone surface 23 and the lugs 29 are retracted within the slots 16.

The mandrel 13 is further provided with a means or part for cooperating with the shoulders on the blocks 38 to actuate or compress the packing means 12. This part may be carried by the connecting member 45 and is in the nature of a split extensible spring sleeve comprising a ring 51 and a multiplicity of spring fingers 52 depending from the ring. The ring 51 is supported for rotation and may be arranged on the upper part of the member 45. I have shown the ring 51 positioned between a collar 53 on the section 42 and an upwardly facing shoulder 54 on the member 45 to be held against longitudinal movement. The arms or fingers 52 slope or curve downwardly and outwardly and are formed so that they tend to spring outwardly. The width of the fingers 52 is such that the fingers are too wide to enter the slots 16 and is such that at least one finger 52 will spring into each slot 37. The fingers 52 are in spaced adjacent relation and may be proportioned so that their width is less than one-half the width of the slots 37 to insure the entrance of at least one finger 52 in each slot. The lower ends of the fingers 52 are preferably straight and substantially horizontal to cooperate with the shoulders 40. When the mandrel 13 is in its initial position illustrated in Fig. 1 the fingers 52 are confined in the body 10 below the slots 37. Following disconnection of the threads 20 and 46 the mandrel 13 is moved upwardly at which time the fingers 52 ride up in the body 10 and pass out of the body. The lower ends of the blocks 38 are tapered or sloped to allow the fingers 52 to freely slide past the blocks. The upper end 55 of the cone member 22 slopes downwardly and inwardly to guide the fingers 52 back into the body 10 when the mandrel 13 is lowered to actuate the means 12, as will be later described.

The fluid handling means 14 provides for the full, effective flushing of both the open lower portion of the well W and the liner L and is such that the packing means 12 and the gripping means 11 are completely avoided or by-passed by the returning flushing fluid so that these means do not interfere with the return flow and do not become mudded up. The flushing means or fluid handling means 14 includes the slots 37 referred to above. The size or capacity of the slots 37 is ample so that the slots easily handle the full volume of the flushing fluid. During the flushing operations the slots 37 have extensive lower portions exposed or open below the packing means 12 to place the interior of the body 10 in full communication with the surrounding space 15 for the free upward return of the fluid through the upper portion of the body 10 which carries the gripping means 11 and the unactuated packing means 12.

The means 14 further includes a fluid discharging or directing means on the lower section 43 of the mandrel 13 which comprises a plurality of vertically and circumferentially spaced discharge ports 56 provided in the lower portion of the section 43, and sealing plungers or cups 57 mounted on the section 43 above and below the ports 56. The packers or cups 57 are formed to slidably seal with the interior of the liner L and thus confine the discharge from the ports 56 to clear or wash the perforations of the liner L. The lower end of the section 43 is initially open so that the washing fluid is discharged directly into

the well during the initial washing operation which is for the purpose of cleaning the walls of the well preparatory to suspending the liner. Valve means is provided to close the lower end of the section 43 when it is desired to clean or wash the liner L. An upwardly facing valve seat 58 is provided in the section 43 below the ports 56. A valve member or ball 59 may be dropped or pumped down the string 41 and through the sections 42 and 43 to cooperate with the seat 58 when the liner L is to be flushed.

In employing the liner hanger of the invention the parts are assembled and conditioned to assume the positions illustrated in Fig. 1 of the drawings and the mandrel 13 is secured to the lower end of the string 41 whereupon the assembly is run into the well. The string 41 may be lowered to bring the lower end of the liner L the desired distance above the well bottom. Water or other fluid is then circulated or pumped down through the string 41 to wash the open lower portion of the well W. The fluid discharges from the lower end of the section 43 to pass out through the shoe S and washes the well wall. If desired, the string 41 may be moved up and down as the fluid is discharged to more thoroughly wash the open lower part of the well. The returning washing fluid flows upwardly through the passage 15 to the slots 37, then passes in through the slots to continue upwardly through the body 10 and casing C. The returning fluid thus by-passes the means 11 and 12.

Following this initial washing operation the string 41 is lowered to engage the shoe S with the bottom of the well and is then rotated through say six or eight revolutions to thread or move the mandrel 13 upwardly with respect to the liner L and the body 10. During this unthreading operation the engagement of the shoe S with the well bottom holds the liner L and the body 10 against turning. The upward movement of the mandrel 13, resulting from the cooperation of the threads 20 and 46, brings the mandrel 13 to its intermediate position described above to release or free the slips 24 for action. When the mandrel 13 is moved or unthreaded upwardly the ring 49 moves away from the lugs 29 and the spring 28 urges the slips upwardly along the cone surface 23. Upward movement of the slips 24 is accompanied by outward movement of the slips so that the lugs 29 are retracted from the interior of the body 10 and are moved outwardly into the slots 16. The operation just described conditions the slips 24 for operation.

The string 41 is then raised to bring the liner L to adjacent the desired final position. The threads 20 and 46 remain engaged so that the liner hanger and the liner L are raised with the string 41. During this upward movement the spring loaded slips 24 merely drag against the internal surface of the casing C, their roughened surfaces or teeth being formed to readily slide upwardly in the casing C. When the liner L has been raised to the selected position the string 41 is allowed to settle or move downwardly to complete the actuation of the slips 24 and to test the slip grip. If the string 41 moves downwardly a distance less than it was raised it indicates that the slips 24 have obtained a proper gripping engagement with the casing C. In most instances the slips 24 obtain a firm final engagement with the casing C almost immediately and the liner hanger and liner move downwardly but a short distance.

Following the actuation of the slips 24 the

string 41 is rotated to disconnect the thread 46 from the thread 20 and the string is raised to release the setting string from the liner hanger. Through this operation the setting section of the structure is freed from the well section for free movement relative thereto. The valve or ball 59 is then dropped or pumped down through the string 41 and mandrel 13 to come to rest on the seat 58. Washing fluid or flushing fluid is circulated down through the string 41 and mandrel 13 to discharge from the ports 56. The fluid discharged from the ports 56 is confined between spaced packers or sealing cups 57 and is obliged to discharge outwardly through a limited number of slots of the liner L so that it thoroughly clears the perforations or slots. During this washing of the liner L the string 41 may be moved upwardly and downwardly so that the perforations of the liner are cleared or washed throughout the length of the liner.

The washing fluid, after its discharge through the perforations of the liner L, returns or flows upwardly around the liner and through the space 15. This upwardly flowing fluid passes inwardly through the open lower parts of the slots 37 and then flows up through the body 10 into the casing C and flows up through the casing to the ground surface. The diversion of the washing fluid through the slots 37 completely by-passes the fluid around or past both the gripping means 11 and packing means 12. The gripping means 11 and packing means 12 restrict and obstruct the already limited space around the body 10 and the returning washing fluid passes in through the slots 37 with little or no tendency to flow up around the upper portion of the body 10 which carries the means 11 and 12. Accordingly, there is no obstruction retarding the return flow of the washing fluid and the gripping means 11 and packing means 12 are not liable to become mudded up.

When the liner L has been washed the setting string 41 is moved downwardly to reenter the fingers 52 in the body 10. The string 41 is lowered until the ends of the fingers 52 engage the shoulders 40. With the fingers 52 in engagement with the shoulders 40 the weight or a portion of the weight of the setting string 41 is applied to the upper gland 30 of the means 12 through the medium of the fingers 52 and the shoulders 40. This results in shearing or fracturing of the shear pin 34 and the packing means 12 is moved down with the string 41 until the lower gland 31 rests on the ribs 19. The weight or the portion of the weight of the string 41 thereafter imposed on the upper gland 30, by the engagement of the fingers 52 with the shoulders 40, compresses the packing 32. In this manner the packing 32 may be compressed to effectively and dependably seal between the interior of the casing C and the exterior of the body 10. Fig. 5 of the drawings shows the packing 32 in its actuated or sealing condition. It is to be observed that the packing 32 seals between the casing C and the body 10 in a zone below the slots 37 thus sealing off the slots from the open lower portion of the well bore W.

Following the actuation or compression of the packing 32 the setting string 41 is withdrawn from the well. When this is done the fingers 52 merely ride up in the body 10 until they pass out of the body. The upward withdrawal of the mandrel 13 leaves the interior of the hanger free and entirely unobstructed for the free flow of

the well fluids and for the insertion and installation of other well equipment.

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 hanger, for a well liner and to be handled by a tubular setting string having an extension entering the liner, comprising a tubular body to be secured to the upper part of the liner, means for releasably connecting the string with the body, the string being operable to conduct washing fluid to the liner through the extension, gripping means supported by the body for supporting the body and liner in the well, packing means supported by the body operable to seal the body in the well, the gripping means and packing means being spaced above the releasable connecting means, the body having at least one by-pass port located below the packing means when the packing means is unactuated for passing the returning fluid from around the liner into the body to flow upwardly therethrough past the packing means without commingling with fluid entering the well.

2. A hanger, for a well liner and to be handled by a tubular setting string having an extension entering the liner, comprising a tubular body to be secured to the upper part of the liner, means for releasably connecting the string with the body, the string being operable to conduct washing fluid to the liner through the extension, gripping means supported by the body for supporting the body and liner in the well, packing means supported by the body for sealing the body in the well, the gripping means and packing means being spaced above the releasable connecting means, the body below the packing means having at least one by-pass port for passing the returning fluid from around the liner into the body to flow upwardly therethrough past the packing means without commingling with fluid entering the well, and means operable to position the packing means to prevent flow through said port from around the liner.

3. A liner hanger for use on a tubular well string comprising a tubular body to be secured to the upper part of the liner, means for releasably connecting the string with the body so the string extends into the body with clearance thus leaving a passage for fluid, the string being operable to conduct washing fluid through the body to the liner to pass outwardly therethrough, gripping means carried by the body for gripping the well wall to support the body and liner in the well, and packing means carried by the body for sealing the body in the well, the gripping means and packing means being spaced above the releasable connecting means, the body between the releasable connecting means and the portion carrying the gripping means and the packing means having at least one by-pass port for passing the returning washing fluid from around the liner into said passage to flow upwardly therethrough.

4. In a liner hanger for use on a tubular setting string, a tubular body to be secured to the liner, gripping means carried by the body operable to engage in the well to support the liner therein, longitudinally shiftable packing means carried by the body below the gripping means operable

to seal the hanger in the well, a tubular mandrel on the setting string extending downwardly into the body with clearance with respect to the interior of the body to leave a fluid passage in the body, a threaded connecting means for releasably and shiftable connecting the mandrel with the interior of the body at a point below the packing means, the string and mandrel being adapted to conduct fluid to the liner to discharge outwardly therethrough, the body between said releasable and shiftable connecting means and the packing means having a port to allow said fluid to return through said passage, and means on the mandrel operable upon movement of the same relative to the body subsequent to the release of said releasable and shiftable connecting means for moving the packing means downwardly relative to the body and to actuate the packing means to seal the hanger in the well at a point below the port.

5. A well tool comprising a tubular body having a fluid port in its wall and a passage leading upwardly from said port, means distinct from the port and passage for conducting fluid through the body to discharge into the well, a packer on the exterior of the body movable along the body between a position clear of the port and a position where it closes the port and operable to seal the body in the well, releasable means holding the packer in the first named position, and means for releasing the releasable means and for moving the packer to the position where it closes off flow through the port.

6. A well tool comprising a tubular body having a fluid port in its wall, a packer on the exterior of the body movable along the body between a position where it leaves the port open and a position where it closes the port and operable to seal the body in the well, a part on the packer located to be at the port with the packer in both of said positions, a shiftable mandrel entering the body, and means on the mandrel engageable with said part for moving the packer to the position where it closes off flow through the port.

7. A well tool for use on a well string comprising a tubular body having an opening in its wall and having an inclined external surface, a gripping member on the tubular body for gripping the well wall operable by said surface upon relative movement between the body and member and initially in a retracted position at the inner end of the surface, means normally urging the gripping member along said surface to bring the gripping member into engagement with the well wall, an inwardly projecting part on the gripping member received in said opening and extending into the body when the gripping member is in the initial position, a mandrel on the string extending into the tubular body, co-engageable means on the body and mandrel operable upon manipulation of the string to change the relative longitudinal positioning of the body and mandrel, and a part on the mandrel engageable with the said part on the gripping member within the body to hold the gripping member inactive and out of engagement with the well wall when the body and mandrel are in certain relative longitudinal positions and disengageable from said gripping member part upon said change in the relative longitudinal positions of the body and mandrel so that the gripping member is freed to be actuated into engagement with the well wall, the said part on the gripping member being of such inward extent as to be retracted outwardly to be clear of the interior of the body when the

gripping member is actuated into final gripping engagement with the well wall by movement of the body in the well.

8. In a tool for use on a well string, a tubular body, packing means shiftable axially on the exterior of the body and expansible to seal between the body and the well wall, a tubular mandrel on the string extending into the body with clearance to leave a passage therein, a releasable connection between the body and mandrel, releasable means for initially retaining the packing means in a raised position on the body, the body having spaced longitudinal slots for putting said passage in communication with the well below the packing means when the packing means is in the raised position, lugs on the packing means extending into the slots, and spring fingers on the mandrel adapted to enter said slots and engage the lugs following the release of said connection so that downward force may be applied to the packing means to release the packing means and to move the packing means below said slots for actuation.

9. In a tool for use on a tubular well string, a tubular body, packing means shiftable axially on the exterior of the body and expansible to seal between the body and the well wall, a tubular mandrel on the string extending into the body with clearance to leave a passage therein, a releasable connection between the body and mandrel, releasable means for initially retaining the packing means in a raised position on the body, the body having spaced longitudinal slots for putting said passage in communication with the well below the packing means when the packing means is in the raised position, lugs on the packing means extending into the slots, an abutment on the body below the slots, and parts on the mandrel adapted to enter the slots and act downwardly against the lugs to release said retaining means and move the packing means downwardly against the abutment and act on the packing means to expand it.

10. In a liner hanger for use on a tubular setting string, a tubular body to be secured to the liner, packing means shiftable axially on the exterior of the body and expansible to seal between the body and the well wall, a tubular mandrel on the setting string extending into the body with clearance to leave a passage therein, a releasable connection between the body and mandrel, releasable means initially retaining the packing means in a position spaced above the releasable connection, the portion of the body between the releasable connection and the packing means when in initial position having spaced longitudinal slots for putting said passage in communication with the well below the packing means, lugs on the upper portion of the packing means extending into the slots, an abutment on the body below the slots, parts on the mandrel initially positioned out of cooperation with the slots when the mandrel is connected to the body and adapted upon release of said connection and manipulation of said mandrel to move in the slots and act downwardly against the lugs to release said retaining means, move the packing means downwardly against the abutment and expand the packing means, and means for retaining the packing means expanded.

11. A tool for use on a well string comprising a tubular body, means on the exterior of the body for gripping the well wall including inclined surface means on the body and gripping slips

operable outwardly by the inclined surface means upon a given relative movement between the body and slips, the slips being initially positioned at the inner end of said surface means, a mandrel on the string extending into the body, a releasable connection between the body and mandrel operable while still engaged to produce relative axial movement between the mandrel and body, the body having a slot in its wall, spring means tending to expand the slips, and means for holding the slips retracted when the body and mandrel are interconnected in certain relative longitudinal positions and releasable to release said slips by said relative axial movement between the body and mandrel, said holding means comprising a part on a slip of the gripping means projecting through the slot into the interior of the body when the slips are retracted and retracted from the interior of said body upon said outward actuation of the slips, and a part on the mandrel movable thereby and engageable with the part on the slip to hold the slip in retracted position.

12. A well tool for use on a well string comprising a tubular body having an opening in its wall and having an inclined external surface, a gripping member on the tubular body for gripping the well wall operable by said surface upon relative movement between the body and member and initially in a retracted position at the inner end of the surface, means normally urging the gripping member along said surface to bring the gripping member into engagement with the well wall, an inwardly projecting part on the gripping member received in said opening and extending into the body when the gripping member is in the initial position, a mandrel on the string extending into the tubular body, co-engageable means on the body and mandrel operable upon manipulation of the string to change the relative longitudinal positioning of the body and mandrel, and a part on the mandrel engageable with the said part on the gripping member within the body to hold the gripping member inactive and out of engagement with the well wall when the body and mandrel are in certain relative longitudinal positions and disengageable from said gripping member part upon said change in the relative longitudinal positions of the body and mandrel so that the gripping member is freed to be actuated into engagement with the well wall, the said part on the gripping member being of such inward extent as to be retracted outwardly to be clear of the interior of the body when the gripping member is actuated into final gripping engagement with the well wall by movement of the body in the well.

13. The combination with a tubing string of: a liner hanger body member including inclined slip expanding faces and slips adapted to ride on said faces, there being openings through said body member adjacent said faces and restraining elements on said slips extending through said openings into the interior of said body member when said slips are retracted on said faces; and means for suspending said liner hanger body member from said tubing string, including a releasable connection providing for relative movement between said tubing string and said body member and restraining means associated with said liner hanger suspending means and engageable with said restraining elements for holding said slips in a retracted position, and disengageable from said slips upon relative movement between said liner hanger body and said

tubing string, and resilient means operable upon release of said slips to urge said slips into expanded position.

14. In a liner hanger, a tubular packer body, a packing sleeve surrounding said packer body and adapted to be axially compressed and radially expanded into sealing contact with a surrounding casing, a packing setting collar surrounding said packer body adjacent one end of said packing sleeve and movable on said packer body for axially compressing said packing sleeve, slots in the packer body and means on the setting collar projecting through said slots toward the interior of the packer body, a tubular member axially movable within said packer body and said means, and leaf spring members extending longitudinally in circumferentially spaced relationship about the exterior surface of said tubular member, said leaf spring members having one of their ends secured to said tubular member and having their opposite ends free from said tubular member and resiliently biased in a radially outward direction whereby said tubular member and said leaf spring members may be drawn in one direction through said means and upon movement of said tubular member in the opposite direction the free ends of said leaf spring members will engage and move said means in a direction to cause said setting collar to axially compress said packing sleeve.

15. Well apparatus of the character described including two connected sections, one a well section to be set in a well and including a body and a packer for sealing said well section in the well, the other a setting section for conducting fluid to the apparatus and for handling the well section and being detachable from the well section for removal from the well independently of the well section, a liner carried by the well section to depend therefrom into the well, and an extension on the setting section depending therefrom and into the liner to conduct fluid downwardly into the liner, there being a port in the well section whereby fluid discharged from the extension and flowing upwardly around the liner is admitted into the well section to discharge from the apparatus above the packer, the packer being located relative to the port to be operable to close off flow through the port from around the liner.

16. Well apparatus of the character described including two connected sections, one a well section to be set in a well and including a body and a packer for sealing said well section in the well, the other a setting section for conducting fluid to the apparatus and for handling the well section and being detachable from the well section for removal from the well independently of the well section, a liner carried by the well section to depend therefrom into the well, an extension on the setting section depending therefrom and into the liner to conduct fluid downwardly into the liner, a port in the body whereby fluid from around the liner is conducted through the body past the packer without commingling with fluid entering the well through the apparatus, the packer being operable to close off flow through the port in the body from around the liner, and means whereby the packer is operated by the setting section.

17. In a liner hanger for use on a tubular setting string, a tubular body to be secured to the liner, gripping means carried by the body operable to engage in the well to support the liner

therein, packing means shiftable on the exterior of the body operable to seal the body in the well, a tubular mandrel on the setting string extending downwardly into the body with clearance to leave a fluid passage in the body, means for releasably and shiftable connecting the mandrel with the body at a point below the packing means, the string and mandrel being adapted to conduct fluid to the liner, the body between the last named means and the packing means having a port to allow fluid passing up around the liner to return through said passage, and means operable by manipulation of the string for actuating the packing means to a position to close off flow through the port from around the liner.

18. A tool for use on a well string comprising a tubular body, the body having spaced slots and a sloping external surface, slips movable outwardly by said surface upon movement relative to the body in one direction, spring means tending to move the slips relative to the body in said direction, the slips being initially positioned in a retracted position at the inner end of said surface, lugs on the slips projecting inwardly through said slots when the slips are in retracted position, a mandrel on the string shiftable and releasably connected with the body for relative axial movement therebetween, and a part on the mandrel initially engaging with the lugs and holding the slips retracted against action of said spring, said part being movable out of engagement with the lugs by axial movement of the mandrel relative to the body thereby releasing the slips for movement by said spring means.

19. A liner hanger for use on a tubular well string comprising, a tubular body to be secured to the upper part of the liner, means for releasably connecting the string with the body so as to extend into the body with clearance, the string being operable to conduct washing fluid to the liner and well, gripping means on the body for supporting the body and liner in the well, and packing means on the body for sealing it in the well, there being a port in the body for bypassing said fluid upwardly through that portion of the body which carries the gripping and packing means, the packing means being shiftable downwardly on the body by manipulation of the string relative to the body for closing off flow through the port.

GLENN D. JOHNSON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
Re. 21,085	O'Neill	May 16, 1939
387,675	Dresser	Aug. 14, 1888
891,065	Heeter	June 16, 1908
1,242,539	Fuller	Oct. 9, 1917
1,248,881	Mack	Dec. 4, 1917
1,604,771	Gill	Oct. 26, 1926
1,606,402	Crowell	Nov. 9, 1926
2,084,611	Crickmer	June 22, 1937
2,085,997	Phipps	July 6, 1937
2,189,937	Broyles	Feb. 13, 1940
2,291,371	Buchanan et al	July 28, 1942
2,292,345	Arutunoff	Aug. 11, 1942
2,303,556	Johnson et al	Dec. 1, 1942
2,318,167	Knowlton	May 4, 1943