

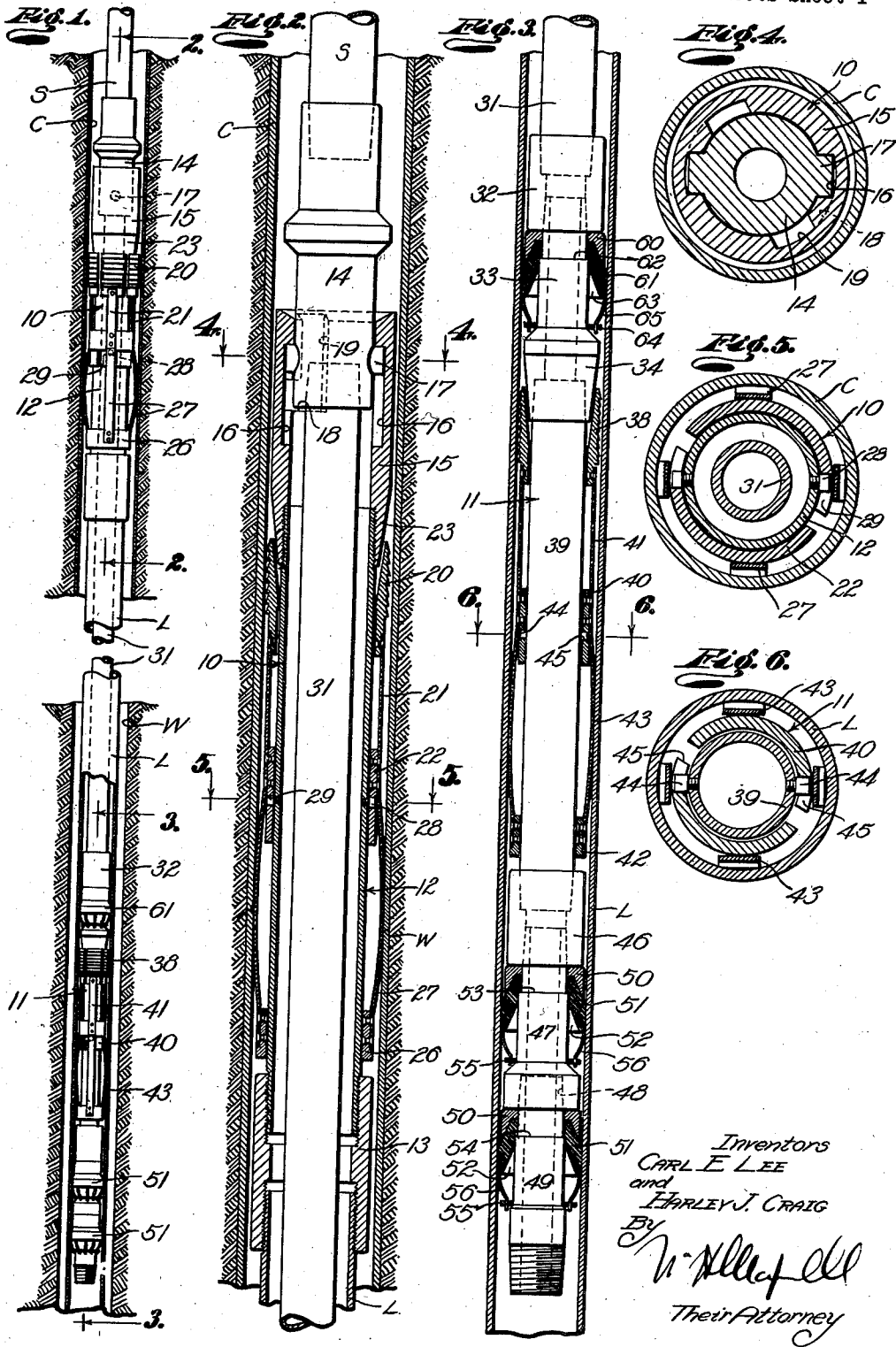
March 22, 1938.

C. E. LEE ET AL
LINER HANGER

2,111,793

Filed May 26, 1936

2 Sheets-Sheet 1



Inventors
CARL E. LEE
and
HARLEY J. CRAIG
BY
W. H. Lee
Their Attorney

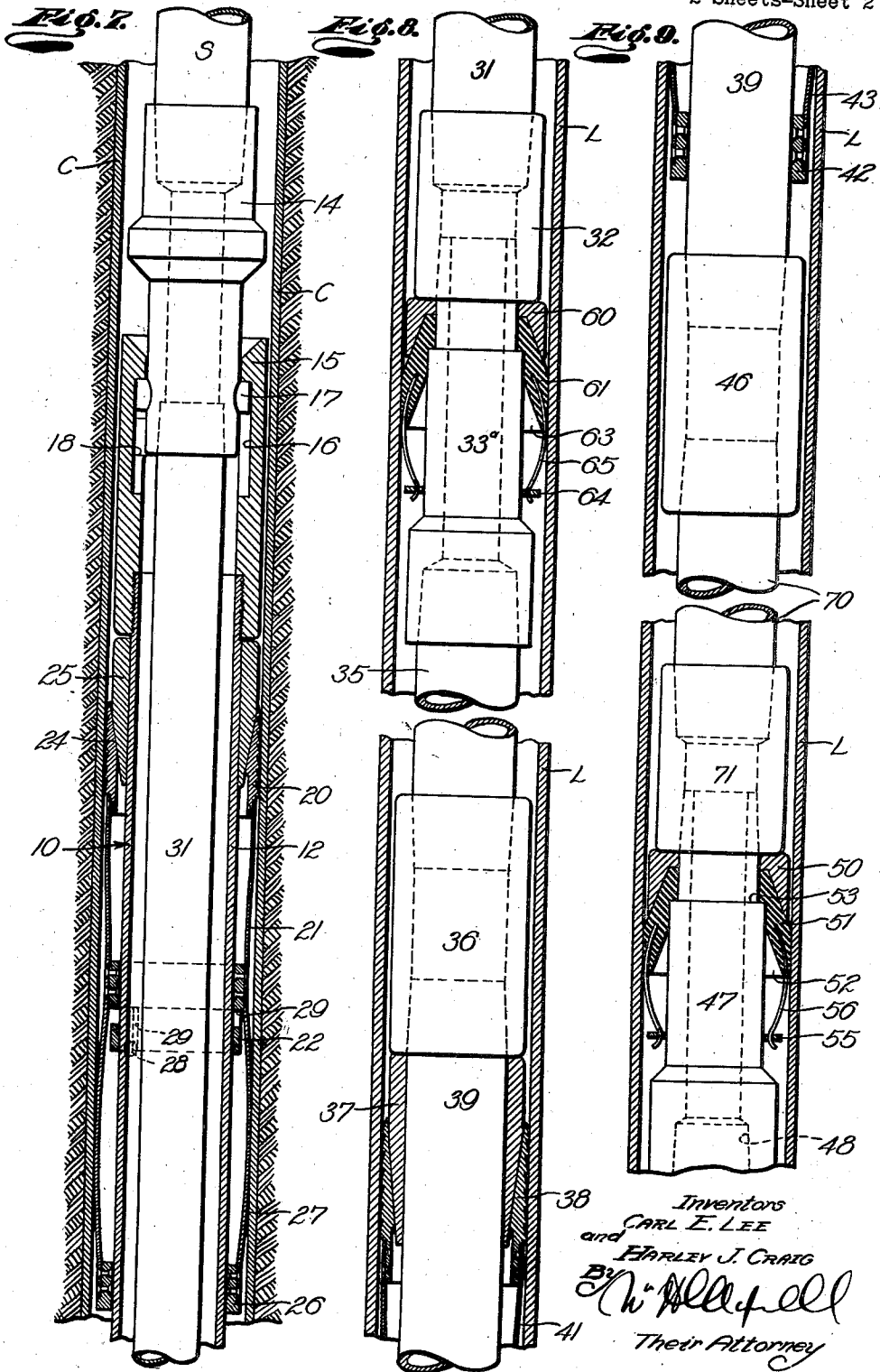
March 22, 1938.

C. E. LEE ET AL
LINER HANGER

2,111,793

Filed May 26, 1936

2 Sheets-Sheet 2



Inventors
CARL E. LEE
and
EARLEY J. CRAIG
By
W. H. Hall
Their Attorney

UNITED STATES PATENT OFFICE

2,111,793

LINER HANGER

Carl E. Lee and Harley J. Craig, Houston, Tex.

Application May 26, 1936, Serial No. 31,817

15 Claims. (Cl. 166-1)

This invention relates to well equipment and relates more particularly to a liner hanger. A general object of this invention is to provide a practical, effective and dependable tool for hanging and retaining a well liner in a selected position in a well.

When cementing a liner in a well with the conventional apparatus it is often necessary to place the cement under a high pressure to force it to the bottom of the well and upwardly around the lower end of the liner. The cement under high pressure sometimes "washes" or raises the liner from the proper position and spoils the cementing operation.

Another object of this invention is to provide a liner hanger that is operable to securely hold a liner against upward movement as well as downward movement.

Another object of this invention is to provide a tool for securing or hanging a liner in a well that is adapted to suspend the liner in the selected position and then impose the weight, or a portion of the weight, of the cementing string on the liner to hold it against upward displacement.

Another object of this invention is to provide a liner hanger of the character mentioned in which the parts or apparatus for imposing the weight of the cementing string on the liner may be removed from the well upon completion of the cementing operation.

Another object of the invention is to provide a liner hanger of the character mentioned in which the drill pipe or setting pipe may be released from the hanger prior to the cementing operations whereby the pipe and the hold down tool may be easily withdrawn from the well following the cementing operations by simply raising or pulling the pipe out of the well.

Another object of this invention is to provide a liner hanger of the character mentioned that embodies effective packing means for preventing the cement from passing upwardly in the liner.

Another object of this invention is to provide a liner hanger of the character mentioned that is positive in operation and that is easy to control.

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

Fig. 1 is a side elevation of the tool provided by the present invention showing it in position in the well and illustrating a portion of the liner in longitudinal cross section. Fig. 2 is an enlarged

fragmentary vertical detailed sectional view taken substantially as indicated by line 2-2 on Fig. 1. Fig. 3 is an enlarged longitudinal detailed sectional view of the lower portion of the tool taken substantially as indicated by line 3-3 on Fig. 1. Figs. 4 and 5 are enlarged transverse detailed sectional views taken as indicated by lines 4-4 and 5-5, respectively, on Fig. 2. Fig. 6 is an enlarged transverse detailed sectional view taken as indicated by line 6-6 on Fig. 3. Fig. 7 is an enlarged view similar to Fig. 2 showing a slightly modified arrangement of parts. Fig. 8 is an enlarged fragmentary longitudinal detailed sectional view of an alternative construction and Fig. 9 is an enlarged fragmentary sectional view of the lower portion of the apparatus illustrated in Fig. 8.

The tool provided by the present invention includes, generally, a hanger 10 for hanging or suspending a liner L in a well W, and a hold-down tool 11 for imposing the weight of a cementing string S on the liner L to hold it against upward displacement.

The hanger 10 is operable to suspend the liner L from a casing C set in the well W. The hanger 10 includes a tubular body 12. The body 12 is adapted to extend through the casing C with substantial clearance and is removably connected with the string S. A coupling 13 connects the lower end of the body 12 with the upper end of the liner L. In accordance with the broader aspects of the invention various suitable means may be employed for releasably connecting the upper end of the body 12 with the string S. In the drawings we have illustrated what is commonly termed a "setting tool" for releasably securing the body 10 to the string S.

The setting tool comprises a mandrel 14 and a tubular adapter 15 for receiving the mandrel 14. The mandrel 14 is tubular and is threaded on the lower end of the string S. The adapter 15 may be directly threaded on the upper end of the body 12 as illustrated in Figs. 1 and 2 of the drawings. Grooves 16 are provided in the interior of the adapter 15 to receive lugs 17 on the mandrel 14. The grooves 16 extend vertically and have lateral branches 18 between their ends. Entering grooves 19 are provided on the interior of the adapter 15 and communicate with the lateral branches 18 to allow the lugs 17 to be entered in and removed from the grooves 16 and branches 18. When the lugs 17 are in the grooves 16 the setting tool forms an effective and dependable connection between the string S and the body 12 of the hanger.

The liner hanger 10 includes slips 20 for gripping the interior of the casing C to suspend the

liner L. The slips 20 have roughened or toothed outer sides and have inclined inner sides. The slips 20 are secured to the upper ends of the spring reins 21 which in turn are secured to a ring 22. The ring 22 surrounds and is shiftable on the body 12. In the form of the invention illustrated in Figs. 1 to 6, inclusive, of the drawings the slips 12 are actuated by cooperation with an inclined abutment or face 23 on the adapter 15. In the optional modification illustrated in Fig. 7 of the drawings the slips 20 are actuated by cooperation with an inclined face 24 of a ring or cone 25 surrounding the body 12.

Means is provided for controlling the slips 20. A ring 26 shiftable surrounds the body 12 some distance below the ring 22. Outwardly bowed leaf springs 27 extend between and are secured to the rings 22 and 26. The springs 27 are adapted to bear outwardly against the interior of the casing C to yieldably resist movement of the slips 20 in the casing so that downward movement of the body 12 may bring the face 23 into expanding or actuating cooperation with the slips 20. A control latch is preferably provided between the slip ring 22 and the body 12 to prevent premature or unintentional actuation of the slips 20. In the particular construction illustrated in the drawings the slip controlling latch consists of screws or lugs 28 on the body 12 cooperating with bayonet type slots 29 in the ring 22, the lugs 28 initially or normally cooperating with slots 29 to prevent relative longitudinal movement between the body 12 and slips 20. Suitable partial turning of the string S followed by longitudinal movement of the string releases the lugs 28 from the lateral portions of the slots 29 so that the body 12 may be moved downwardly to effect the actuation of the slips 20. The slips 20 forced outwardly against the interior of the casing C by the inclined face 23 may dependably suspend or hang the body 12 and the liner L connected therewith.

The hold-down tool 11 is connected with the string S and may be operated or employed to impose the weight, or a portion of the weight, of the string S on the liner L to prevent the liner from being "washed" or displaced upwardly. The tool 11 is inserted in the liner L and extends through the body 12 of the hanger 10. The tool 11 includes an elongate tubular section 31 extending longitudinally through the body 12. The upper end of the section 31 may be threaded in the lower end of the mandrel 14. A coupling 32 may be threaded on the lower end of the coupler section 31. A nipple or member 33 is threaded in the lower end of the coupling 32. In the form of the invention illustrated in Figs. 1 to 6, inclusive, of the drawings the member 33 is provided with an inclined abutment or slip cone 34. In Figs. 8 and 9 we have shown a section of tubing 35 connected with the lower end of a member 33 and an adapter 36 on the lower end of the tubing 35. A slip cone 37 engages against the adapter 36. It is to be understood that any number of tubular sections 35 may be employed as found necessary to locate the cone 37 in the desired position in the liner L.

The hold-down tool 11 includes slips 38 for gripping the interior of the liner L to transmit the weight of the string S to the liner. The hold-down tool 11 comprises a tubular body 39 connected to or extending downwardly from the member 33, or, as shown in Figs. 8 and 9, extending downwardly from the adapter 36. A slip ring 40 surrounds the body 39. Spring reins 41

extend upwardly from the ring 40 and carry the slips 38. The slips 38 are toothed to properly grip the interior of the liner L and have inclined inner sides for cooperating with the cone 34, or the cone 37, as the case may be.

Means is provided for controlling the slips 38. A ring 42 surrounds the body 39 at a point below the ring 40. The ring 42 is freely shiftable on the body 39. Outwardly bowed leaf springs 43 extend between and connect the rings 40 and 42. The springs 43 bear outwardly against the interior of the liner L to yieldingly resist movement of the slips 38 in the liner so that downward movement of the string S relative to the liner L may actuate the slips 38. Latch means normally connect the ring 40 and body 39 to prevent unintentional actuation of the slips 38. The latch means may comprise lugs 44 on the body 39 cooperating with bayonet type slots 45 in the ring 40. The lugs 44 may be released from the bayonet slots 45 by suitable rotational and longitudinal manipulation of the string S so that the string S may be allowed to settle for the purpose of actuating the slips 38. The cone 34 or the cone 37 may actuate the slips 38 against the interior of the liner L and transmit the weight, or a portion of the weight, of the string S to the liner L through the slips 38 to hold the liner against upward displacement.

The invention includes sealing means or packing means for preventing the upward flow or passage of cement in the liner L. A coupling 46 is provided on the lower end of the body 39 and a packing mandrel 47 is threaded in the lower end of the coupling 46. As shown in Fig. 9 of the drawings, the mandrel 47 may be connected with the coupling 46 by a section 70 and a coupling 71. The section 70 may be of any desired length. A socket 48 is provided in the lower end of the mandrel 47 and a lower packing mandrel 49 is threaded in the socket 48. Each mandrel 47 and 49 carries an inverted annular cup 50. The cup 50 on the mandrel 47 bears upwardly against the coupling 46, or the coupling 71, while the cup 50 on the mandrel 49 bears upwardly against the lower end of the mandrel 47. Packing rings 51 are seated upwardly in the cups 50 and project downwardly and outwardly to seal against the interior of the liner L. The rings 51 may be formed of rubber or the like and their lower sides are relieved or provided with downwardly flaring sockets 52. The sockets 52 of the rings 51 are adapted to receive fluid pressure to expand the rings outwardly into sealing contact with the interior of the liner L. Upwardly facing shoulders 53 and 54 are provided on the mandrels 47 and 49, respectively, to assist in retaining the packing rings 51 in position. Rings 55 surround the mandrels 47 and 49 below the packing rings 51. Flexible wires or bands 56 are embedded in or otherwise secured to the packing rings 51. The lower ends of the wires or bands 56 are secured to the rings 55. The rings 55 are free to move upwardly when the packing rings 51 expand outwardly.

A sealing unit or packing unit may be provided on the tool 11 above the slips 38. In the structure illustrated in Figs. 1 to 6, inclusive, of the drawings an annular inverted cup 60 surrounds the member 33 and bears upwardly against the lower end of the coupling 32. A packing ring 61 similar to the rings 51 is seated in the cup 60 and is adapted to seal outwardly against the interior of the liner L. A shoulder 62 on the member 33 may assist in holding the 75

packing ring 61 in the cup 60. The packing ring 61 flares downwardly and outwardly or is provided with a socket 63 in its lower side adapted to receive fluid under pressure. A free ring 64 surrounds the member 33 below the packing ring 61. Wires or bands 65 are embedded in the ring 61 and have their lower ends secured to the ring 64. In the arrangement illustrated in Figs. 8 and 9 of the drawings the cup 60 of the upper packing unit surrounds the member 33^a to bear upwardly against the coupling 32.

In operation the body 12 may be secured to the string S through the medium of the adapter 15 and the mandrel 14 and the section 31 may be secured to the mandrel 14 as shown in the drawings. The liner is connected with the body 12 by the coupling 13. The assembly may be run into the well on the lower end of the string S to the selected or predetermined position. To actuate the hanger 10 the string S is turned to free the lugs 28 for longitudinal or vertical movement in the slots 29 and the string S is moved downwardly or allowed to settle. This downward movement of the string S brings the inclined face 23, or the inclined face 24, into actuating engagement with the slips 20. The springs 27 frictionally engage the casing C to yieldably resist movement of the slips 20 during the downward movement of the body 12 with the string S. The engagement of the slips 20 with the interior of the casing C provides for the dependable suspension of the body 12 and the liner L carried thereby. It is to be noted that the liner may be suspended in any selected position without providing a shoulder on the wall of the well to carry it.

Following the actuation of the hanger 10 the string S may be manipulated to free the lugs 17 from the grooves 16 and to remove the lugs upwardly through the grooves 19. When the string S has been disconnected from the body 12 of the hanger 10 it may be turned and moved longitudinally to release the lugs 44 from the slots 45. The string S may then be moved downwardly or allowed to settle to actuate the slips 38. During the downward movement of the string S and the body 39 the springs 43 frictionally engage the liner L to yieldably resist downward movement of the slips 38. Thus downward movement of the string S brings the cone 34, or the cone 37, into actuating engagement with the slips 38. The cone 34, or the cone 37, is adapted to actuate the slips 38 outwardly into tight gripping engagement with the interior of the liner L and is then adapted to bear on the series of slips 38 to transmit the weight or a portion of the weight of the string S to the liner L. This weight of the string S imposed on the liner L may be sufficient to positively prevent upward displacement of the liner.

The cement is then pumped downwardly through the string S to flow through the section 31, the body 39, and to ultimately discharge from the mandrel 49. The cement may be pumped into the well under sufficient pressure to flow upwardly past the lower end of the liner L to fill the well around the liner without danger of raising the liner from the selected proper position. The weight of the string or the portion of the weight of the string S imposed on the liner L through the slips 38 dependably resists upward movement of the liner L. In practice sufficient cement is discharged from the lower end of the mandrel 49 to flow upwardly to or beyond the upper end of the liner so that the liner is cemented solid in the well. The expansible packing rings 61 and 61 are operable to dependably

seal with the interior of the liner L to prevent the cement under pressure from passing upwardly through or into the liner. The packing rings 51 and 61 are expansible by pressure below them and are effective in preventing the upward passage of cement in the liner L. Upon completion of the cementing operation the string S may be raised to withdraw the tool 11 upwardly from the liner L leaving the liner and the hanger 10 in the well for the production of the well. As the mandrel 14 has been released from the adapter 15 prior to the actuation of the tool 10, the string S carrying the tool 11 may be raised and withdrawn without releasing any connections, or the like.

Having described only typical preferred forms and applications of our invention we do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to ourselves any variations or modifications that may appear to those skilled in the art or fall within the scope of the following claims.

Having described our invention, we claim:

1. Apparatus for arranging a liner in a well comprising, a liner hanger operable to suspend the liner in the selected position in the well, and a hold down tool for engaging the interior of the liner to hold the liner against upward displacement.

2. Apparatus for arranging a liner in a well comprising, a string to be run in the well, a liner hanger releasably connected with the string and carrying the liner, the liner hanger including means for gripping the well casing to suspend the liner, and a hold down tool connected with the string for gripping the interior of the liner to impose the weight of the string on the liner.

3. Apparatus for arranging a liner in a well comprising, a string to be run in the well, a liner hanger releasably connected with the string and carrying the liner, the liner hanger including means for gripping the well casing to suspend the liner, and a hold down tool connected with the string to extend downwardly into the liner and operable to impose the weight of the string on the liner, the hold down tool including means for releasably gripping the internal wall of the liner to transmit the weight of the string thereto.

4. Apparatus for cementing a liner in a well including, a cementing string, a liner hanger, a releasable connection between the hanger and the string, the hanger including means for gripping the interior of the well casing to suspend the liner, and means for holding the liner against upward displacement comprising a tubular body connected with the string to extend into the liner, and gripping means on said body for gripping the interior of the liner to transmit the weight, or a portion of the weight, of the string thereto.

5. Apparatus for cementing a liner in a well including, a cementing string, a liner hanger, a releasable connection between the hanger and the string, the hanger including means for gripping the interior of the well casing to suspend the liner, and means for holding the liner against upward displacement comprising a tubular body connected with the string to extend into the liner and operable to conduct the cement downwardly, gripping means on said body for gripping the interior of the liner to impose the weight, or a portion of the weight, of the string thereon, and means packing between said body

and the liner to prevent the upward flow of cement therebetween.

6. Apparatus for cementing a liner in a well including, a cementing string, a liner hanger, a releasable connection between the hanger and the string, the hanger including means for gripping the interior of the well casing to suspend the liner, and means for holding the liner against upward displacement comprising a tubular body connected with the string to extend into the liner and operable to conduct the cement downwardly, gripping means carried by the body for gripping the interior of the liner to impose the weight, or a portion of the weight, of the string thereon, and means controlling the said gripping means.

7. Apparatus for cementing a liner in a well including, a cementing string, a liner hanger, a releasable connection between the hanger and the string, the hanger including means for gripping the interior of the well casing to suspend the liner, and means for holding the liner against upward displacement comprising a tubular body connected with the string to extend into the liner and operable to conduct the cement downwardly, gripping means carried by the body for gripping the interior of the liner to impose the weight, or a portion of the weight, of the string thereon, and means preventing operation of the gripping means releasable by manipulation of the string subsequent to the release of said connection.

8. Apparatus for cementing a liner in a well including, a cementing string, a liner hanger, a releasable connection between the hanger and the string, the hanger including means for gripping the interior of the well casing to suspend the liner, and means for holding the liner against upward displacement comprising a tubular body connected with the string to extend into the liner and operable to conduct the cement downwardly, gripping means on said body for gripping the interior of the liner to impose the weight, or a portion of the weight, of the string thereon, and packing means above and below said gripping means for sealing between the body and liner to prevent the upward flow of cement therebetween.

9. Apparatus for cementing a liner in a well including, a cementing string, a liner hanger, a releasable connection between the hanger and the string, the hanger including means for gripping the interior of the well casing to suspend the liner, and means for holding the liner against upward displacement comprising a tubular body connected with the string to extend into the liner, an inclined abutment on the body, slips operable by said abutment to grip the liner to transmit the weight of the string thereto, and a control for the slips.

10. Apparatus for cementing a liner in a well including, a cementing string, a liner hanger, a releasable connection between the hanger and the string, the hanger including means for gripping the interior of the well casing to suspend the liner, and means for holding the liner against upward displacement comprising a tubular body connected with the string to extend into the liner, an inclined abutment on the body, slips operable by said abutment to grip the liner to transmit the weight of the string thereto, and means associated with the slips to resist their longitudinal movement whereby the string may be moved longitudinally to bring the abutment into actuating cooperation with the slips.

11. Apparatus for cementing a liner in a well including, a cementing string, a liner hanger, a releasable connection between the hanger and the string, the hanger including means for gripping the interior of the well casing to suspend the liner, and means for holding the liner against upward displacement comprising a tubular body connected with the string to extend into the liner, a shiftable cage around the body, slips on the cage, an inclined face on the body for actuating the slips into gripping engagement with the liner to transmit the weight of the string thereto, and means on the cage for resisting movement of the cage in the liner.

12. Apparatus for cementing a liner in a well including, a cementing string, a liner hanger, a releasable connection between the hanger and the string, the hanger including means for gripping the interior of the well casing to suspend the liner, and means for holding the liner against upward displacement comprising a tubular body connected with the string to extend into the liner, a shiftable cage around the body, slips on the cage, an inclined face on the body for actuating the slips into gripping engagement with the liner to transmit the weight of the string thereto, means on the cage for resisting movement of the cage in the liner whereby movement of the body may actuate the slips, and latch means connecting the cage with the body releasable by manipulation of the string.

13. Apparatus for cementing a liner in a well including, a cementing string, a mandrel on the lower end of the string, a tubular hanger body carrying the liner, an adapter on the hanger body releasably receiving the mandrel, means on the hanger body for gripping the well casing to suspend the liner, a tubular body secured to the mandrel to extend into the liner and conduct the cement thereto, and means carried by said tubular body for gripping the liner to impose the weight of the string thereon following the release of the mandrel from the adapter.

14. Apparatus for cementing a liner in a well including, a cementing string, a mandrel on the lower end of the string, a tubular hanger body carrying the liner, an adapter on the hanger body releasably receiving the mandrel, means on the hanger body for gripping the well casing to suspend the liner, a tubular body secured to the mandrel to extend into the liner and conduct the cement thereto, means carried by said tubular body for gripping the liner to impose the weight of the string thereon following the release of the mandrel from the adapter, and an inverted packing cup on the tubular body for sealing with the liner.

15. Apparatus for cementing a liner in a well including, a cementing string, a mandrel on the lower end of the string, a tubular hanger body carrying the liner, an adapter on the hanger body releasably receiving the mandrel, means on the hanger body for gripping the well casing to suspend the liner, a tubular body secured to the mandrel to extend into the liner and conduct the cement thereto, means carried by said tubular body for gripping the liner to impose the weight of the string thereon following the release of the mandrel from the adapter, and inverted packing cups on the tubular body above and below the last named means for sealing with the liner.

CARL E. LEE.
HARLEY J. CRAIG.