Feb. 24, 1948. R. E. O'DONNELL 2,436,525

LINER SETTING AND CEMENTING TOOL

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Fig. 1

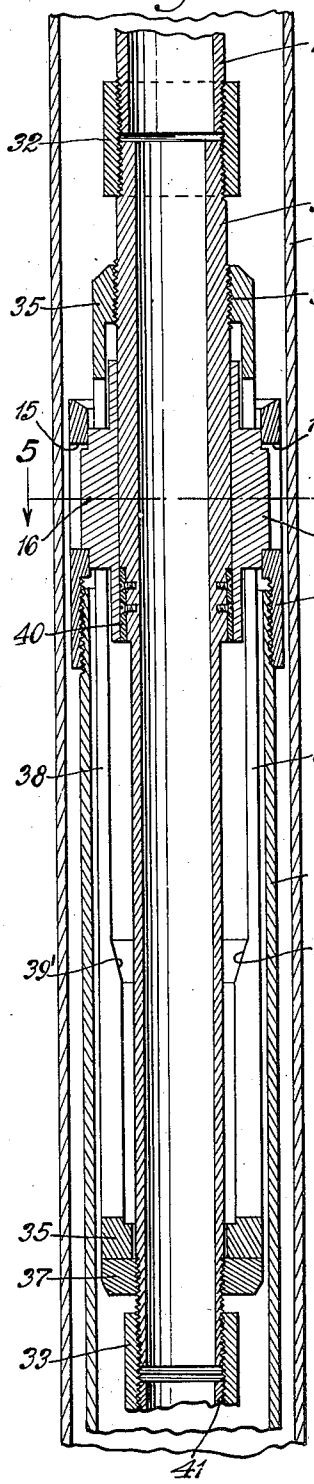


Fig. 2

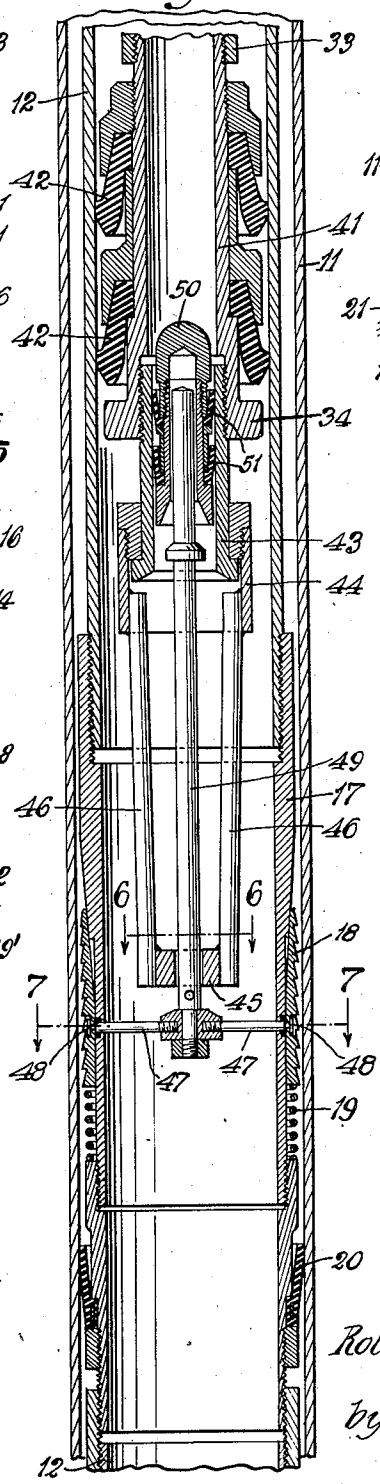
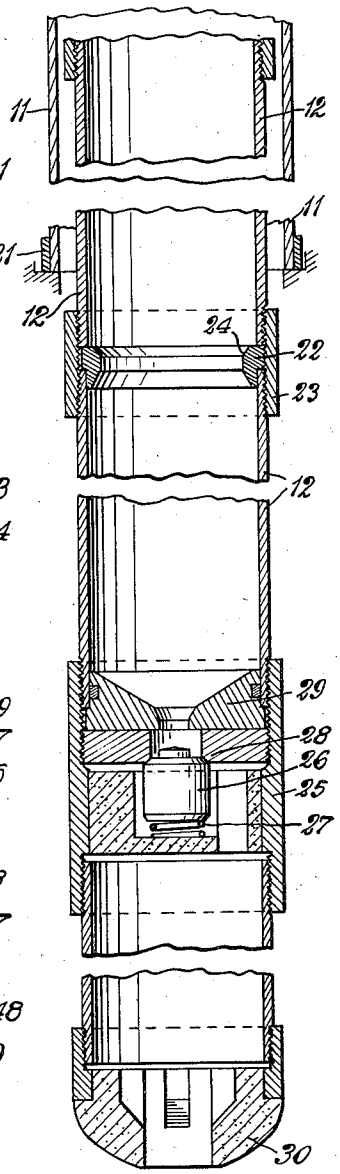


Fig. 3



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Fig. 4

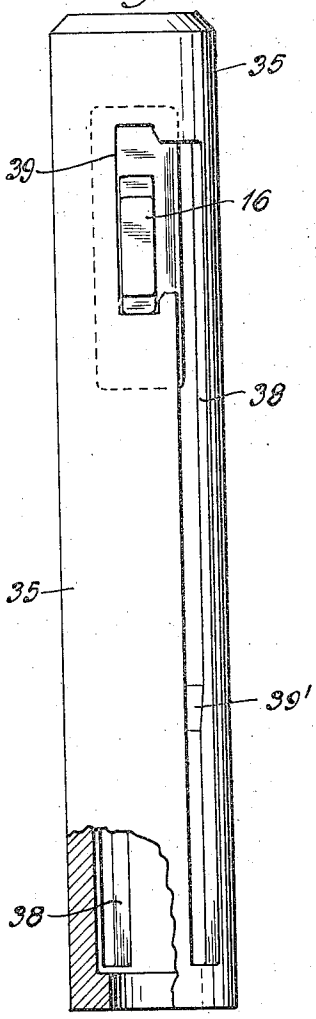


Fig. 5

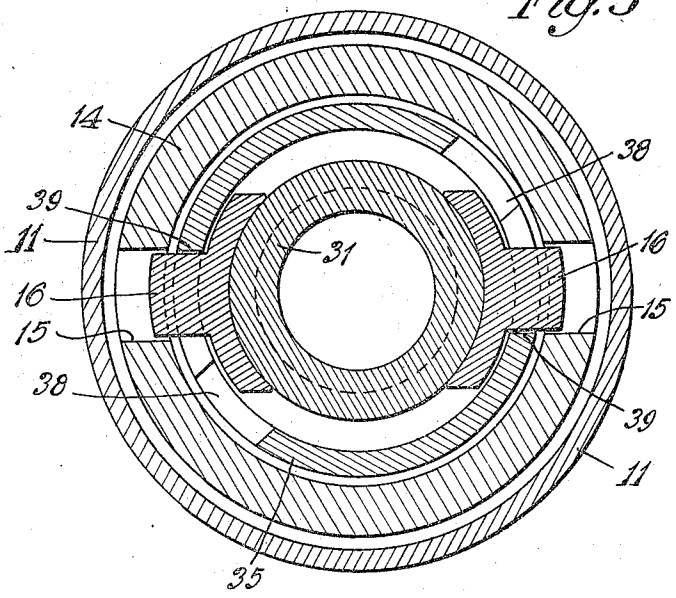


Fig. 7

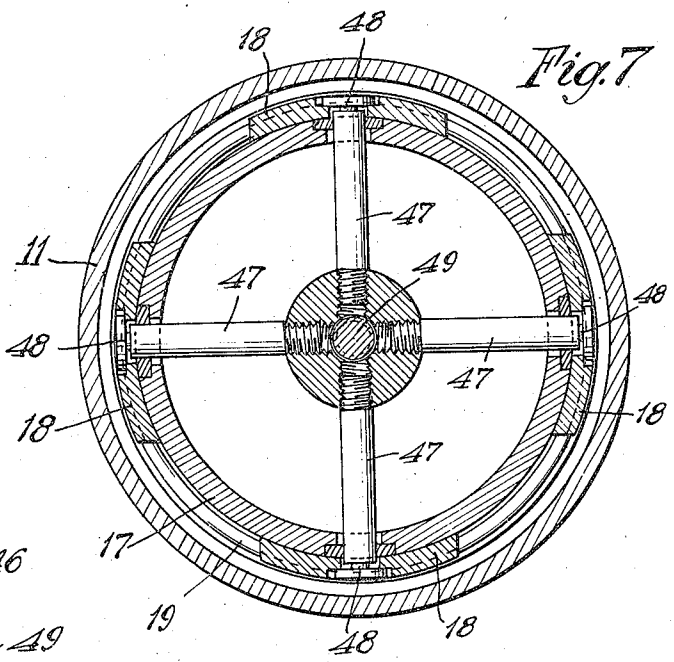
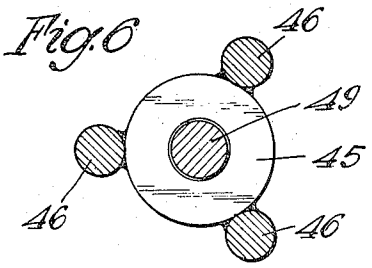


Fig. 6



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LINER SETTING AND CEMENTING TOOL

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2 Claims. (Cl. 166—1)

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This invention relates to liner setting tools, and more particularly to an arrangement for permanently affixing a liner to a casing in an oil well, and for cementing the liner in place.

It is common practice in casing off oil wells to mount a liner in the lower end of the casing adjacent the producing formation of the well, such liner usually being run into the well on drill pipe or tubing which is detachably connected to the liner and removed from the well after the liner is set. In accordance with the present invention, special means is provided for setting the liner and for enabling the liner to be cemented after it is set so that after the cement has hardened the liner may be perforated at the level of the producing formation.

It is one object of the invention to devise apparatus which will permit a liner to be lowered into a well on tubing or drill pipe together with an arrangement whereby the liner may be hung on the casing in the well, after which the tubing may be manipulated in such a way as to direct cement around the outside of the liner, means being provided for holding the cement slurry in place until it is set, while the drill pipe or tubing together with the parts attached thereto is removed from the well. After the cement slurry has been squeezed around the outside of the liner, the excess is washed out of the interior.

Other objects and advantages reside in certain novel features of the arrangement and construction of parts, as will be apparent from the following description, taken in connection with the accompanying drawings in which:

Figure 1 is a fragmentary vertical cross-sectional view of casing of an oil well with tubing therein, and with the upper portion of apparatus constructed in accordance with the principles of the present invention shown in vertical cross-section;

Figure 2 is a similar vertical cross-sectional view of an adjacent portion of the casing showing an intermediate part of apparatus constructed in accordance with the invention;

Figure 3 is a similar vertical cross-sectional view of still another portion of the casing showing the lower part of apparatus constructed in accordance with the present invention, Figures 1, 2, and 3 illustrating contiguous portions of a single embodiment of the invention;

Figure 4 is a view in side elevation, partially cut away, of the apparatus of Figure 1, used to lock the tubing to the liner as the liner is lowered into the well;

Figure 5 is a transverse cross-sectional view of

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the apparatus of Figure 1, the view being taken on the line 5—5 of Figure 1;

Figure 6 is a transverse cross-sectional view of the cage provided to catch the slip tripping mechanism shown in Figure 2, the view being taken on the line 6—6 of Figure 2; and

Figure 7 is a transverse cross-sectional view of the slip retaining mechanism shown in Figure 2, the view being taken on the line 7—7 of Figure 2.

Referring to the drawing in detail, it will be seen that oil well casing is illustrated at 11. Within the casing 11, there is a liner 12 connected by a tool which will presently be described, to a string of drill pipe or tubing 13, which, of course, extends to the top of the well.

As illustrated, the liner 12 may be made up of a number of sections of pipe together with suitable couplings and accessory parts. In the form illustrated a supporting collar 14 is screw-threaded upon the upper end of the liner. This collar is provided with diametrically opposed slots 15, the purpose of which is to receive embossed portions on floating liner support pins 16, so that the liner is hung on these pins which are, in turn, suspended on a mandrel connected to tubing, while the liner is lowered into the well. The arrangement for releasably connecting the liner 12 to the mandrel and hence to the tubing 13 is hereinafter called the latching means. The slots 15 are shown as rectangular in shape having the length shown in Figure 1 and the width shown in Figure 5. They are of the same shape as the embossed portions of pins 16.

Some distance below the supporting collar 14 the liner 12 is provided with the slip assembly and setting means particularly shown in Figure 2. A slip body 17 tapered at its lower end is made up as part of the liner, in accordance with the usual practice. The slips 18 have downwardly directed wickers as illustrated, on the outside and they are shaped on the inside to conform with the taper of the body 17. Beneath the slips 18 a coil spring 19 surrounds body 17 to urge the slips 18 upwardly with respect to the body 17. Once the slips 18 are released, the liner 12 is hung or set in the casing 11, the weight of the liner then being borne by the body 17 and the slips 18 which grip the casing 11.

Beneath the coil spring 19 a swab cup or packer 20 is mounted on liner 12 so as to prevent the downward flow of fluid between the casing 11 and the exterior of the liner 12 while permitting the upward flow of fluid through this annular space. Some considerable distance beneath the swab cup 20 and preferably below the shoe 21 of the casing

the liner 12 is provided on its inside with a cast iron stop ring 22, this being clamped within one of the ordinary connecting collars 23. This stop ring is provided with a valve seat 24 on its upper edge.

Near the bottom of the liner 12 a float collar 25 of usual construction is provided, this collar having a float valve 26 urged by a spring 27 against a valve seat 28. In addition the float collar 25 is preferably provided with a bridging ball seat 29. Of course, the lower end of the liner may be provided with the customary guide shoe 30.

In accordance with the invention the liner is lowered into the well and fixed to the casing. The tubing 13 which lowers the liner into the well is connected to a mandrel 31 by means of a collar 32. The mandrel 31 carries latching means for connecting the liner to the tubing and setting means adapted to release the slips.

The latching means for supporting the liner 12 on the tubing 13 as it is being lowered into the well, will first be described. This includes an outer case 35 which is of larger diameter than the mandrel but less than the diameter of the liner 12. The case 35 remains integral with the mandrel 31 at all times, being screw-threaded upon the mandrel 31 at its upper end as illustrated at 36, while its lower end rests upon and abuts against a collar 37, screw-threaded upon the mandrel 31. The floating support pins 16 mentioned above, are sections of cylinders with step-like projections or studs thereon, as shown in cross-section in Figure 5. These are mounted for sliding vertical and rotational movement in the annular space between the mandrel 31 and the case 35. The case 35 is provided with diametrically opposed J-slots as shown at 38 in Figures 1 and 4. The studs of pins 16 project through the J-slots 38 in the case 35 at all times. They also project into the slots 15, in the collar 14 supporting the liner until the liner is set. When the projecting studs of the pins 16 are in the offset portions 39 of the J-slots 38 (in which portions they are shown in Figure 4), they are held practically immovable vertically with respect to the mandrel 31, there being only sufficient play afforded by the dimensions of the offset portion 39 of the J-slot and the pins 16 to permit easy manipulation.

Until the slips 18 connect the liner 12 to the casing, rotation of the tubing 13 does not disconnect the liner from it, because the liner merely rotates with the tubing. But when the liner 12 is set in the casing by the slips 18, manipulation of the tubing 13 operates to detach the tubing from the liner. When the slips are set, if the mandrel 31 is rotated to the right, as viewed from above with respect to the liner 12, the pins 16, which are held against rotation with respect to the liner 12 by the slots 15, are moved into the longitudinally extending portions of the slots 38 in the case 35. When the pins are in that position the mandrel 31 may be moved upwardly with respect to the pins 16. It will be seen (Figure 1) that the lower portion of the mandrel 31 is of smaller outside diameter than the upper portion. As a result, if the mandrel 31 is raised with respect to the pins 16 a sufficient distance, the pins 16 move radially inwardly to fit along the lower portion of the mandrel 31 which is reduced in diameter. This moves the embossed portions of pins 16 out of slots 15 and completely disengages the same from collar 14 and liner 12. The lower portion of the case 35 has a smaller inside diameter than the upper portion, being tapered inwardly as illustrated at 39' so that once the pins 16 are moved radially inwardly they cannot again be moved outwardly. It will thus be seen that the inside diameter of the case 35 and the outside diameter of the mandrel 31 have somewhat corresponding reductions in diameter. Accordingly the annular space between them, which serves as a guide for the pins 16, causes the pins to move radially inwardly in response to rotational and longitudinal movement of the mandrel with respect to the pins. However, this movement cannot occur until the slips 18 are set to prevent rotation of the liner 12 with the mandrel. Leaf springs 40 may be provided adjacent the shoulder of the mandrel 31 to serve as latches and thus prevent accidental upward movement of the pins 16 once they have been moved downwardly with respect to the mandrel 31.

Valve means 34 is provided at the lower end of the mandrel 31, as shown in Figure 2. This valve means is adapted to engage valve seat 24 when the mandrel is lowered as hereinafter described. Valve means 34 has an upwardly extending hollow stem 41 which is coupled to the mandrel 31 by the collar 33. On the outside of the stem 41 one or more swab cups 42 are mounted in inverted position, these cups serving to prevent the upward flow of fluid in the space between the mandrel 31 and the liner 12.

The setting means for releasing the slips 18 to set the liner in the casing will now be described. This is operated hydraulically and consists of slip retaining means and tripping means. Depending from the valve means 34 is a sleeve 43. Upon the sleeve 43 there is mounted a cage consisting of rings 44 and 45 connected by three vertical rods 46. As the liner is lowered into the hole the slips 18 are held in the retracted or inoperative position shown in Figuer 2 by the slip retaining means which consists of four radial shear pins or rods 47, each of which is provided with a reduced section as shown at 48, so as to break easily when the inner ends of the rods 47 are pressed downwardly. As shown in Figures 2 and 7, the inner ends of the rods 47 are connected to a tripping rod 49 which extends upwardly into the sleeve 43.

At the upper end of the rod 49 (Figure 2) a tripping plug 50 is illustrated. This plug is not in the device when it is being lowered into the well, but is dropped into the tubing and pumped downwardly therethrough when it is desired to trip the retaining means holding the slips 18. It will be seen that the tripping plug 50 is provided with flexible cups 51 so that when the plug 50 enters the sleeve 43, a seal is provided against downward flow of fluid past the plug. Thus the plug 50 and the rod 49 constitute hydraulically operated means for tripping the slip retaining means 47.

The operation of the tool is as follows:

With the parts of the liner setting tool in the position illustrated in Figures 4 and 5 of the drawing, the tubing 13 with the apparatus illustrated is lowered into the well to the point where it is desired to set the liner. The tripping plug 50 is then placed in the tubing and pumped down until it enters the sleeve 43, at which time the pump pressure is transmitted to the tripping rod 49 to move it hydraulically. As the rod 49 is forced downwardly the shear pins 47 break or pull out at the points 48, thus releasing the slips 18 so that the spring 19 moves the slips 18 upwardly upon the tapered body 17, until the slips 18 engage the inside of the casing 11 and wedge between body 17 and casing 11.

Until the operations just described are com-

pleted, the liner 12 is suspended upon the tubing 13 through the mandrel 31 and associated parts which constitute the latching means. When the slips 18 engage the casing, however, the liner is supported upon the casing. The tubing 13 may then be disconnected from the liner. To accomplish this, the tubing 13 is lowered slightly, and rotated to the right as viewed from above, as it is lifted back up. This causes the studs of pins 16 to enter the longitudinal portions of the J-slots 38, and as the tubing 13 and the mandrel 31 are raised up further, the pins 16 move inwardly to disengage collar 14, as described above, and from then on the tubing 13 and mandrel 31 are completely disconnected from the liner.

The tubing 13 and mandrel 31 may now be lowered down through the liner until the valve means 34 seats upon the stop ring 22, in which position a positive seal is provided against movement of fluid in either direction through the space between the liner and the tubing 13. With the parts in this position, cement slurry may be pumped downwardly through the tubing 13, mandrel 31, valve stem 41, and on down through the float collar 25 and shoe 30, and upwardly around the entire liner 12 and into the annular space between the liner 12 and the casing 11, the pressure exerted causing the slurry to flow past the cup 20. It will be apparent that the sleeve 43 depending from the valve body 34 will then be unobstructed, inasmuch as the tripping rod 49 and the tripping plug 50 will by that time have moved downwardly into the cage provided by the rods 46 and the rings 44 and 45.

After the slurry has been squeezed as described, the liner setting and cementing tool may be removed from the well. It is preferable to circulate excess cement out of the inside of the casing and out of the liner as the setting and cementing equipment is removed. This is best accomplished by dropping a bridging ball (not shown in the drawing) down to effect a seal on the bridging ball seat 29. It will be seen that when the bridging ball is seated, pressure may be exerted to wash out the interior of the liner and the interior of the casing above the liner without transmitting any pressure downwardly through the floating collar 25 or around the outside of the liner, a seal on the outside of the liner being effected by the swab cup 20. The circulation of excess cement slurry out of the liner and casing may be accomplished by pumping the washing fluid downwardly through the tubing and upwardly through the annular space between the tubing and the casing if the tubing is raised sufficiently to move the inverted swab cups 42 up to a point above the top of the liner. Perhaps the better practice, however, is to circulate the washing fluid in the reverse direction, before removing the cups 42 from the liner. These cups 42 are so designed as to permit downward flow of fluid between the liner 12 and the valve stem 41, and hence if the washing fluid is circulated downwardly through the annular space outside the tubing and upwardly inside the tubing, excess slurry can in this way be washed out of the interior of the upper part of the liner.

In order to permit the bridging ball to move downwardly and effect a seal on the bridging ball seat 29, the cage 44—45—46 is especially designed as illustrated to avoid the bridging ball being hung up therein.

While only one embodiment of the invention has been shown and described herein it is obvious that various changes may be made without departing from the spirit of the invention or the scope of the annexed claims.

I claim:

1. In combination, a liner for use in oil wells having a collar provided with supporting slots, a mandrel adapted to be connected on tubing and having latching means cooperating with the slotted collar of said liner to connect the liner to the mandrel, said latching means including a case integrally secured on the mandrel and having J-slots therein, pins mounted in floating position between the main body of the mandrel and said case, said pins having studs projecting through the J-slots in said case and, when in the upper portion of said J-slots, extending into the supporting slots on the collar of said liner, both said mandrel and said case having variations in diameter in the annular space between the two to provide guiding means to move said pins radially inwardly in response to relative rotational and longitudinal movement of said mandrel with respect to said pins to withdraw the studs on said pins from the slots in the collar of said liner.

2. In combination, a liner for use in oil wells or the like having slips thereon adapted to engage casing in the well to support the liner on the casing, and a tool adapted to be run on drill pipe or tubing for setting the liner, said tool including a mandrel, a case on the mandrel having J-slots therein, pins for supporting the liner on the mandrel, said pins being mounted in floating position between the mandrel and case and having studs located in the offset portions of said J-slots and in slots in said liner whereby the liner is latched to said case by said pins while being lowered into the well, means for moving said pins radially inwardly to release the liner from said case in response to relative rotational and longitudinal movement between said mandrel and said liner, hydraulicaly operated setting means connected to said mandrel and initially holding the slips on said liner in retracted or inoperative position while the liner is being lowered into the well and operable for releasing said slips to engage the casing and support the liner on said casing and prevent rotation thereof with respect to said mandrel.

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