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SETTING TOOL FOR CEMENT RETAINERS

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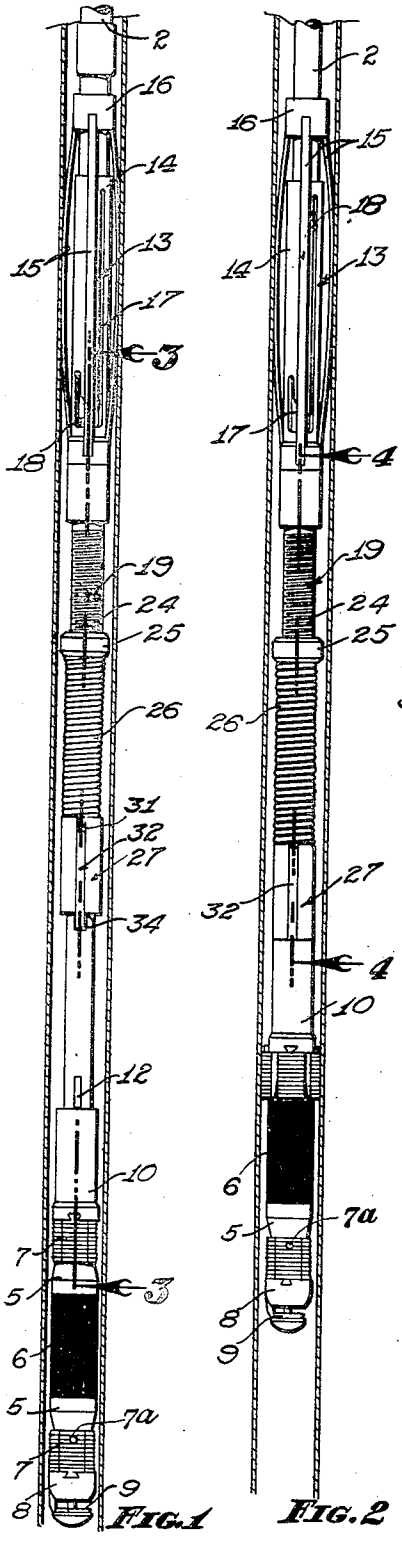


FIG. 1

FIG. 2

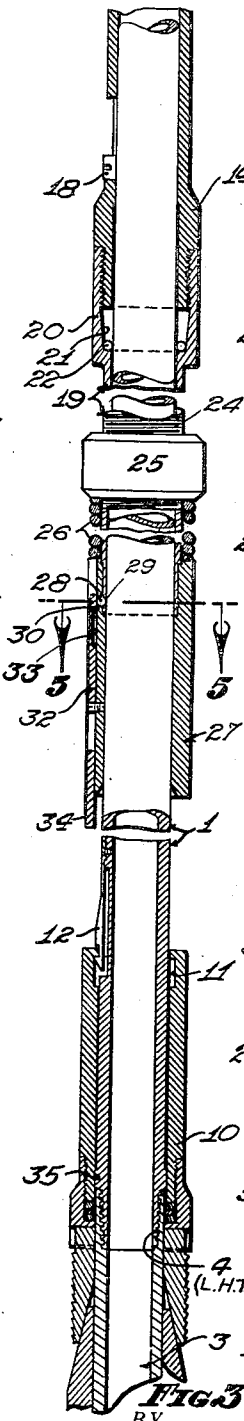


FIG. 3

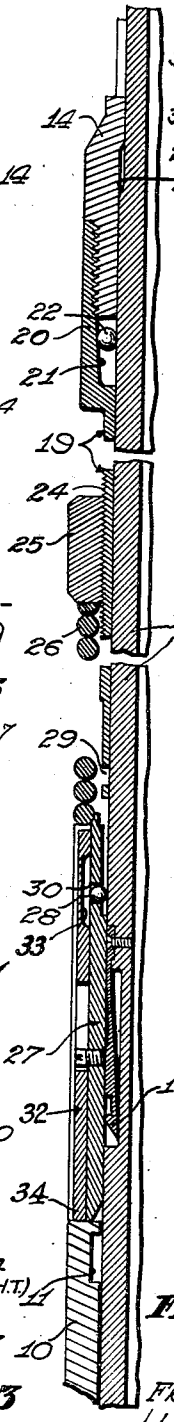


FIG. 4

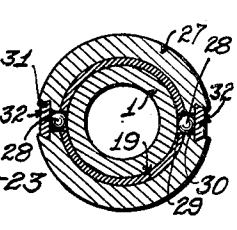


FIG. 5

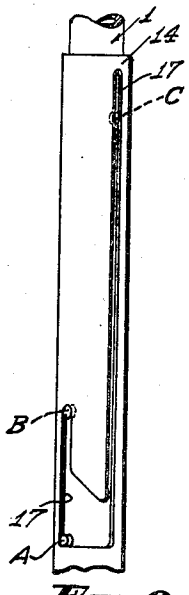


FIG. 6

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SETTING TOOL FOR CEMENT RETAINERS

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Application April 22, 1940, Serial No. 330,830

4 Claims. (Cl. 166—12)

Our invention relates to setting tools for cement retainers, and among the objects of our invention are:

First, to provide a setting tool for cement retainers or bridging plugs which is adapted to be interposed between a cement retainer or the like and a tubing string, and which is responsive to manipulation of the tubing string to set the cement retainer or bridging plug, as the case may be;

Second, to provide a setting tool of this character which is particularly fool-proof in that the possibility of accidentally setting the cement retainer is minimized;

Third, to provide a setting tool which is so arranged that even though the setting tool should be caused to operate prematurely, the cement retainer or bridging plug may still be urged downwardly to the desired level and the setting tool may thereafter be readily disconnected;

Fourth, to provide a setting tool which incorporates a safety device whereby should the cement retainer be lowered below the desired level, or engage an obstruction, the setting tool and cement retainer may be readily removed from the well so that the obstruction may be cleared away;

Fifth, to provide a setting tool of this character which provides an uninterrupted passage from the tubing string to the cement retainer without lateral openings or ports so that cementing operations through the tubing string, setting tool and cement retainer may be carried on without hindrance;

Sixth, to provide a setting tool of this character which incorporates a traveling sleeve arrangement mounted on a tubular mandrel and having a friction gauge adapted to engage a surrounding casing, the sleeve arrangement adapted by relative movement with the mandrel to set the cement retainer, but having however sufficient free play to permit normal upward movement of the tubing incidental to making up the stands of tubing into the tubing string, so that regardless of whether the sleeve arrangement is locked in its operative position or has become accidentally unlocked, the cement retainer will not be set prematurely;

Seventh, to provide a setting tool of this character which incorporates a novel, externally-positioned trip device for causing operation of the setting tool, which device is however inherently protected against accidental operation; and

Eighth, to provide a setting tool which is particularly adapted for setting cement retainers or bridging plugs of the type shown in copending application, Serial No. 325,618, filed March 23, 1940, now Patent No. 2,297,031, granted Sept. 29, 1942.

With the above and other objects in view, as may appear hereinafter, reference is directed to the accompanying drawing, in which:

Figure 1 is an elevational view of our setting tool shown in association with a cement retainer, the parts being shown in the positions assumed when the setting tool is being lowered into a well casing;

Figure 2 is a similar elevational view showing the parts in the positions assumed upon initial operation of the setting tool, in which the cement retainer has been locked in the casing, but before it has been moved into its packing position;

Figure 3 is an enlarged fragmentary, longitudinal sectional view taken through 3—3 of Figure 1;

Figure 4 is a further enlarged fragmentary sectional view taken through 4—4 of Figure 2;

Figure 5 is a transverse sectional view taken through 5—5 of Figure 3; and

Figure 6 is an elevational view of the cage sleeve, illustrating particularly the J slot and coacting locking pin.

Our setting tool includes a tubular mandrel 1 which is connected at its upper end to a tubing string 2, preferably through a suitable slip joint such as disclosed in Patent No. 1,944,481. The lower end of the mandrel 1 is connected to a cement retainer mandrel 3, preferably by a coarse left-hand threaded connection 4.

The cement retainer, with which our setting tool operates, has provided on its mandrel 3 a pair of expander cones 5, between which is positioned a packing element 6 of rubber or analogous material. The conical portions of the expander cones 5 coact with sets of slips 7. The lower set of slips abut a head member 8 provided at the lower end of the cement retainer mandrel. A suitable valve 9 may be provided in the head 8. The upper set of slips abut a setting sleeve 10 which initially extends upwardly beyond the cement retainer mandrel, which is initially positioned around the lower end of the setting tool mandrel 1.

The setting sleeve 10 is provided at its upper end with an internal annular channel 11 which forms a shoulder for engagement with a latch 12. The upper end of the latch 12 is secured to the setting tool mandrel and its free end extends downwardly for coaction with the setting sleeve for initially locking the setting sleeve against downward movement.

At the upper portion of the setting tool mandrel there is provided a cage structure 13 which comprises a cage sleeve 14 fitted around the mandrel, to which are attached the lower ends of several bow springs 15. The upper ends of the bow springs connect to a collar 16 likewise slidable on the mandrel 1. The sleeve 14 is provided with a J slot 17 and the mandrel 1 is provided with a coacting retainer pin 18.

The lower end of the cage sleeve 14 is attached to a tube 19 and the attaching portions form a clutch 20. The clutch defines an annular channel having a clutch face 21 converging slightly downwardly in relation to the mandrel 1. Clutch balls 22 are provided in the clutch. The upper portion of the mandrel 1 is slightly smaller in outside diameter than its lower portion, there being formed at the junction of these two portions a tapered shoulder 23. When the clutch 20 is above the shoulder 23 the clutch balls are inoperative to form a binding connection between the clutch and the mandrel, but when the clutch is opposite the larger or lower portion of the mandrel the clearances are such that the balls 22 function to lock the clutch against upward movement with respect to the mandrel.

The tube 19 is provided with an externally threaded upper section 24 which receives a traveler nut 25, which forms an abutment for the upper end of a setting spring 26 coiled around the lower portion of the tube 19 and constituting a yieldable member. The lower end of the setting spring 26 bears against a setting collar 27 which forms a restraining means initially holding the spring compressed. The setting collar is initially secured to the lower end of the tube 19 by one or more key balls 28 which fit in registering holes 29 and 30 provided, respectively, in the telescoping or overlapping lower end portion of the tube 19 and upper end portion of the setting collar 27 near the ends thereof.

The setting collar is provided with one or more longitudinal channels 31 of dovetail cross section which receive correspondingly shaped keeper bars or trigger members 32. Initially the keeper bars are positioned so that their upper ends cover the holes 30 in the setting collar, thereby maintaining the key balls in position to lock the setting collar and tube 19 together. Each keeper bar 32 is provided with an internal groove 33 which, when the keeper bar is moved upwardly relative to the setting collar, registers with the recess 30 in the collar to allow the key balls to move clear of the tube 19 and thereby permit downward movement of the setting collar 27 away from the tube 19. The lower ends 34 of the keeper bars or trigger members 32 normally extend downwardly beyond the lower end of the setting collar 27 so as to engage the setting sleeve 10, as will be described hereinafter. The setting sleeve together with the key balls and trigger member, or keeper bar, may be considered in their entirety as a restraining means.

Operation of our setting tool is as follows: Initially the setting tool and cement retainer are assembled as shown in Figures 1, 3 and 5, that is, the keeper bars 32 retain the key balls 28 in the holes 29 and 30; and the traveler nut 25 is screwed downwardly on the spring 26 to place the spring under compression; the clutch 20 is positioned opposite the smaller diametered upper portion of the mandrel 1, and the retainer pin 18 occupies a position at the lower end of the J slot 17, as indicated by A in Figure 6.

During downward movement of the setting tool the friction afforded by the bow springs 15 holds the cage structure 13, tube 19 and setting collar 27 in an upper position in respect to the mandrel 1, thus maintaining the retainer pin 18 in the position A shown in Figures 1 and 6.

When the desired location is reached the tubing and mandrel 1 is rotated to the right, as viewed in Figure 6, then slowly raised. When the retainer pin has reached a position near the upper end of the longer portion of the J slot, which is position C shown in Figure 6, the keeper bars 32 engage the sleeve 10 and are moved upwardly until the key balls 28 are released from holes 29 in the tube 19, whereupon the spring 26 urges the setting collar 27 and sleeve 10 downwardly, forcing the upper set of slips 7 to wedge between the corresponding cone 5 and the well casing, as shown in Figure 2. Before the keeper bar 32 engages the sleeve 10 the clutch 20 has passed downwardly beyond the mandrel shoulder 23, so that the clutch functions to prevent upward movement of the cage 19 and traveler nut 25, relative to the mandrel 1 enabling the force of the spring to be exerted downwardly on the setting collar 27 and therefore on the setting sleeve 10. In moving downwardly relative to the mandrel 1, the setting collar 27 which has an internally beveled lower end which rides upon the latch 12 to disengage the latch from the setting sleeve, yet does not itself catch on the latch. The latch is released just before the setting collar 27 engages the setting sleeve.

After the upper set of slips has been set, as shown in Figure 2, continued upward movement of the tubing string causes theh lower set of slips and lower cone to move upwardly on the cement retainer mandrel until the packing sleeve 14 is fully expanded. Suitable shear pins 7a connect the lower set of slips 7 with respect to its expander cone, so that the packing sleeve is first expanded before the slips move upwardly to lock the expander cone. After the cement retainer is anchored in the casing by setting both the upper and lower sets of slips a conventional cementing operation is carried on through the cement retainer. When this is completed the left-hand threaded joint, or connection, 4 is unscrewed, separating the setting tool from the bridging plug. It is customary to make the cement retainer of drillable material so that it may be subsequently drilled up when desired.

In order that the setting collar 27 may be withdrawn with the setting tool, the lower end of the mandrel 1 may have a slight shoulder 35. The slip joint, which is preferably interposed between the setting tool and the tubing string, serves to reduce the strain on the left-hand threaded connection to facilitate its disconnection. Such slip joints are conventionally used with left-hand thread connections between tubing strings and well tools. The keeper bar is so arranged that the setting collar is released before the setting collar engages the setting sleeve, as indicated by dotted lines in Figure 4. This enables the setting collar to strike the setting sleeve so that, if desired, conventional shear pins may be employed between the upper set of slips and expander cone.

Normally the pin 18 is positioned so that it is in line with the shorter portion of the J slot and therefore can move only from position A (shown in Figure 6) to position B, should the tubing be raised. In the course of lowering the tubing string it is necessary to connect sections or stands of the tubing end to end, and to do this the tub-

ing string is temporarily held by slips coacting with the rotary table at the mouth of the well. As each stand is connected it is necessary to raise the tubing slightly to disconnect the slips before lowering the tubing string into the well. This upward movement of the tubing string has the effect of moving the retainer pin 18 from the position A to some position upwardly with respect to the J slot. If the pin remains opposite the shortest side of the J slot it cannot move beyond position B. This may be assured under ordinary conditions by rotating the tubing string and mandrel 1 to the left, as viewed in Figure 6, from time to time.

In order to prevent accidental operation of the setting tool, even though the retainer pin should not be maintained in the position A, but should align with the longer portion of the J slot, sufficient clearance is provided between the setting collar 27 and the setting sleeve 10, as well as between the clutch 20 and the mandrel shoulder 23, to permit the necessary upward travel of the tubing string to release the rotary slips at the well mouth, thus whether or not care is exercised in lowering the tool into the well there is little or no danger of prematurely setting the cement retainer. The primary purpose, however, of the J slot, particularly the shorter side thereof, is to enable the setting tool and cement retainer to be withdrawn from the well in the event that an obstruction should be encountered, or for any other reason it is desired to remove the cement retainer without setting it. It is merely necessary in removing the setting tool to rotate the tubing and mandrel 1 to the left from time to time, as viewed in Figure 6, as it is being raised. It should be noted that the lower end of the J slot is relatively wide and that the upper edge of the cross portion of the J slot is beveled in a direction to guide the retainer pin into the shorter side of the J slot.

Various changes and alternate arrangements may be made within the scope of the appended claims, in which it is our intention to claim all novelty inherent in the invention as broadly as the prior art permits.

We claim:

1. The combination with a well device adapted to be set within a casing by relative longitudinal movement of its parts, of a setting tool comprising a mandrel removably attached to said device and suspended from a tubing string; a sleeve slidably fitting said mandrel; a spring on said sleeve; releasable spring restraining means maintaining said spring under compression connected with said sleeve and including a trigger initially projecting below said restraining means and engageable with said well device upon relative movement between said mandrel and sleeve to release said spring; releasable latching means between said sleeve and mandrel initially holding said sleeve, spring and restraining means clear of said well device; and a clutch coacting between said sleeve and mandrel for limiting said sleeve to unidirectional movement on said mandrel toward said well device.

2. The combination with a well device adapted to be set within a casing by relative longitudinal movement of its parts, of a setting tool comprising: a mandrel removably attached to said device and suspended from a tubing string; a spring; releasable means restraining said spring under compression; a trigger for releasing said restraining means to permit said spring to engage and move parts on said device to set position; and a unidirectional clutch coacting with said mandrel; said spring, restraining means, trigger and clutch being unidirectionally slidable as a unit on said mandrel toward said well device to engage said trigger with said well device to release said restraining means.

3. The combination with a well device adapted to be set within a casing by relative longitudinal movement of its parts, of a setting tool comprising: a mandrel removably attached to said device and suspended from a tubing string; a sleeve slidably fitting said mandrel; a spring on said sleeve; releasable spring restraining means maintaining said spring under compression connected with said sleeve and including a trigger initially projecting below said restraining means and engageable with said well device upon relative movement between said mandrel and sleeve to release said restraining means; means associated with said sleeve and engageable with a surrounding casing, tending to restrain said sleeve against movement relative to said casing, whereby said mandrel may move relatively to said sleeve; and an initially inoperative clutch means operative upon relative movement of said sleeve and mandrel beyond a predetermined amount for limiting said sleeve to unidirectional relative movement on said mandrel toward said well device.

4. A setting tool comprising: a mandrel; readily disconnectable means for joining said mandrel to a device adapted to be set within a casing; and a setting mechanism slidable bodily as a unit on said mandrel into engagement with said device, said setting mechanism including and carrying a clutch means engageable with said mandrel to limit said setting mechanism to movement toward said device and lock said setting mechanism against movement away from said device, said setting mechanism also including and carrying a spring, a restraining means initially holding said spring compressed and a trigger for releasing said restraining means, said trigger projecting axially from one end of said mechanism to engage said device upon movement of said setting mechanism along said mandrel into proximity thereto and upon such engagement to release said spring for action on said device.

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