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WELL DEVICE SETTING TOOL
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Figure 1
Figure 2
Figure 3
Figure 4
Figure 5

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A tool for setting well devices in wells having a gripping clip loosely confined in its axial bore for reciprocal movement into and out of supporting engagement with a well device, the bore including a portion for sustaining the clip in supporting position and an enlarged upper portion or counterbore to permit expansion of said clip into releasing position. Due to its connection to the well device, the gripping clip is movable into the counterbore upon relative downward movement of the tool to release said clip from such movement by the engagement of said device with the depending actuating rod of restraining means of the time-delay type which overrules said clip. Preferably, the latter is of one-piece construction and is formed of resilient rod-like material so as to be highly flexible and capable of being inserted into the bore of the tool through the open lower end of said bore with the clip connected to the well device.

This invention relates to new and useful improvements in tools for setting well devices in wells.

One object of the invention is to provide an improved tool for setting well devices in wells upon stops or other supports therein and having novel means for releasably connecting the tool to a well device and permitting lowering of the device on a cable, wire line or pipe through the flow conductor or tubing of a well and disconnection by mere downward movement of said tool relative to said device.

Other objects of the invention are to provide an improved setting tool having novel gripping means for releasable connection with a well device and adapted to be movably confined within the tool for movement into and out of supporting engagement with the well device; to provide said tool with a bore having a diameter sufficient to confine the gripping means in supporting position, the upper portion of the bore being enlarged to permit expansion of said gripping means out of its supporting position into releasing position and upwardly-facing means at the lower portion of said bore and between said bore and its enlarged upper portion for supporting said gripping means in its supporting and releasing positions; to provide novel gripping means of such transverse dimension and flexibility as to be capable of being inserted with the upper end of a well device into said bore of said tool through its lower end after attachment to the well device upper end whereby said bore may be of minimum diameter; to provide said gripping means with a pair of opposed flexible portions having means at their lower ends for movement into and out of detachable connection with a well device upon inward and outward flexing of the portions; to provide inwardly-directed projections at the lower ends of said flexible portions of said gripping means for movement into and out of detachable engagement with openings in a well device; to provide said tool with restraining means for resisting movement of said gripping means from its supporting position to its releasing position; to provide restraining means which coacts with a well device to control movement of said gripping means from its supporting position to its releasing position whereby said gripping means is freely movable relative to the restraining means; and to provide restraining means of the time-delay type whereby movement of the gripping means from its supporting position to its releasing position is prevented for a predetermined interval of time.

A construction designed to carry out the invention will be hereinafter described, together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawing, wherein an example of the invention is shown, and wherein:

FIG. 1 is a longitudinal, sectional view, partly in elevation, of a setting tool constructed in accordance with the invention and detachably connected to the upper end of a well device for lowering into a well.

FIG. 2 is a view, partly in elevation and partly in section, showing the setting tool and well device in releasing position.

FIG. 3 is an enlarged, perspective view of one of the nuts for mounting one of the piston members on the piston rod of the restraining means.

FIG. 4 is an enlarged, perspective view of the gripping element in releasing position.

FIG. 5 is an enlarged, longitudinal, sectional view of an intermediate portion of the setting tool showing the relationship of the piston members during downward movement of said tool relative to the well device, and

FIG. 6 is a longitudinal, sectional view of the lower portion of the setting tool showing the disengaging of the gripping element and well device during manual insertion thereof into said tool.

In the drawing, the numeral 10 designates the elongate, cylindrical body or housing of a tool for setting well devices, such as the device A, in wells upon conventional stops or other supports (not shown) in the usual manner.

Although subject to variation, the well device A has a reduced upper end or a fishing neck 11 at its upper end for releasable connection with the setting tool, and as shown, the fishing neck may be provided at the upper end of a connecting member or sub 12 screwthreaded on the upper end of the well device by a pin and box connection 13. In addition to the usual annular groove or recess 14, the upper extremity of the fishing neck may have a pair of diametrically-opposed, radial openings 15 and recesses 16 above said groove for engaging engagement with a gripping element or clip 16 which forms a part of the setting tool. Longitudinal grooves or recesses 17 extend upwardly from the openings 15 so as to enlarge or relieve the outer, upper portions of said openings to facilitate engagement and disengagement of the gripping element.

As shown most clearly in FIG. 4, the gripping element 16 includes a substantially annular, upper portion or head 18 having a pair of elongate, divergent portions or legs 19 depending therefrom in opposed relationship. Inwardly-directed feet or projections 20 are provided on the lower ends of the legs 19 for engaging in the openings 15 of the fishing neck 11 when said legs are forced inwardly or toward each other (FIG. 1). Due to the grooves 17 of the fishing neck, the legs of the gripping element are adapted to be disposed within the perimeter of said neck when the feet or projections 20 are fully engaged within the openings of said neck (FIG. 6). Preferably, the gripping element is of one-piece construction and may be formed of wire or other resilient rod-like material, with its head 18 being coiled in a helix to provide the necessary flexibility of the legs. It is noted, however, that the head could be of rigid construction with the flexibility being obtained from the resilient legs of the legs 19 so long as said head is annular or has an opening extending axially therethrough. Also, it is contemplated that the feet or projections of the legs could be designed to engage the annular groove 14 of the fishing neck rather than the openings 15,
in which event, said openings would be unnecessary and could be eliminated.

A connecting member or sub 21 is provided at the upper end of the housing 10 and has an upstanding, screwthreaded pin 22 for connecting with a socket member 23 which is adapted to be attached to the lower end of a cable, wire line or pipe (not shown) for lowering the setting tool into a well. The lower portion of the sub 21 has a screwed threaded bore 24 for receiving the connecting pin 22. An upper end or pin 25 of an upper housing section 26 which may contain restraining means B, as will be hereinafter explained. A lower housing section or sleeve 27 is screwthreaded onto the lower end of the upper section 26 and its cylindrical bore 28 is adapted to receive the gripping element 16 as well as the fishing neck 11 of the sub 12. The bore 28 is of such diameter that it confines the legs 19 of the gripping element in inwardly flexed position (FIG. 1) and has an annular, upwardly-facing shoulder 29, which is preferably bevelled, at its lower portion for supporting and preventing downward displacement of said element. As shown at 30, the lower portion of the bore may be of reduced diameter to provide the shoulder 29 and preferably, is of greater diameter than the head 18 of the gripping element to permit the upward passage of said element through bore portion into said bore. As a result, the gripping elements may be engaged with the fishing neck and then inserted into the bore 28 through its reduced lower portion 30 to detachably connect the well device A to the lowering tool. Since the grooves 17 of the fishing neck permit the legs 19 of the gripping element to be wholly disposed within the circumference of said fishing neck when the feet 20 are fully engaged within the openings 15 as shown in FIG. 6, the lower portion of the rod may be of minimum diameter or of only slightly greater diameter than said neck.

The upper portion of the bore 28 is enlarged to provide a shoulder 31, similar to the shoulder 29, and a counterebore 32 which is of such a diameter to permit outward flexing of the legs 19 of the gripping element and disengagement of the feet 20 from the openings 15 of the fishing neck 11 for disconnecting the well device A from the lowering tool (FIG. 2). Due to the upwardly facing shoulder 31, the released gripping element 16 is confined within the counterebore 32 to permit withdrawal of the tool from the well. The bevel of the latter shoulder facilitates movement of the gripping element from the counterebore into the bore 28 when it has a head of greater diameter than the shoulder 29 or bore portion 30 or when said element is of insufficient flexibility, whereby said element must be inserted through said counterebore before being engaged with the fishing neck and positioned in said bore. In either event, the gripping element is released from the fishing neck when it is moved upwardly from the bore into the counterebore by said neck upon downward movement of the tool relative to the well device.

The restraining means B is adapted to prevent premature disconnection of the well device A from the setting tool and is shown to be of the time-delay type requiring continued relative downward movement of said tool, such as when said device comes to rest on a stop in a well. Preferably, the restraining means includes a cylinder or cylindrical bore 33 extending throughout the upper housing section 26 below its pin 25 and having a cylindrical plug 34 screwthreaded in and closing its lower end. A piston assembly 35, of less diameter than the cylinder 33, is reciprocable therein and has an axial piston rod or actuating member 36 and an axial guide rod or member 37 which extends therethrough, respectively, and through openings 37 in the plug 34 and housing pin 25 (FIG. 1). The lower portion of the rod 36 is adapted to depend through the counterebore 32 of the lower housing section 27 as well as the annular head 18 of the gripping element and to terminate a slight distance above the fishing neck 11 of the sub 12 so as to permit limited downward movement of the setting tool relative to the well device without actuating the restraining means, continued relative movement of said tool being prevented by said rod engaging said neck. Annular glands 38 are screwthreaded to the piston 36 or actuating member 36 and are cylindrical or rings 39, disposed in said openings and surrounding the piston and guide rods, into sealing engagement with said rods (FIG. 5). The plug 34 may carry a similar external packing element 40 for sealing off between the lower end of the cylinder 33 into which it is screwedreduced. The guide rod 36' equals the displacement of the piston rod 36 and its upper portion is reciprocable within the bore of the upper gland 38. An axial bore 41, of relatively small diameter, extends upwardly from the bore 24 of the sub 21 to accommodate the guide rod upon relative upward movement of the piston assembly. Preferably, the bore 24 and the counterebore 32 have lateral pressure-equalizing ports 42.

A helical spring 43 is confined on the guide rod 36' between the upper end of the cylinder 33 and the piston assembly 35 for urging said piston downwardly as shown most clearly in FIG. 5. The piston assembly, preferably, includes a pair of coating, nested, cup-like members or pistons 44 and 45 having upstanding, peripheral skirts or walls 46 and 47 in concentric, spaced relationship, respectively, and axial openings 48 and 49 for mounting on the piston rod 36. Nuts 50 and 51 are screwthreaded on the upper end portion of the piston rod in spaced relation for slidably confining the outer, larger piston 44 therewithin, the axial opening 48 of said piston being of larger diameter than said rod to permit relative movement of said piston and provide a passage therethrough opening 49. The upper portion of the latter opening is enlarged to provide a recess 52 for accommodating the lower portion of the overlying nut 50 and permitting flow therearound, while the lower portion of said opening has a circumferential, stepped enlargement or recess 53 to receive the underlying nut 51 and an annular packing element or ring 54 confined on the rod 36 by said underlaying nut for sealing off said opening upon relative upward travel of said rod in said opening. As shown in FIG. 3, a diametric channel or groove 55 is formed in the underside of the overlying nut 50 and permits flow therethrough opening 48 upon downward travel of the piston assembly within the cylinder 33 which moves its larger piston 44 into engagement with said nut. It is noted that the nut 50 may be of the self-locking type.

The inner, smaller member or piston 45 is screwthreaded by its opening 49 on the lower end portion of the guide rod 36' and is clamped against displacement by an overlying jam nut 56. Due to the force of the spring 43, the smaller piston is urged downwardly so as to be disposed within the larger piston 44 in engagement with the nut 50 and with its peripheral wall 47 in concentric, spaced relation to the peripheral wall 46 of said larger piston. Axially-extending ports 57 are formed in the smaller piston to permit free flow therethrough in addition to the flow therearound. The cylinder 33 is filled with a suitable liquid, preferably one that has a stable viscosity at the relatively high temperatures encountered in deep wells. Although the larger and the smaller piston relatively close fit with the cylinder wall, a slight clearance is provided therewithin to restrict rather than prevent flow around said piston.

When it is desired to set a well device, such as the device A, in a well, the fishing neck 11 of said device is connected to the gripping element 16 by means of rod 24, and forcing its legs 19 inwardly to engage the feet 20 in the openings 15 of said fishing neck. The feet are held manually in engagement with the openings during insertion of the gripping element into the bore 28 of the lower housing section 27 through the reduced lower portion 30 of said bore, said reduced bore portion maintaining this
attachment (FIG. 6). As shown in FIG. 1, the feet 20 are adapted to rest on the shoulder 29 and are held against disengagement from the openings 15 by the legs 19 bearing against the wall of the bore so as to position the upper end of the fishing neck in relation to the lower end of the piston rod 36. The setting tool 10 is connected to the lower end of a cable, wire line or pipe by the sub 21 for lowering the device A into the well until said device comes to rest on a stop. When the gripping element 16 has a head of larger diameter than the bore 28 or is insufficiently flexible to permit insertion through the reduced lower portion of said bore, it is necessary to separate the housing sections to permit insertion of said element through the upper end of the counterbore 32 for attachment therein to the fishing neck 11 prior to positioning said element in said bore and reconnecting said housing sections. As pointed out hereinbefore, the feet of the gripping element may be designed to engage the annular groove 14 of the fishing neck instead of its openings.

Due to the spacing of the fishing neck 11 from the piston rod 36, limited downward movement of the setting tool relative to the well device A is permitted without actuation of the restraining means B, such as when said device momentarily hangs on a pipe joint or other obstruction. Continued relative downward movement of the tool is prevented by the engagement of the fishing neck with the piston rod which is urged downwardly with the piston assembly 35 by the helical spring 43. When the well device comes to rest on the stop, the engagement of the fishing neck 11 and piston rod 36 holds said rod and its nut 51 stationary whereby the larger piston 44 moves downwardly with the setting tool relative to said rod and nut into engagement with the packing ring 54 for distorting said ring so as to seal off the axial openings 45 (FIG. 2). In order to continue downward movement of the tool relative to the well device, the liquid in the cylinder 33 above the piston assembly must bypass said piston assembly through the annular space between the cylinder wall and the skirt 46 of the larger piston and the form of the helical spring must be overcome. Thus, a time delay is provided so as to control the release of the gripping element, the lapse of time varying in accordance with the clearance between the cylinder and piston walls and/or the weight imposed on the setting tool.

Upon relative downward movement of the setting tool sufficient to position the gripping element 16 within the counterbore 32 as shown in FIG. 2, the legs 19 of said element flex outwardly to disengage the feet 20 from the openings 15 of the fishing neck 11 so as to detach said tool from the well device and permit withdrawal of said tool from the well. Due to the grooves 17, complete disengagement of the feet is unnecessary. During removal of the tool, the force of the helical spring 43 moves the piston assembly 35 downwardly. Since the nut 51 moves downwardly with the piston rod 36, the packing ring 54 moves out of sealing engagement with the bottom of the recess 53 of the larger piston 44 to permit the liquid therefore to flow upwardly through the axial opening 48 as well as externally of said piston. Although the liquid below the piston assembly forces the larger piston into engagement with the nut 50, the diametric groove 55 of said nut permits upward flow of the liquid into the recess 52 and through the smaller piston 45 as well through the annular space between the walls 46 and 47 of said pistons. As a result of these passages around and through the pistons, the downward movement of the piston assembly is much faster than its relative upward travel within the cylinder 33.

The gripping element 16 remains in the counterbore 32 due to its legs 19 resting on the shoulder 31, but may be removed readily upon separating the housing sections 26 and 27. As noted hereinbefore, the gripping element is subject to variation and may be of less flexible construction as well as being incapable of passing through the reduced lower portion 30 of the bore 28. The latter, however, is a highly desirable feature because it saves time and effort in connecting the setting tool to the well device. Also, it is pointed out hereinbefore that the use of the gripping element is not limited to the use of the restraining means B or the particular structure thereof since said element will function without said means and since other types of restraining means may be employed with said element.

In addition, it is noted that the piston assembly 35 is subject to variation and that the illustrated construction only represents a preferred embodiment. Of course, when the setting tool is suspended from a cable or wire line, it is necessary to mount a weight member or sinker bar on the cable or line in order to force said tool downwardly relative to the well device and the gripping element attached to its fishing neck.

What I claim and desire to secure by Letters Patent is:
1. A tool for setting a well device in a well including a housing having an axial bore at its lower end portion for receiving the upper end of the well device, releasable gripping means loosely confined in the bore so as to be freely reciprocable therein for movement into and out of supporting engagement with the upper end of the well device, said bore being of a diameter sufficient to confine the gripping means in supporting position and having inwardly extending upwardly facing means at its lower portion for supporting said gripping means in its supporting position, said bore being stepwise to provide a counterbore at its upper portion to permit expansion of said gripping means out of its supporting position into releasing position and to provide upwardly facing shoulder means for supporting said gripping means in its releasing position, said gripping means being movable into the counterbore due to its compactness.

2. A setting tool as set forth in claim 1 wherein the releasable gripping means includes a member adapted to move into and out of supporting engagement with the upper end of the well device upon relative downward movement of the housing, and restraining means in the upper portion of said housing for preventing movement of said gripping means into said counterbore upon downward movement of said housing relative to the well device, the restraining means being axially movable relative to said gripping means and including a member depending through said counterbore for engagement by the well device upper end to prevent movement of said gripping means into said counterbore until actuation of said restraining means.

3. A setting tool as set forth in claim 1 wherein the releasable gripping means includes a head having an opening to permit the depending member of the restraining means to extend therethrough, flexible legs depending from the head, and inwardly directed projections on the lower end portions of the legs for movement into and out of detachable connection with the upper end of the well device upon inward and outward flexing of said legs, the well device having openings in its upper end for receiving the projections, said lower end portions of said legs being adapted to rest on the upwardly facing means at the lower portion of the bore of the housing and between said bore and its counterbore for supporting said gripping means in said bore and counterbore, the head of said gripping means having less flexible transverse dimension than said upwardly facing means at the lower portion of said bore to permit insertion of said gripping means into said bore through its lower end with said projections of said legs engaged with the openings of the bore.

4. A tool for setting a well device in a well including a housing having an axial bore at its lower end portion for receiving the upper end of the well device, and releasable gripping means loosely confined in the bore so as to be freely reciprocable therein for movement into
and out of supporting engagement with the upper end of the well device, said bore being of a diameter sufficient to confine the gripping means in supporting position and having inwardly extending upwardly facing means at its lower portion for supporting said gripping means in its supporting position, said bore being stepped to provide a counterbore at its upper portion to permit expansion of said gripping means out of its supporting position into releasing position and to provide upwardly facing shoulder means for supporting said gripping means in its releasing position, said gripping means being movable into the counterbore due to its connection to the well device upon relative downward movement of the housing.

5. A setting tool as set forth in claim 4 wherein the releasable gripping means is of sufficient flexibility to permit its insertion into the bore of the housing through the lower end of said bore with the upper end of the well device in supporting engagement with said gripping means.

6. A setting tool as set forth in claim 4 wherein the gripping means has opposed inwardly directed projections, the upper end of the well device having opposed openings for receiving the projections of said gripping means.

7. A setting tool as set forth in claim 4 wherein the releasable gripping means includes a head portion, flexible legs depending from the head portion, and means on the lower portions of the legs for movement into and out of detachable connection with the upper end of the well device upon inward and outward flexing of said legs.

8. A setting tool as set forth in claim 7 wherein the lower end portions of the legs of the releasable gripping means are adapted to rest on the upwardly facing means at the lower portion of the bores of the housing and between said bore and its counterbore for supporting said gripping means in said bore and counterbore.

References Cited

UNITED STATES PATENTS

849,952 4/1907 Willis 287—119 X
1,838,543 12/1931 Goldstein 287—119 X
2,483,044 9/1949 Gongwer 24—230.1
2,296,397 9/1942 Muhlback 294—86.24 X
3,186,745 6/1965 Lyles 287—119

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