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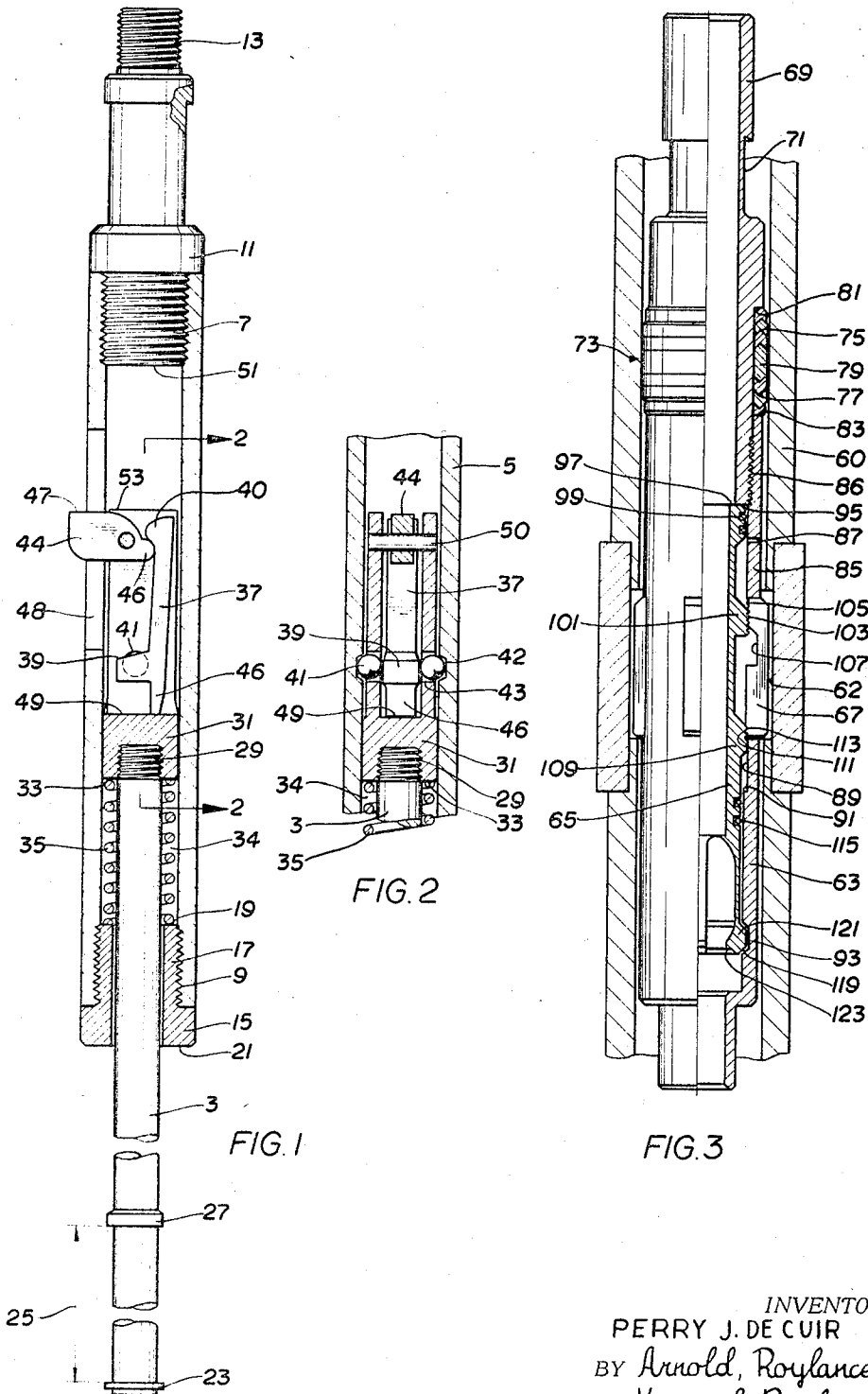
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3,430,699

ANCHORABLE AND RELEASABLE WELL TOOL

Filed Dec. 14, 1967

Sheet 1 of 3



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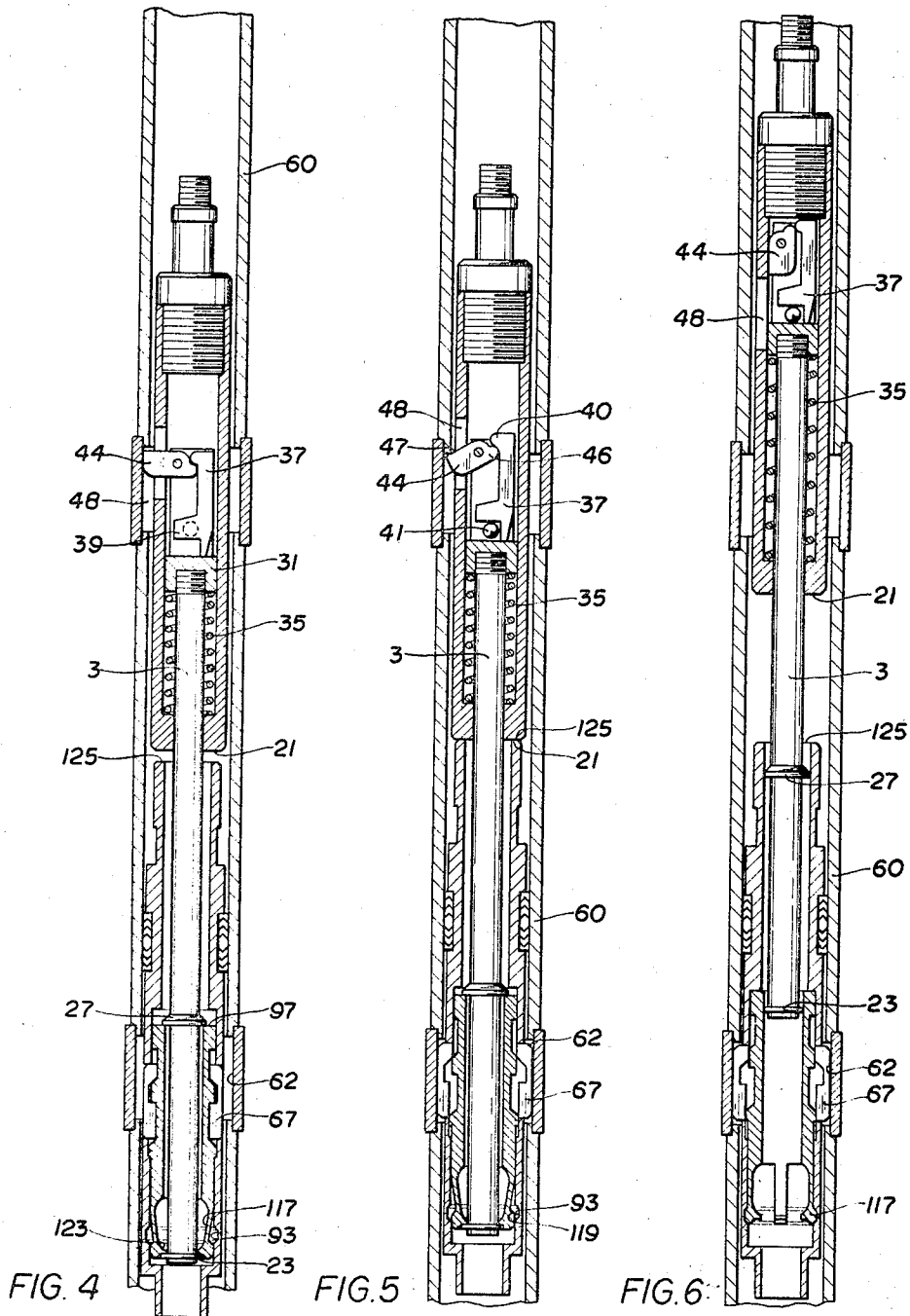
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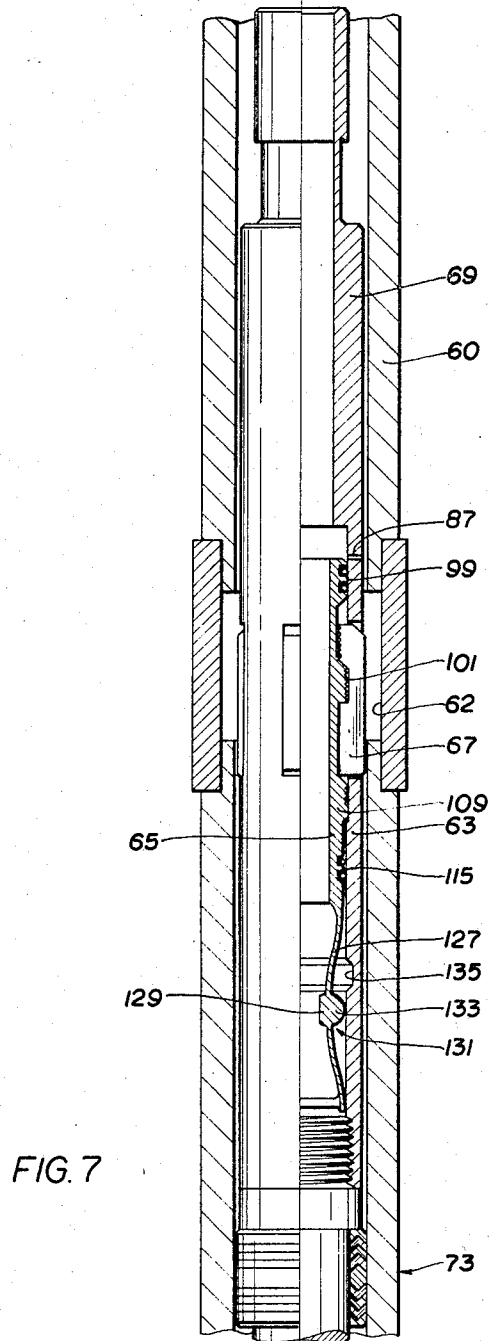
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Sheet 3 of 3



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ANCHORABLE AND RELEASABLE WELL TOOL

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ABSTRACT OF THE DISCLOSURE

An anchorable and releasable well tool is provided for being set by a wireline suspended setting tool having a position sensing and triggering means and a depending connecting rod with an enlarged bottom flange and a suitable driving shoulder. The well tool comprises an internal and external mandrel, the external mandrel having radially extendable slips for engaging a cavity in the well casing (affording the anchoring), and a plurality of depressions for cooperating with mating protrusions on the internal mandrel. The internal mandrel includes a radial resilient setting means (such as a plurality of depending arms or bows) for grasping the flange on the rod when driven downward by the driving shoulder thereon, and protrusions for allowing the slips to remain radially inward during setting and for pushing the slips anchorably outward into the desirable cavity in the casing where anchoring is to occur. The slips are anchored in the casing by these protrusions upon the upward movement of the internal mandrel, which also allows the radial resilient setting means to release the setting tool for extraction from the casing. The sensing and triggering means senses and acts on the connecting rod of the setting tool at the desirable time to cause this anchoring to occur. The setting tool unanchors the well tool in a substantially reverse manner from the anchoring procedure for subsequent lowering and setting in a new location, if desired.

The invention described herein relates to well tools and more particularly to a well tool that may be anchored downhole in a well. Generally, the well tool described herein in the form of several preferred embodiments pertains to a novel arrangement of parts that may be thought of as comprising a well setting tool or anchor carrier and the well tool anchor (that part which is left in place). The cooperative operation of the parts in the well tool anchor not only provides a means whereby the anchor may be secured by the setting tool at the desirable location along the well casing, but also provides means whereby the anchor may be subsequently moved downward into a new secured position without first being retrieved to the surface.

It is often desirable to affix an anchor within a well casing at a desired, remote depth below ground level. Also, after the purpose has been served for which the anchor was secured, it is usually desirable to remove the anchor. Of course, this should be done with as much ease as possible and without loss of the anchor or damage thereto and without damage to the well casing. Moreover, if the anchor is anchored and retrieved so as to leave it in an undamaged condition, then it may advantageously be used over and over again. Finally, if all of the above can be provided by a well tool combination that reveals to the operator of the tool that the anchor is properly and securely anchored when the setting tool is removed therefrom, yet another advantage results. None of the prior art has achieved all of the above needs to the extent of the invention hereinafter described. As will be seen, in addition to functioning in such a manner to accomplish all of the above, many other advantages are also accomplished.

The inventive well tool herein described may be thought of as a novel combination of a setting tool, anchor and proper-setting indicator device. Moreover, the anchor itself may be thought of as constituting a novel inventive sub-combination.

The setting tool generally comprises a support member readily attachable to and suspendable by a wireline cable for manipulation from ground level, a telescopically mounted depending rod attached to the anchor during setting and biased by a bias means for upward movement with respect to the support member, and triggering means which holds the rod downwardly with respect to the support member during setting and which is triggerable when the anchor is disposed at the desirable location in the well pipe (e.g., as revealed by engagement with an appropriate well pipe groove) to initiate the anchoring operation by allowing the bias means to move the rod (and the part of the anchor attached thereto) upwardly to effect locking, as hereinafter described.

The anchor which is generally suitable for being secured at an internal cavity of a well casing, such as at a nipple or box connection, generally comprises an external mandrel and a telescopically movable, internal mandrel. The external mandrel has at least one radially movable, inwardly biased slip or key for engaging the well casing cavity and two internal depressions. The first of these depressions engages a first projection on the internal mandrel for allowing the slip to be radially at its inward position (and hence free of the well casing) during setting. The first projection is removed from the first depression to effect anchoring of the slip and hence a whole anchor portion of the tool. This first depression in the external mandrel may either be in the slip itself or below the slip.

The second depression in the external mandrel receives a second projection on the internal mandrel, this projection being located on a resilient arm thereof. During setting, this second projection is located below the depression (the resilient arm thereby being pushed radially inward to hold the depending rod of the setting tool by appropriate interconnection). In effecting anchoring, this second projection is moved upward (as above described for the setting tool), thereby releasing the rod of the setting tool and causing the first projection to move the slip or key radially outward into the well casing cavity.

The trigger means included as part of the setting tool when in the running position (during the lowering of the setting tool and anchor downwardly through the well casing) bumps along the surface of the well casing annulus. Upon upward movement when the setting tool-anchor combination is in the proper location, the trigger trips to release a spring which coacts with the connecting rod attached to the internal mandrel. Movement of the internal mandrel forces the slips of the external mandrel outwardly, these slips dragging the surface of the well casing until a cavity large enough to receive the slips is encountered. When the slips set the anchor in place by their outward movement into the cavity, then the connecting rod is released.

The resilient arm on the anchor may either be in the form of a depending arm from the main part of the internal mandrel, or in the form of a bow. Also, preferably a plurality of evenly spaced, circumferentially disposed slips and arms are provided. Various other unique features of the well tool may also be included, all of which are discussed more fully hereinafter with the detailed discussion of each of the above features.

So that the manner in which the above recited advantages, objects and features of the invention, as well as others which will become apparent, are attained can be understood in detail, more particular description of the invention briefly summarized above may be had by refer-

ence to the embodiments thereof which are illustrated in the appended drawings, which drawings form a part of this specification. It is to be noted, however, that the appended drawings illustrate only typical embodiments of the invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

In the drawings:

FIG. 1 is a partial side elevation view of a preferred embodiment of the setting tool as it would appear secured with the anchor during the setting thereof.

FIG. 2 is a cross-sectional view on a reduced scale, taken at line 2—2 of FIG. 1.

FIG. 3 is a side elevation view, partially in central vertical section, showing a preferred embodiment of the anchorable well tool anchored within a well casing.

FIG. 4 is a side elevation, partially in vertical section, showing the setting tool and anchor as secured together as a unit as they would appear let in a well casing to the desired depth.

FIG. 5 is a view similar to FIG. 1, but showing the setting tool and anchor unit just prior to setting of the anchor in the well casing.

FIG. 6 is a view similar to FIG. 4, but showing the anchor secured in the well casing after being released by the setting tool but before the setting tool has been removed from the well casing.

FIG. 7 is an alternate preferred embodiment of the anchorable well tool or anchor.

Now referring to the illustrated embodiments of the invention more in detail, there is generally shown in FIG. 1 a preferred embodiment of an anchor setting tool suitable for suspension in the well casing by a cable without contacting the sides thereof, except as hereinafter described.

The anchor setting tool is comprised generally of a tubular support member 1, a cylindrical mandrel or connecting rod 3 for movement therein, and their associated, functionally related operating parts. Support member 1 is formed by a tube 5 having upper internal threads 7 and lower internal threads 9. Upper internal threads 7 engage mating external threads in head member 11 which is provided with an upper portion 13 for securing, such as by external threads 14, to a wireline assembly or the like for letting the anchor setting tool and the anchorable well tool or anchor carried therewith into and from the well from above, the details of such letting in and removing mechanism not being shown, but which are of conventional design.

Lower internal threads 9 receive and are secured to base member 15 by a reduced connecting portion 17 having an upward abutment face or spring seat 19. Base member 15 has a downward abutment face 21 provided with an axial opening through which cylindrical connecting rod 3 projects and freely telescopes. Connecting rod 3 is provided at its lower end with a radially enlarged portion, such as an annular flange 23, for securing with the anchor in a manner to be described. At a location 25 axially above flange 23 on rod 3 is an annular downward abutment face or shoulder 27, which may alternately be a series of downward abutments located in a common transverse plane of the connecting rod.

Provided at the upper end of connecting rod 3 are threads 29 to secure the connecting rod to trigger block 31, having mating internal threads in a receiving opening. Trigger block 31 is provided with a circumferential downward abutment face 33, thus forming a circumferential space 34 between spring seat 19 and face 33 and annularly between the external surface of connecting rod 3 and the internal surface of tube 5.

Expandable means either in the form of a compressible expansion means, a powder charge, or preferably a compression spring 35 is mounted in circumferential space 34 for urging support member 1 and connecting rod 3 in opposite directions upon release of the expandable

means. Trigger means for releasing the expandable means at a predetermined time is provided in the form of a trigger assembly mounted in trigger block 31. The trigger assembly comprises trigger arm 37 having a lower lug 39 and an upper lug 40. Lower lug 39, when in its lower or cocked position as shown in FIG. 1, engages a pair of trigger locking balls 41, pressing them radially outward into tube-locking recesses 42 provided in tube 5, as best seen in FIG. 2. Trigger locking balls 41 are mounted in trigger block ball grooves 43 provided in trigger block 31. A downward projection 45 of arm 37 contacts an upward surface 49 of trigger block 31.

The upper lug 40 of the trigger assembly is arranged to contact with a sensing means conveniently shown in the form of a rigid projecting member or collar pawl 44 pivotally mounted on trigger block 31 by pivot pin 50 and provided with a pawl cam 46 for engaging upper lug 40, and with an upward facing pawl point 47 projecting through pawl slot 48 provided in tube 5, contacting the well casing into which the tool is lowered in a manner to be described. Underneath pawl point 47 and downwardly facing is a gradually rounded surface. A small clothes-pin type spring (not shown) is secured around pivot pin 50 with one end contacting tube 5 and the other end secured to collar pawl 44, thus urging the collar pawl very slightly in a counterclockwise position as viewed in FIG. 1. Thus pawl cam 46 is urged very lightly into contact with upper lug 40, but not with sufficient force to trip the trigger assembly, which is secured by the resistance of trigger-locking balls 41 against lower lug 39. Also, pawl 44 may be rotated clockwise within slot 48 to bring the pawl within the radial limits of tube 5.

It will be observed that the depending connecting rod is telescopically mounted in the support member for relative movement therein within defined limits, since base member 15 limits the rod movement downward, thereby securing the support member and the connecting rod together so that they may be lowered in a well casing as a unit and not become accidentally parted. Lower abutment face 51 of head member 11 limits the upper movement of the connecting rod when upward abutment face 53 of trigger block 31 comes in contact therewith (upon expansion of spring 35).

The anchorable well tool or anchor is shown in one preferred embodiment in FIG. 3. In the position there shown, the anchor has already been secured in the well casing and the setting tool has been released. It may be seen that the object of the tool is to anchor itself within casing 60 at an existing internal cavity 62, which may be formed at the mating ends of tube casing sections or joints by an appropriate collar, the ends of the casing within the collar being axially spaced apart to form the cavity.

The anchorable well tool or anchor comprises generally an external tubular section or mandrel 63 and an internal, telescopically mounted mandrel 65 used for carrying the anchor by interconnecting with the setting tool and for anchoring the anchor in position in the well casing as manipulated by the setting tool in a manner to be described.

Mounted within the wall of the external mandrel 63 are a plurality of slips or keys 67 capable of radial extension. Preferably the plurality of slips that are circumferentially spaced around the external mandrel are uniformly spaced and are mounted substantially within a common transverse plane, so that they may all be accommodated within a common internal cavity 62 within well casing 60 for jointly supporting the anchor in place.

At the upper end of the external mandrel 63 is a conventional head piece 69, including a circumferential external groove 71 for removing the tool by an inwardly grasping fishing tool. Mounted conveniently just below this head piece is a packing assembly 73 comprising a plurality of oppositely facing V-type packing rings 75 and 77 separated by a spacer 79. The V-type ring assem-

bly is confined against upward movement at its upper end by an external annular flange 81 on the mandrel and at its lower end by an external annular flange 83. Flange 83 may be formed at the upper end of a well flow control device 85, which forms a part of the external mandrel by being threaded onto the lower threaded end 86 of head piece 69. These V-type packing rings are conventional and provide expansion and friction securing of the anchor within the casing when there is a pressure differential axially above and below the rings about the anchor by the fluids circulating within the casing.

A plurality of ports 87 communicate through the wall of flow control device 85. These ports are in substantially a common transverse plane at a location that will be explained more in detail later.

As previously mentioned, located within the wall of the external mandrel and mounted for radial movement are slips 67. Attached to the slips in conventional manner are resilient urging means, such as one or more coil springs (not shown), which retain the slips within the internal diameter of the casing during setting or translation of the well tool through the casing. Therefore, as will be seen, in anchoring the tool, the inward urging of these slip springs must be overcome in order to extend the slips radially outwardly into the cavity of the casing.

An internal radial depression 107 exists in each of the plurality of slips 67 for receiving a mating external protrusion on the internal mandrel during the setting operation, as more fully described later hereinafter. Below the slips is another internal radial depression 89, terminating at its lower end by an annular, upwardly facing shoulder 91. Another protrusion on the internal mandrel rides within depression 89 during the setting operation. During anchoring the protrusions mating with depressions 107 and 89 move out of their respective depressions and forcibly extend the slips radially outward in a manner more fully explained hereinafter when the complete sequence of operation is discussed.

Still further axially below the slips is a second internal depression or recess 93 within the internal wall of the external mandrel, which provides locking means between the external and internal mandrel of the anchor at anchoring.

The internal mandrel which has been alluded to above has an external diameter which is slightly smaller than the internal diameter of the external mandrel, thereby permitting telescopic action therewith. The internal mandrel of the anchor has a central longitudinal opening therethrough for a purpose to be more fully explained below and which allows free passage of fluid through the anchor when it is anchored in place. Upper head piece 69 of the external mandrel at its lower end (at threads 86) forms a downward abutment face 95 which on the one hand limits the upward movement of the internal mandrel and also provides an internal upward abutment face or shoulder 97 of the internal mandrel for mating with a portion of the setting tool (the internal diameter of the internal mandrel being less than the internal diameter of head piece 69). Upward abutment face 97 of the internal mandrel allows this mandrel to be telescoped within the external mandrel.

The internal mandrel contains several outwardly projecting or radially protruding parts, which will be enumerated from top to bottom. Near the top of the mandrel is conventional O-ring coupling 99 which allows the internal mandrel to move with respect to the external mandrel without appreciable fluid leaking therebetween. Below this O-ring coupling is an external protrusion 101 having in the external face thereof a plurality of annular grooves 103 which mate with similar grooves in the internal surface of slip 67 above internal depressions 107 therein. Other forms of serrated surfaces could also be provided. Another protrusion 109, including annular grooves 111, is mounted for traveling within depression 89 and, when moved in position for outwardly moving

slips 67, mates with grooves 113 located in the internal surface of slips 67 at its lower end. Below protrusion 109 is another O-ring coupling 115, which is similar to coupling 99. In all positions of relative telescopic movement of the mandrels, O-ring coupling 115 never is placed above shoulder 91, even with the internal mandrel at its upward limit.

Finally, depending from the main body portion of the internal mandrel are a plurality of radially compressed resilient setting arms 117, these arms being sprung for radial outward movement if not otherwise constrained by the internal surface of the outward mandrel or cylinder. At the lower end of each arm is a knob portion 121 having an external projection 119 and an internal projection 123. External projection 119 mates with depression or recess 93 in the internal surface of the external mandrel when the internal mandrel is moved to its upper limit with respect to the external mandrel. Internal projection 123 acts as an internal holding means for holding annular flange 23 on connecting rod 3 during the setting operation (when the internal mandrel is at its lower position with respect to the external mandrel). When external projection 119 of knob 121 is mated with depression 93, the setting arms are flexed outwardly sufficiently such that the internal diameter defined by the plurality of internal projections 123 permits releasing of flange 23.

Now referring to the sequence of operation in setting the anchor just described with the setting tool, refer to FIGS. 4, 5 and 6. In FIG. 4, the setting tool is shown secured to the anchor, the anchor having been lowered by the setting tool to a position immediately prior to the anchoring operation. The cooperative placement of the parts of the setting tool and the anchor there existing establish the setting tool as being "cocked." It may be observed that the connecting rod of the setting tool is at its lowermost position, compression spring 35 being compressed by a trigger block 31. Trigger arm 37 holds trigger block 31 downward and, in turn, is held against upward movement by locking balls 41, in the manner previously described. Collar pawl 44 is positioned for movement out of slot 48. Although in FIG. 4 pawl 44 is located opposite a cavity in the casing and therefore rotates outwardly about pivot pin 50, while being lowered in the casing, the rounded surface of the pawl contacts the casing surface to rotate pawl 44 clockwise about pivot pin 50 to align the pawl in approximately vertical position away from the trigger arm.

In order to "cock" the anchor consider that initially the anchor is in FIG. 3 condition, the setting arms 117 flexed outwardly with external projection 119 resting in internal depression 93 of the external mandrel. Connecting rod 3 depending from the setting tool is lowered so that the annular downward abutment face or shoulder 27 is in contact with upward abutment face or shoulder 97 of the internal mandrel of the anchor. In cocking the internal mandrel downward with respect to the external mandrel, downward abutment face 27 contacts upward face 97 only after flange 23 is located slightly below internal projection 123. Upon further downward movement of the connecting rod external projection 119 is moved out of depression 93, internal projection 123 at the same time moving radially inward to secure flange 23. This establishes the cocked condition existing in FIG. 4. In this position, it should be further noted that downward abutment face 21 of the base member of the setting tool is spaced slightly apart from upward abutting face 125 of the anchor, this being the upwardmost portion of head piece 69 of the external mandrel.

When the pawl goes into the cavity in casing 60 just above that in which it is desired to anchor the anchorable well tool, pawl point 47 comes into contact with the casing wall at the top of the cavity. Upon upward pulling of the wireline attached to the setting tool, as shown in FIG. 5 trigger arm 37 is urged upward by the counter-clockwise rotation of the pawl such that lower lug 39 thereof is moved upward with respect to locking balls

41, thereby releasing compression spring 35. Spring 35, upon release, moves connecting rod 3 telescopically upward within tube 5 the setting tool. This action results in the pulling up of the anchor to contactingly mate downward abutment face 21 of the setting tool with upward abutment face 125 of the anchor. At this time, slips 67 are located at the desirable location opposite the cavity 62 of casing 60. (Before the anchor is pulled slightly upward, slips 67 may be located just below cavity 62.) The mating of abutment faces 21 and 125 prevents further movement of connecting rod 3 and the anchor without their separation. Therefore, since the force resulting from the expansion of compression spring 35 is sufficient to move connecting rod 3 further upward, the anchoring operation is performed, as shown in FIG. 6.

Now turning to FIG. 6, it will be seen that upon this further upward movement of the connecting rod, external projection 119 of knob 121 on the setting arms is moved into depression 93 of the external mandrel of the anchor. This flexing of the setting arms to their outward position moves the internal diameter of the arms outward such that flange 23 at the bottom of the connecting rod is freed to move upward with respect to the internal mandrel of the anchor, which it does upon still further movement of the connecting rod. At the same time, protrusion 101 is moved out of depression 107 to contact the internal slip surface at its upper end and protrusion 109 is moved upwardly out of depression 89 to contact the internal slip surface at its lower end. The chamfered edges of the protrusions and the depressions facilitate this movement. The combined effect of the protrusions acting on the internal slip surface is the radial outward movement of the slip within the casing cavity to thereby effect anchoring.

It should be further noted that pawl 44 has moved upward sufficiently within tube 5 that it no longer is opposite pawl slot 48 and therefore does not have any tendency to interfere with the further upward movement of the setting tool as a whole. Hence, it may be seen that the setting tool may completely be removed from the casing by the wireline, thereby leaving the anchor in place with its slips urged outwardly into the cavity 62 of the casing.

As an assist in performing the trigger release operation to anchor the tool in place as has been described, the ring grooves on the outward protrusions 101 and 109 of the internal mandrel of the anchor matingly contact with the ring grooves on the internal surface of the slips, thereby effecting a positive fit. Further, once the anchor tool has met a satisfactory pressure differential between the fluid below and above packing assembly 73, the O-type packing rings are urged radially outwardly into friction contact with the internal surface of casing 60, to further hold the anchor in place while the more positive anchoring of the anchor by slips 67 is accomplished, as above described.

The setting tool may be forceably pulled from the anchor, even though the anchor is not properly anchored with the slips 67 in cavity 62. For instance, the anchor could be somehow lodged or wedged within the casing at an improper position sufficiently tight to allow upward movement of the wireline to pull by brute force the setting tool therefrom. In this event, the operator at the top of the well would know that the anchor is not properly anchored by observing that flange 23 is scarred. The operator then could take remedial action. That is, if internal projection 123 is still held in its internal position as shown in FIG. 4 and rod 3 is forced therefrom, flange 23 would be torn up by internal projection 123 and would show considerable scarring. On the other hand, if the slips are properly set such that projections 119 are within depression 93, this scarring would not result, flange 23 being released as previously described.

It may be observed that there are a plurality of lateral ports 87 located in the external mandrel and communicating with the external and internal surfaces thereof. These

ports are located substantially in a common transverse plane of the anchor. When the anchor is anchored within the casing, ports 87 are disposed below the O-ring coupling 99 in the internal mandrel. With ports 87 in this location, fluid which is outside of the mandrel, that is, between the external mandrel and casing 60, exerts pressure upward on the internal mandrel with respect to the external mandrel, thereby holding the slips in the anchored position. On the other hand, during setting, that is, when the internal mandrel is telescoped downward with respect to the external mandrel, ports 87 are located above O-ring coupling 99, thereby providing fluid passage from the external surface of mandrel 63 to the internal area of the anchor. This means that during the lowering of the anchor by the setting tool passage of fluid freely goes around the internal mandrel and actually provides a downward urging of pressure on the mandrel, thereby assisting in the holding of the internal mandrel in the cocked position.

Also, it should be further noted that although, as shown, packer assembly 73 is located above the slips, alternately or in addition thereto a packer assembly could be provided below the slips and perform substantially the same function.

If it is desirable to anchor the anchor at a location lower than that location where it is first positioned, this may be done by using the same tool used in the initial setting of the anchor, no special additional tool being required. In such event, the setting tool is cocked and lowered back into the well casing. Basically, the reverse procedure from that which has been described for anchoring the anchor is accomplished. When the connecting rod of the setting tool enters into the anchor the downward abutment face 27 on the rod comes into contact with upward abutment face 97 on the internal mandrel of the anchor. This action drives the internal mandrel downward with respect to the external mandrel, thereby causing the internal mandrel to be secured about flange 23 of the connecting rod and also moving the external protrusions on the internal mandrel opposite their corresponding depressions, namely, moving protrusion 101 opposite depression 107 and moving protrusion 109 opposite depression 89. The internal spring arrangement which urges the slips radially inward then causes the slips to move out of cavity 62, thereby unanchoring the anchor. After subsequent lowering of the setting tool-anchor combination to a new location, upon upward movement of the wireline with respect to the casing, the setting tool and the anchor act as before to anchor the anchor in place and to release the setting tool for removal. Notice that no retrieval of the anchor by a fishing tool is required to accomplish this manipulation.

To finally remove the anchor, any conventional fishing tool capable of grasping external groove 71 in head piece 69 may be used.

An alternate structure for the anchorable well tool or anchor is shown in FIG. 7. For simplicity, like parts of the anchor structure shown there are numbered to correspond with the parts of the anchor shown in FIG. 3. Instead of a plurality of depending setting arms 117, the anchor shown in FIG. 7 comprises a plurality of radially compressed resilient bows 127, having located at the respective approximate center locations thereof, knobs 129. Each knob 129 has an internal projection 131 and an external projection 133 which travels in contact with the internal surface of the external mandrel when the internal mandrel is in the cocked position. The bows are mechanically biased to urge knobs 129 outwardly. Upon upward movement of the internal mandrel with respect to the external mandrel, knob 129 allows bow 127 to flex outwardly when external projection 123 mates with depression 135 in the external mandrel. It should be noted that during setting internal projection 131 holds flange 23 of connecting rod 3 in the same manner that internal projection 123 of setting arm 117 does in the FIG. 3 em-

bodiment. That is, flange 23 is located just below internal projection 131 during setting, but when bow 127 moves outwardly the internal dimension of the internal mandrel at that point spreads outwardly sufficiently to release flange 23 for upward movement, thereby releasing the setting tool from the anchor.

Although a plurality of setting arms 117 has been described for the embodiment shown in FIG. 3 and a plurality of bows 127 has been described for the embodiment shown in FIG. 7, it is apparent that in a simplified structure only one setting arm or only one bow is required. In such a structure, the operation would be somewhat mechanically unbalanced since locking force would be exerted in only a single direction, but such a structure is operable. Therefore, what has been illustrated in FIGS. 3 and 7 are preferred embodiments, respectively, of structures having depending setting arms and bows, rather than the simplified version.

The preferred setting tool which has been described above includes a convenient triggering means for sensing when the slips are opposite the desirable cavity in casing 60. It does this by having a projecting arm for engaging a cavity casing just above the one where the slips in the anchor are to be attached. It is not required to have a setting tool of exactly the same triggering mechanism, so long as the connecting rod has a suitable mating flange that may be secured within the anchor as previously described and there is some sort of appropriate sensing and releasing means for actuating the internal mandrel with respect to the external mandrel in the general manner described above. Even though one method of sensing is by having a triggering mechanism having a pawl which comes in contact with the cavity therein, any suitable sensing means of the triggering mechanism may be used which, upon such sensing, has positioned the slips with respect to the desirable cavity within the casing where anchor is to be made.

One other advantage the anchor that has been described has over the prior art anchors is that it is dischargeable from its anchored position in well casing 60 by the dropping of the proper sized ball or other object down the casing, if desired. The internal diameter of the longitudinal central opening of the mandrel affords face 97, as previously discussed. An object striking this face with sufficient force moves the internal mandrel downward with respect to the external mandrel being held in the casing by slips 67. When the internal mandrel moves downward, then protrusions 101 and 109 are lowered into mating depressions 107 and 89, respectively, to permit the slips to move radially inward by the inwardly urging spring attached thereto and out of locking relationship with casing cavity 62. Once the anchor is unanchored in this manner, then it is free to fall to the bottom of the casing. This scheme of removing the anchor, of course, should only be employed when the loss of the anchor is of smaller concern than the inconvenience of leaving the anchor in the casing and when the normal way of removing the anchor by the setting tool or the like is for some reason not available.

While several embodiments of the invention have been described, it is obvious that various additional substitutions or modifications of the structure may be made without varying from the scope of the invention.

What is claimed is:

1. An anchorable well tool suitable for being anchored by a setting tool in a well casing having an internal cavity therein, comprising

an external mandrel having an external diameter for allowing said external mandrel to pass longitudinally through the well casing and having an internal recess;

at least one slip mounted for radial movement within said external mandrel and having an internal depression;

resilient urging means attached to said slip for retaining said slip within the internal diameter of the well

casing during translation of the well tool therethrough; and

an internal mandrel disposed within said external mandrel,

said internal mandrel, including

at least one radially compressed resilient setting arm, having

an internal holding means for securing the setting tool when said setting arm is constrained inwardly, and

external projecting means for constraining said setting arm inwardly when said internal mandrel is telescoped downwardly of said external mandrel during setting and for mating with said internal recess of said external mandrel when said internal mandrel is telescoped upwardly with respect to said external mandrel in anchoring the well tool, said upward telescoping causing said setting arm to move outwardly to release the setting tool, and

external protruding means for mating with said depression in said slip during setting and for radially extending said slip within the internal cavity of the well casing to effect anchoring of the well tool when said internal mandrel is telescoped upwardly with respect to said external mandrel.

2. An anchorable well tool as described in claim 1 wherein said internal mandrel includes a main body portion having a central longitudinal opening therethrough for receiving a depending rod portion of the setting tool for being held by said internal holding means, and wherein said radially compressed resilient setting arm is dependently secured to said main body portion.

3. An anchorable well tool as described in claim 2, wherein said internal mandrel includes an upwardly facing shoulder above said resilient setting arm for contacting a mating shoulder on said setting tool, thereby providing a means for telescoping said internal mandrel downwardly with respect to said external mandrel and securing the setting tool to the well tool by the inward movement of said setting arm.

4. An anchorable well tool as described in claim 1 wherein said internal mandrel includes a main body portion having a central longitudinal opening therethrough for receiving a depending rod portion of the setting tool for being held by said internal holding means, and wherein said radially compressed resilient setting arm is a flexible bow attached top and bottom to said main body portion, said internal holding means and said external projecting means being located at the approximate center of said bow.

5. An anchorable well tool as described in claim 1, wherein said internal holding means of said resilient setting arm includes an internal projection for fitting upwardly of a radially enlarged portion of the setting tool when said setting arm is constrained inwardly to secure the setting tool against upward movement and for allowing upward extraction of the setting tool from the well tool when said setting arm moves outwardly.

6. An anchorable well tool as described in claim 1, wherein said external mandrel has an internal depression adjacent and beneath the location of said slip within said external mandrel, and wherein said internal mandrel has an external protruding means for mating with said depression in said external mandrel during setting and for assisting in radially extending said slip within the internal cavity of the well casing to effect anchoring of the well tool when said internal mandrel is telescoped upwardly with respect to said external mandrel.

7. An anchorable well tool as described in claim 1, wherein said external protruding means of said internal mandrel has an outwardly facing serrated surface and the internal surface of said slip above said internal de-

pression has a matching serrated surface to effect positive traction mating when the well tool is anchored and to seal said surfaces against excessive flow of fluids within the well casing.

8. An anchorable well tool as described in claim 1, wherein said external mandrel includes packing means for temporarily holding said well tool within the well casing and to thereby carry at least part of the weight of said well tool during anchoring.

9. An anchorable well tool as described in claim 1, wherein said external mandrel includes at least one port located above the top of said internal mandrel when said internal mandrel is at its lowest position, thereby directing fluid flowing between the external mandrel and the well casing around said slip.

10. An anchorable well tool suitable for being anchored by a setting tool in a well casing having an internal cavity therein, comprising

an external mandrel having an external diameter for allowing said external mandrel to pass longitudinally through the well casing and having an internal recess; at least one slip mounted for radial movement within said external mandrel having an internal depression adjacent and beneath the location of said slip within said external mandrel;

resilient urging means attached to said slip for retaining said slip within the internal diameter of the well casing during translation of the well tool there-through; and

an internal mandrel disposed within said external mandrel,

said internal mandrel, including

at least one radially compressed resilient setting arm, having

an internal holding means for securing the setting tool when said setting arm is constrained inwardly, and

external projecting means for constraining said setting arm inwardly when said internal mandrel is telescoped downwardly of said external mandrel during setting and for mating with said internal recess of said external mandrel when said internal mandrel is telescoped upwardly with respect to said external mandrel in anchoring the well tool, said upward telescoping causing said setting arm to move outwardly to release the setting tool, and

external protruding means for mating with said depression in said external mandrel during setting and for radially extending said slip within the internal cavity of the well casing to effect anchoring of the well tool when said internal mandrel is telescoped upwardly with respect to said external mandrel.

11. An anchorable well tool as described in claim 10 wherein said internal mandrel includes a main body portion having a central longitudinal opening therethrough for receiving a depending rod portion of the setting tool for being held by said internal holding means, and wherein said radially compressed resilient setting arm is dependently secured to said main body portion.

12. An anchorable well tool as described in claim 11, wherein said internal mandrel includes an upwardly facing shoulder above said resilient setting arm for contacting a mating shoulder on said setting tool, thereby providing a means for telescoping said internal mandrel downwardly with respect to said external mandrel and securing the setting tool to the well tool by the inward movement of said setting arm.

13. An anchorable well tool as described in claim 10 wherein said internal mandrel includes a main body por-

tion having a central longitudinal opening therethrough for receiving a depending rod portion of the setting tool for being held by said internal holding means, and wherein said radially compressed resilient setting arm is a flexible bow attached top and bottom to said main body portion, said internal holding means and said external projecting means being located at the approximate center of said bow.

14. An anchorable well tool as described in claim 10, wherein said internal holding means of said resilient setting arm includes an internal projection for fitting upwardly of a radially enlarged portion of the setting tool when said setting arm is constrained inwardly to secure the setting tool against upward movement and for allowing upward extraction of the setting tool from the well tool when said setting arm moves outwardly.

15. An anchorable well tool as described in claim 10, wherein said external mandrel has an internal depression adjacent and beneath the location of said slip within said external mandrel, and wherein said internal mandrel has an external protruding means for mating with said depression in said external mandrel during setting and for assisting in radially extending said slip within the internal cavity of the well casing to effect anchoring of the well tool when said internal mandrel is telescoped upwardly with respect to said external mandrel.

16. An anchorable well tool as described in claim 10, wherein said external protruding means of said internal mandrel has an outwardly facing serrated surface and the internal surface of said slip above said internal depression has a matching serrated surface to effect positive traction mating when the well tool is anchored and to seal said surfaces against excessive flow of fluids within the well casing.

17. An anchorable well tool as described in claim 10, wherein said external mandrel includes packing means for temporarily holding said well tool within the well casing and to thereby carry at least part of the weight of said well tool during anchoring.

18. An anchorable well tool as described in claim 10, wherein said external mandrel includes at least one port located above the top of said internal mandrel when said internal mandrel is at its lowest position, thereby directing fluid flowing between the external mandrel and the well pipe around said slip.

19. Apparatus, comprising

a setting tool suitable for suspension in a well casing by a cable, including

a support member attachable to the cable,

a depending rod mounted in and telescopically movable with respect to said support member, means for urging said depending rod upwardly with respect to said support member,

triggering means for holding said rod in its lower position with respect to said support member during setting and releasing said rod to move upwardly of said support member during anchoring; and

an anchor suitable for being anchored in an internal cavity of the well casing, including

an external mandrel having an external diameter for allowing said external mandrel to pass longitudinally through the well casing and having an internal recess,

at least one slip mounted for radial movement within said external mandrel and having an internal depression,

resilient urging means attached to said slip for retaining said slip within the internal diameter of the well casing during translation of the anchor therethrough, and

an internal mandrel disposed within said external mandrel, said internal mandrel, having

at least one radially compressed resilient setting arm, comprising

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an internal holding means for securing
said depending rod of said setting tool
when said setting arm is constrained
inwardly, and

external projecting means for constrain- 5
ing said setting arm inwardly when
said internal mandrel is telescoped
downwardly of said external mandrel
during setting and for mating with
said internal recess of said external 10
mandrel when said internal mandrel is
telescoped upwardly with respect to
said external mandrel in anchoring the
anchor,

said upward telescoping causing 15
said setting arm to move out-
wardly to release said rod of said
setting tool, and

external protruding means for mating with
said depression in said slip during setting 20
and for radially extending said slip within
the internal cavity of the well pipe to ef-
fect anchoring of the anchor when said
internal mandrel is telescoped upwardly
with respect to said external mandrel, 25

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said support member during anchoring holding
said external mandrel in position and said rod
of said setting tool moving upwardly when re-
leased by said triggering means to anchor the
anchor and then to release said rod of said set-
ting tool to thereby allow extraction of said
setting tool from said anchor.

20. Apparatus as described in claim 19, wherein said
triggering means includes means for engaging the pipe
wall, thereby holding the setting tool and anchor at a
location to permit said slip to enter within the cavity of
the well casing during anchoring.

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