April 21, 1970 D. C. STONE, JR 3,507,329

LOCATING AND ANCHORING DEVICE FOR WELL TOOLS

Filed Nov. 25, 1968 3 Sheets-Sheet 1

Fig. 1A

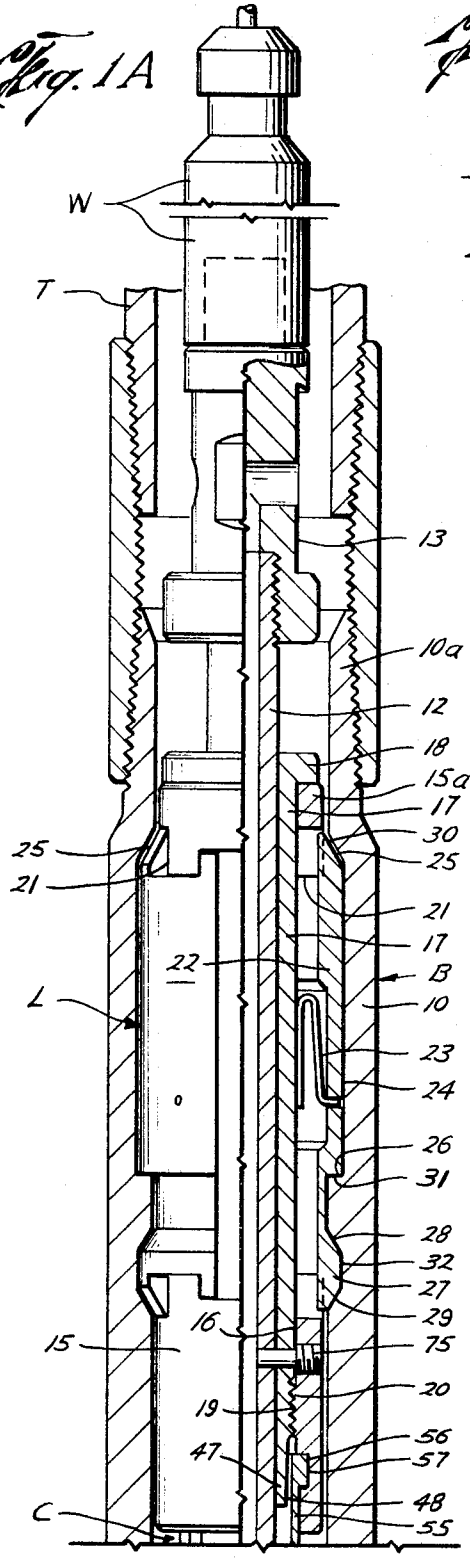
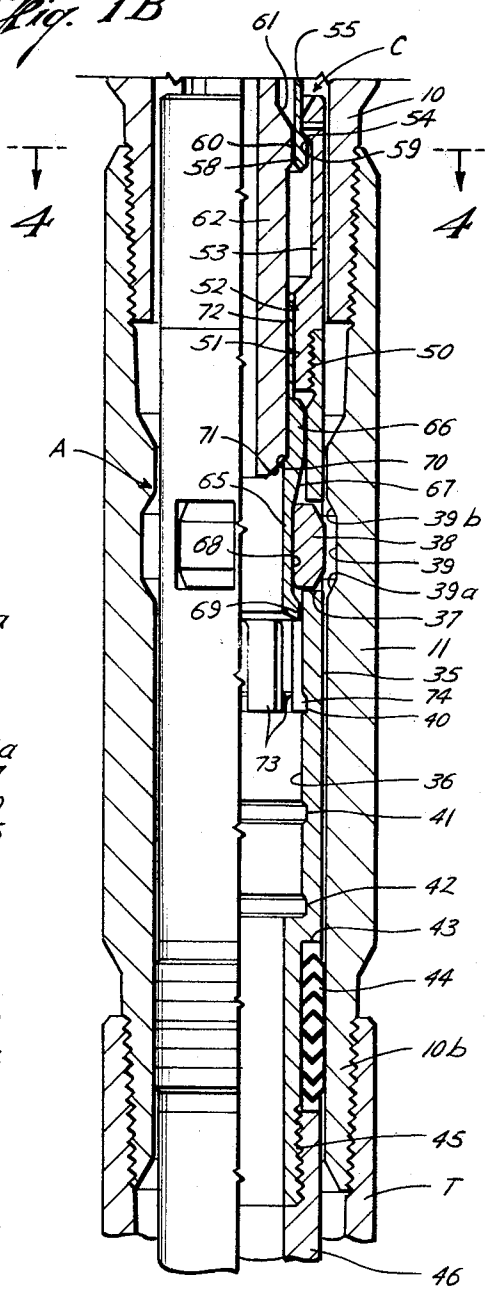


Fig. 1B



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Fig. 2

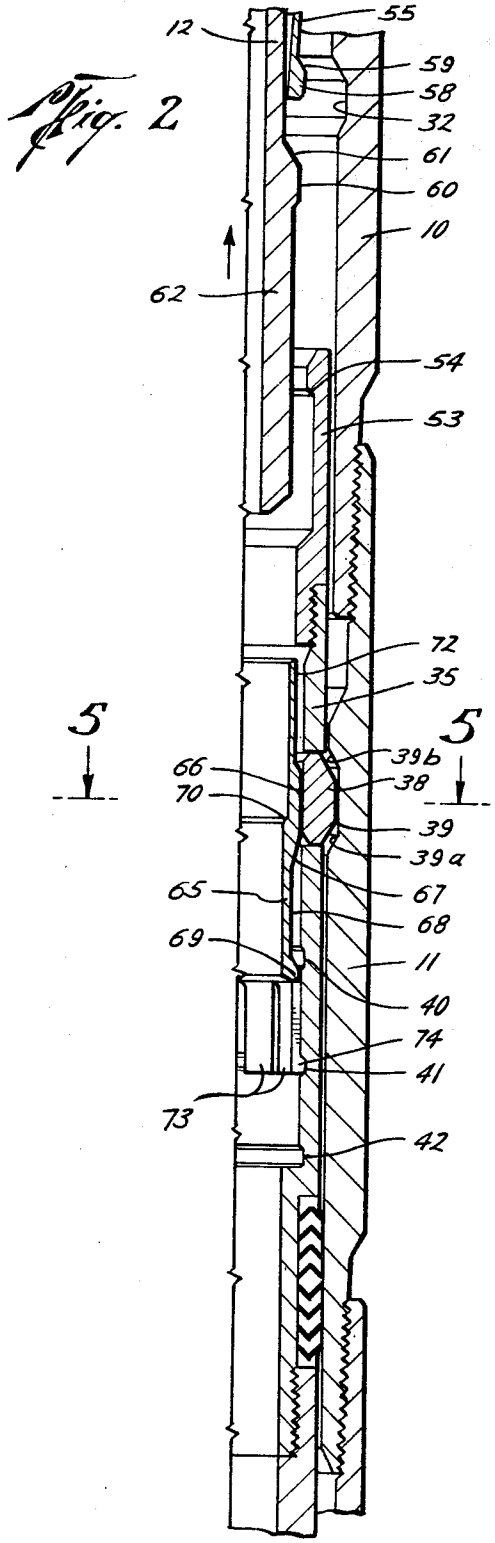
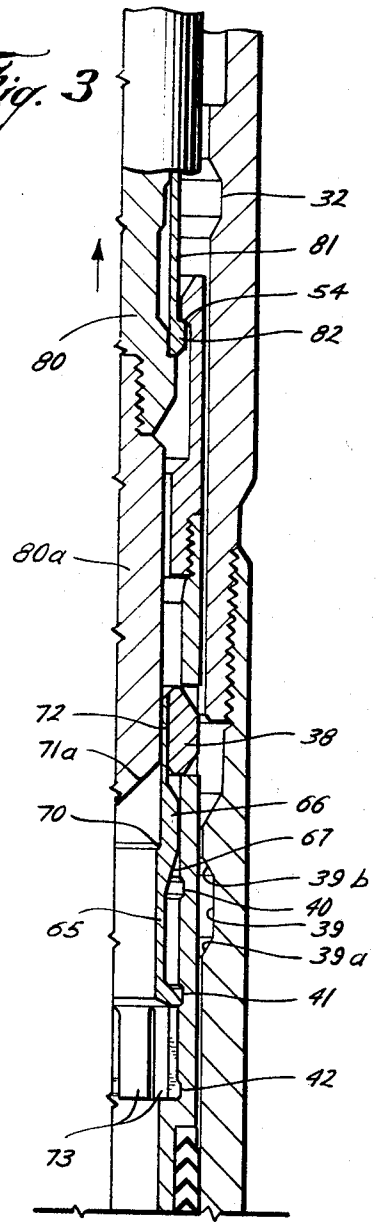


Fig. 3



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LOCATING AND ANCHORING DEVICE FOR WELL TOOLS

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Fig. 6

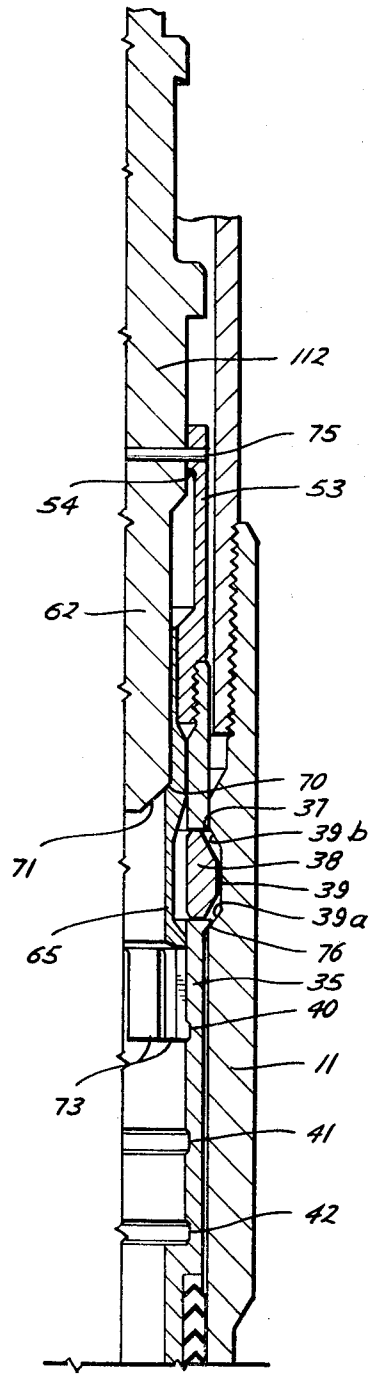


Fig. 4

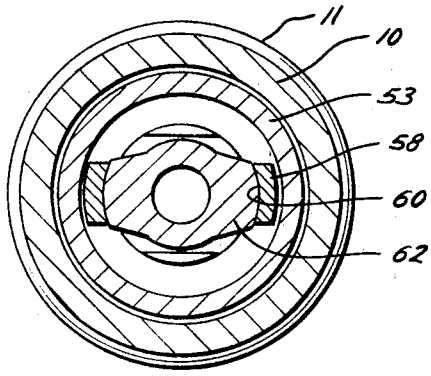
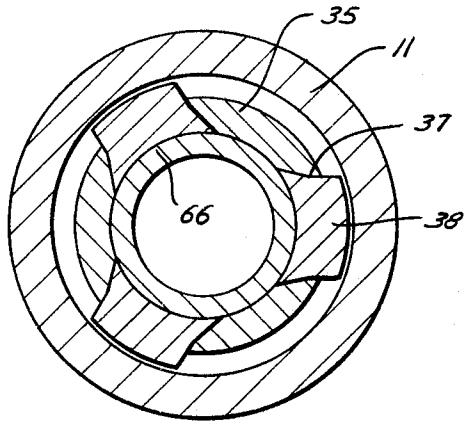


Fig. 5



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LOCATING AND ANCHORING DEVICE FOR WELL TOOLS

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Filed Nov. 25, 1968, Ser. No. 778,610
Int. Cl. E21b 23/02
U.S. Cl. 166—214 8 Claims

ABSTRACT OF THE DISCLOSURE

A tool anchor assembly for insertion in well pipes including a level selector sub-assembly and an anchor sub-assembly, the level selector sub-assembly being adapted to position the anchor sub-assembly at a selected location in the well pipe and thereafter to be released from the anchor sub-assembly for removal from the well pipe.

BACKGROUND OF THE INVENTION

In the oil and gas industry, operations to be conducted in the well often require the positioning of tools, such as pressure regulating or choke devices and the like, at different levels inside the well pipes, generally the production tubing. The installation of such tools is made usually after the tubing has been installed and the production characteristics observed so that the proper level for installation of the tools may be determined.

In anticipation of the necessity for such equipment the tubing string will be equipped initially with one or more landing nipples at different levels, having grooves for receiving the latching elements and also having locator grooves of differing shape or dimensions for cooperation with correspondingly shaped locator keys on the anchor device, whereby to enable anchoring the tools at a preselected level or location in the tubing string.

An assemblage of apparatus for thus anchoring well tools is disclosed in U.S. Patent No. 2,673,614. In this patent, as in other prior art devices for the same purpose, the locator elements and the anchor elements are made parts of a unitary structure which is required to remain in its entirety in the well pipe when the anchor elements have been actuated. As a result, a considerable mass of equipment remains in the well pipe and forms a substantially undesirable restriction in the path of flow of the well fluids through the pipe.

Where, as is often the case, it is desired to install several control devices at different levels in the production tubing, each installation requires the positioning in the well of a corresponding number of such unitary locator-anchoring assemblages, which adds greatly to the cost of the installation, as well as increasing the number of undesirable constrictions in the production string.

SUMMARY OF THE INVENTION

The present invention is directed to an improved anchor device comprising separable anchor and locator sub-assemblies operable to position the anchor assembly at a selected level in the well pipe, and to thereafter enable release of the locator sub-assembly to permit its withdrawal from the well pipe while leaving the anchor sub-assembly in its anchored position.

The anchor sub-assembly includes means, forming part of the releasable connection to the locator sub-assembly, which is engageable by a suitable fishing tool for releasing the anchor sub-assembly from anchoring engagement with the well pipe so that it also may be withdrawn from the well when desired.

With the arrangement in accordance with this invention only the anchor sub-assembly will be left in the well pipe during production. The cost of the tools for equipping a well is thus greatly reduced as compared with more conventional systems, such as described above, and flow restrictions will be reduced to minimal proportions.

Other and more specific objects and advantages of this invention will be come more readily apparent from the following detailed description when read in conjunction with the accompanying drawing which illustrates useful embodiments in accordance with this invention.

In the drawing:

FIGS. 1A and 1B, together, comprise a longitudinal, partly sectional view of an anchor assemblage in accordance with this invention disposed in a well tubing, the parts being shown in the positions occupied before the anchor elements are actuated but after positioning by the locator sub-assembly;

FIG. 2 is a longitudinal, partly sectional view showing the anchor sub-assembly actuated and the locator sub-assembly in process of being removed;

FIG. 3 is a view generally similar to FIG. 2 showing the anchor sub-assembly in process of being retrieved;

FIG. 4 is a cross-sectional view taken along line 4—4 of FIG. 1A;

FIG. 5 is a cross-sectional view taken along line 5—5 of FIG. 2; and

FIG. 6 is a longitudinal, partly sectional view of a modification of the present invention.

Referring to FIGS. 1A and 1B, the assemblage includes a tubular body, designated generally by the letter B, connectible by its opposite ends between adjacent sections of a tubing string T to form a part thereof. In the embodiment, as illustrated, body B comprises a tubular locator nipple **10**, the lower end of which is threadedly connected to the upper end of a landing nipple **11**, the free ends of the nipples are provided with threaded pins **10***a* and **10***b*, respectively, for connecting them into the tubing string.

The anchor structure comprises an upper locator sub-assembly, designated generally by the letter L, a lower anchor sub-assembly, designated generally by the letter A, and a connector sub-assembly, designated generally by the letter C, releasably connecting sub-assemblies A and L to each other.

A tubular mandrel **12** extends axially through the bore of body B and forms a common support for the several sub-assemblies. The upper end of mandrel **12** is threadedly connected to a fishing neck **13** connectible at its upper end to a generally conventional string of wire line tools W, which will ordinarily include a set of jars (not shown), for performing the various manipulations required for operation of the anchor assemblage as will appear subsequently.

Locator sub-assembly L includes a generally tubular locator body **15** having a bore **16** appreciably larger in diameter than mandrel **12**, the annular space thus provided therebetween being occupied by a sleeve **17** through which mandrel **12** is slidable. The upper end of sleeve **17** has an enlarged head **18** engageable with an upper retainer ring **15***a* spaced above body **15**. At a point spaced a short distance above its lower end sleeve **17** is provided with a section of external threads **19** receivable in a section of threads **20** in bore **16** at a point spaced from the lower end of body **15**. The thread sections **19** and **20** permit sleeve **17** to be screwed tightly to body **15**. Sleeve **17** has its lowermost end portion formed to define a downwardly and inwardly tapering smooth-surfaced tip **47** to define with the inner end surface of body **15** below threads **20** a downwardly diverging annular space **48**.

Locator body **15** and retainer ring **15***a* are provided with a plurality of angularly spaced, registering slots **21** arranged to receive and retain the opposite ends of elongate locator keys **22** each of which is biased out-

wardly of the body by a spring **23** bearing against the exterior of sleeve **17**. The exterior shape of keys **22** is made to cooperate with a locator recess **24** of substantially identical complementary shape provided in the bore wall of locator nipple **10**. This complementary arrangement is a well known indexing device by which tools may be landed at a particular location in a pipe string. The aforementioned U.S. Patent No. 2,673,614 illustrates such a locator device, the details of which do not form a part of this invention. As illustrated, keys **22** have a downwardly and outwardly bevelled upper end **25**, a downwardly facing square shoulder **26** spaced from its lower end, the latter being formed below shoulder **26** with an outwardly extending enlargement **27**. The upper end of the latter is defined by an unwardly and inwardly sloping end face **28** and its lower end by a downwardly and inwardly sloping end face **29**.

As noted, the shape of locator recess **24** is of substantially identical complementary shape to the exterior shape of keys **22** and accordingly has a downwardly and inwardly sloping upper end surface **30** matching end surface **25**; an upwardly facing internal square shoulder **31** forming an abrupt stop for the locator subassembly upon engagement by key shoulder **26**; and an annular groove **32** matching in shape enlargement **27** and its sloping end surfaces **28** and **29**.

With the described construction of the locator subassembly and its cooperating locator nipple **10**, it will be evident that when the assemblage is lowered to a point opposite recess **24**, the locator keys will snap into the recess and further downward movement will be stopped abruptly by abutment of shoulder **26** with shoulder **31**. The bevelled end surface **28** of enlargement **27** will cooperate with the related portion of groove **32** to force enlargement **27** inwardly when upward pull is applied to the locator sub-assembly to thereby compress springs **23**, forcing the keys inwardly to allow the locator subassembly to be pulled upwardly out of locator nipple **10** for purposes to be described hereinafter.

Anchor sub-assembly A includes a tubular anchor cage **35** having a bore **36** and provided with a plurality of angularly spaced windows **37** in each of which a locking dog **38** is mounted for radial movement into and out of an annular locking groove **39** in the bore wall of landing nipple **11** when the dogs have been positioned in registration with groove **39** which has bevelled end walls **39***a* and **39***b*.

Beginning a short distance below windows **37**, bore **36** is provided with three successively lower, axially spaced circumferential latching grooves **40**, **41** and **42**, each having bevelled end walls. The lower end of cage **35** below lowermost latching groove **42** is reduced in diameter externally to provide a seat **43** for seal packing **44** adapted to seal between the cage and the wall of nipple **11**. The lower end of cags **35** is externally threaded at **45** for reception in a threaded socket of a tool part **46** which serves as a gland for retaining the packing and which may be a part of a tool which is to be anchored in the tubing.

The upper end of cage **35** has an internally threaded socket **50** adapted to receive the externally threaded pin **51** having an axial bore **52** carried by the lower end of a tubular extension **53**. The upper end of extension **53** is formed with an internal downwardly and inwardly sloping shoulder **54** which forms a part of connector sub-assembly C. Other parts of the latter include a number of angularly spaced latch fingers **55** having hinge knobs **56** at their upper ends received in a hinge groove **57** formed in the bore wall of the lower end of body **15** opposite tip **47**. The lower ends of fingers **55** are thickened to form outwardly projecting latching heads **58** having downwardly sloping, upwardly facing shoulders **59** adapted to be engaged beneath shoulder **54** when urged outwardly by an annular enlargement **60** having a bevelled upper surface **61** formed on a thick walled section **62** defining the lower end portion of mandrel **12** and sometimes hereinafter referred to as a "stinger" or "prong."

It will be evident from the foregoing description of the parts of connector sub-assembly C, that when mandrel **12** is in its fully inserted position, as seen in FIGS. 1A and 1B, enlargement **60** will be thrusting fingers **55** outwardly, placing latching shoulders **59** on latching heads **58** beneath shoulder **54**, thereby maintaining a connection between locator sub-assembly L and anchor sub-assembly A. When stinger **62** is moved downwardly from the position shown in FIG. 1B for a distance placing bevelled surface **61** below latching heads **58**, latching fingers **55** will be free to swing inwardly releasing the engagement between shoulders **59** and **54** whereby to permit the locator sub-assembly to be released from the anchor subassembly for withdrawal from the tubing, as will be described more fully hereinafter.

Slidably mounted in bore **36** of the anchor cage is a tubular latching sleeve **65**, having an intermediate portion thickened outwardly to form an annular expander **66** having a downwardly and inwardly sloping expander surface **67** merging into a generally cylindrical recess **68** in the outer surface of sleeve **65**. The lower end of recess **68** is defined by an outwardly extending lip **69**. Recess **68**, when disposed opposite locking dogs **38** will permit inward movement of the latter sufficient to clear locking groove **39**, as seen in FIG. 1B. Downward movement of sleeve **65** relative to cage **35** will urge dogs **38** outwardly into locking groove **39** through coaction of expander surface **67** with dogs **38**. When expander **66** is disposed behind dogs **38**, the latter will be held in locked position in groove **39**.

The bore of sleeve **65** is counterbored from its upper end to a point intermediate the ends of expander **66** to define an upwardly facing shoulder **70** which is engageable by the lower end **71** of stinger **62**. The portion **72** of sleeve **65** above expander **66** is also reduced in thickness to extend into the annular space between the exterior of stinger **62** and bore **52** of cage extension **53**, when the parts are in the positions shown in FIG. 1B.

The lower end of sleeve **65** carries a collet which is split longitudinally at a plurality of angularly spaced points to form a plurality of resilient detents or fingers **73**, the lower ends of which are formed with outwardly projecting lips **74** adapted to be received in latching engagement in the several latching grooves **40**, **41** and **42**, during the operation of the device to be described subsequently.

When the anchor assemblage is initially inserted in the tubing, one or more shear screws **75** will be mounted in body **15** to extend radially through sleeve **17** and mandrel **12** to initially hold the anchor sub-assembly in the unactuated position illustrated in FIGS. 1A and 1B.

OPERATION

In operation of the above described device, tubing T will be equipped with one or more of the bodies B located at different elevations depending upon where it may be desired to land tools of the general type previously mentioned. As is common practice, it will be understood that the several locator nipples **10** will usually be provided with locator recesses **24** of varying dimensions to enable indexing of the tools at a desired location by the employment of a locator sub-assembly of appropriate configuration to match that of the landing recess. The tool assemblage having mandrel **12** connected to fishing neck **13** and the latter, in turn, suspended from a string of wire line tools will be run into the well tubing. The wire line tools will usually include suitable jar elements (not shown) by which appropriate jarring blows may be applied to the tool string when required in the course of operation.

As indicated previously, the parts of the assemblage are initially in the positions illustrated in FIGS. 1A and 1B. As the assemblage is lowered through tubing T and lo-

cator sub-assembly L comes opposite recess **24** in locator landing nipple **10**, springs **23** will urge keys **22** outwardly, causing shoulders **26** to engage on shoulders **31**, stopping further downward movement of the assemblage, the parts of the locator sub-assembly then occupying the positions illustrated in FIG. 1A.

At this stage, it will be understood that the tool dimensions will have been selected and arranged so that locking dogs **38** will be disposed opposite locking grooves **39** in the anchor landing nipple **11**. When the locator sub-assembly L has been landed, the wire line jars will be operated to apply downwardly directed jarring blows to mandrel **12** sufficient to break shear screws **75**, thereby releasing the mandrel for downward movement relative to the connector sub-assembly C, and the anchor sub-assembly A. The downward movement of mandrel **12**, effected by the jarring blow, will cause stinger **62**, acting on shoulder **70**, to drive expander sleeve **65** downwardly, moving expander **66** behind dogs **38** and pushing the latter outwardly into locking groove **39**, as illustrated in FIG. 2. This downward movement of expander sleeve **65** will force lips **74** of collet fingers **73** out of uppermost groove **40** into the next lower latching groove **41**, which will be spaced sufficiently below latching groove **40** to position expander **66** behind dogs **38**, again as shown in FIG. 2.

Also, the downward movement of stinger **62** relative to cage **35** and its extension **53** will move enlargement **60** below latches **58**, allowing the latter to swing inwardly and clear shoulder **54**. This will result in the release of any further connection between the locator sub-assembly and the anchor sub-assembly. Upward pull may now be applied to the wire line string causing mandrel **12** to be pulled upwardly out of extension **53** and causing shoulder **61** on enlargement **60** to engage beneath latches **55**, enabling upward pull to be applied to the locator sub-assembly. This upward pull will be applied through the coaction of the bevelled ends of enlargements **27** with bevelled end walls **28** of groove **32** to force enlargements **27** out of groove **32**, urging the keys **22** inwardly against the force of springs **23** sufficiently to allow the entire locator sub-assembly to be pulled out of locator landing nipple **10**, and thence upwardly through the tubing string to the surface. This movement is illustrated, in part, in FIG. 2, which also shows latching sleeve **65** in holding position against dogs **38** with collet fingers **73** latched into groove **41**, thereby anchoring the tools supported by the anchor sub-assembly in the desired position.

To withdraw the anchor sub-assembly, the wire line string carrying a catcher head **80** will be run back into the tubing to insert a releasing prong **80***a* into the bore of expander sleeve **65**, as seen in FIG. 3, until lower end **71***a* of the releasing prong again contacts shoulder **70** of the latching sleeve. The wire line operating string will be equipped with catcher head or spear **80** screwed to the upper end of prong **80***a*. Spear **80** will include latching fingers **81** having shouldered heads **82** disposed to engage beneath shoulder **54** on extension **53** when upward pull is to be applied to the anchor sub-assembly.

With the lower end **71***a* of the releasing prong now bearing against shoulder **70**, a downward jarring blow through the wire line string will drive sleeve **65** downwardly sufficiently to move expander **66** below dogs **38**, placing the relatively thin sections **72** of the upper end of the latching sleeve behind dogs **38**, thereby permitting the latter to move inwardly out of locking recess **39**. Downward movement of the latching sleeve to thus release dogs **38** will force collet fingers **73** out of latching groove **41** and move them downwardly until they engage in lowermost latching groove **42**, thereby holding the latching sleeve in the dog-releasing position. Upward pull may now be applied through the wire line string to catcher head **80** and this upward movement will actuate spear **80** to cause latching heads **82** to engage beneath shoulder **54**, thereby again securing the running string to the anchor sub-assembly and permitting the latter to be pulled out of the tubing in response to further upward pull applied to the wire line string.

FIG. 6 illustrates a modification of the device hereinbefore described, in which the locator sub-assembly is dispensed with and only the anchor sub-assembly is to be positioned in the tubing. This situation arises where it is desired to anchor a tool at only one location in the well bore. In this modification, anchor sub-assembly A is substantially identical with that previously described; instead, however, of the latching type connector sub-assembly previously employed, extension **53** is secured directly to a mandrel **112** by means of shear pins **75**. The cage **35** is provided at the base of windows **37** with an outwardly projecting lip **76** adapted to engage the lower end wall **39***a* of recess **39** forming what is termed in the art a "no go" shoulder which limits downward movement of the anchor assembly to a position placing locking dogs **38** opposite groove **39** and preventing further downward movement of the locking dogs on cage **35** relative to landing nipple **11**. In this modification, therefore, landing nipple **11** also functions as the locator nipple. The portion of landing nipple below recess **39** is made to slightly greater thickness than that above the recess, thus causing end wall **39***a* to form an inwardly extending projection for abutting engagement by lip **76**.

To advance the dogs into locking engagement in groove **39**, downward jarring through the wire line string will be applied to break shear pin **75**, thereby driving latching sleeve **65** downwardly by reason of the engagement of lower end **71** of the stinger on shoulder **70** on the latching sleeve and moving collet fingers **73** out of latching recess **40** into latching recess **41**, whereupon the anchor sub-assembly will assume the anchored position as illustrated in FIG. 2.

Removal of the anchor sub-assembly will be effected much the same way as previously described, except the wire line string will be equipped with a suitable catcher device of well-known construction, such as catcher head **80**, adapted to engage shoulder **54** of cage extension **53** after prong **80***a* has jarred the expander sleeve downwardly a sufficient distance to release dogs **38** and bring collet fingers **73** into engagement with latching groove **42**, also as previously described.

It will be understood that various other alterations and modifications may be made in the details of the illustrative embodiments within the scope of the appended claims but without departing from the spirit of this invention.

What I claim and desire to secure by Letters Patent is:

1. A device for releasably anchoring a well tool at a selected level within a well pipe, comprising:

(a) a support member;

(b) a locator sub-assembly mounted on the support member for positioning the device at a selected level in the well pipe;

(c) an anchor sub-assembly mounted on the support member below the locator sub-assembly for anchoring the well tool in the well pipe at said selected level, said anchor sub-assembly comprising:

(i) a tubular cage carrying anchor elements radially movable into and out of engaging positions relative to an opposed locking recess in the well pipe;

(ii) an expander sleeve axially movable in the bore of the cage between positions actuating and releasing said anchor element; and

(iii) cooperating latch means on said sleeve and said cage for holding said sleeve in each of said positions;

(d) connector means releasably connecting the anchor subassembly to the locator sub-assembly; and

(e) means operable in response to longitudinal movement of the support member relative to said anchor sub-assembly to actuate the latter while simultaneous releasing said connector means whereby to

permit withdrawal of said locator sub-assembly said well pipe independently of said anchor sub-assembly.

2. The device according to claim 1, wherein said cooperating latch means comprises:

(a) a plurality of angularly spaced detents carried by the lower end of said sleeve; and

(b) a plurality of axially spaced annular detent-receiving recesses in the opposed bore wall of said cage.

3. The device according to claim 2, wherein said detent-receiving recesses are three in number, and spaced to hold said sleeve in a first release position, an actuating position, and a second release position.

4. A device for releasably anchoring a well tool at a selected level within a well pipe comprising;

(a) a support member;

(b) a locator sub-assembly mounted on the support member for positioning the device at a selected level in the well pipe;

(c) an anchor sub-assembly mounted on the support member below the locator sub-assembly for anchoring the well tool in the well pipe at said selected level;

(d) connector means releasably connecting the anchor sub-assembly to the locator sub-assembly and including:

(i) radially movable latch elements extending between the locator sub-assembly and a latch-engaging part on said anchor sub-assembly; and

(ii) an annular enlargement on said support member longitudinally movable thereby between latch-holding and latch-releasing positions with respect to said latch-engaging part; and

(e) means operable in response to longitudinal movements of the support member relative to said anchor sub-assembly to actuate the latter while simultaneously releasing said connector means whereby to permit withdrawal of said locator sub-assembly from said well pipe independently of said anchor sub-assembly.

5. The device according to claim 4, including frangible means extending between said support member and a part of said locator sub-assembly to initially hold said support member against downward movement relative to said anchor sub-assembly.

6. The device according to claim 2, including an upwardly facing internal shoulder in the bore of said sleeve engageable by downward movement of said support member to move said sleeve between said positions.

7. In combination with a tubular landing section adapted to form a part of a well pipe, said landing section having in the bore wall thereof an annular upper locator recess and a lower annular anchor groove, a well tool anchoring device insertible through the well pipe into said landing section including:

(a) a tubular support member;

(b) a locator sub-assembly mounted on the support member and carrying means projectible into said locator recess to position the anchoring device at a selected level in the well pipe;

(c) an anchor sub-assembly mounted on the support member below the locator sub-assembly and carrying radially expansible anchor elements projectible into said anchor groove for releasably anchoring the device to the landing section; said projectible means and said expansible anchor elements being so spaced that when said projectible means are in said locator recess, said anchor elements are positioned opposite said anchor groove;

(d) connector means releasably connecting the anchor sub-assembly to the locator sub-assembly; and

(e) means operable in response to longitudinal movement of said support member relative to said anchor sub-assembly to project said anchor elements into said anchor groove while simultaneously releasing said connector means whereby to permit withdrawal of said locator sub-assembly from said well pipe independently of said anchor sub-assembly.

8. In combination with a tubular landing section adapted to form a part of a well pipe and having an annular anchor groove in the bore well thereof, a well tool anchoring device insertible through the well pipe into said landing section including:

(a) a tubular support member;

(b) an anchor sub-assembly mounted on the support member including a tubular cage carrying radially expansible anchor elements projectible by relative axial movement of said support member into said anchor groove;

(c) stop means carried by said sub-assembly for landing the sub-assembly in said landing section at a first position at which said anchor elements are in registration with said anchor groove;

(d) means initially securing said support member to said cage in non-projecting relation to said anchor elements and releasable by downward force on the support member to permit downward movement of the latter to a second anchor-element projecting position; and

(e) cooperating latch means on said support member and said cage for holding said support member in each of said positions.

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I. A. CALVERT, Assistant Examiner

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