Dec. 5, 1967 A. K. KLINE 3,356,141

OIL WELL HOLD-DOWN TOOL

Filed March 12, 1965 4 Sheets-Sheet 1

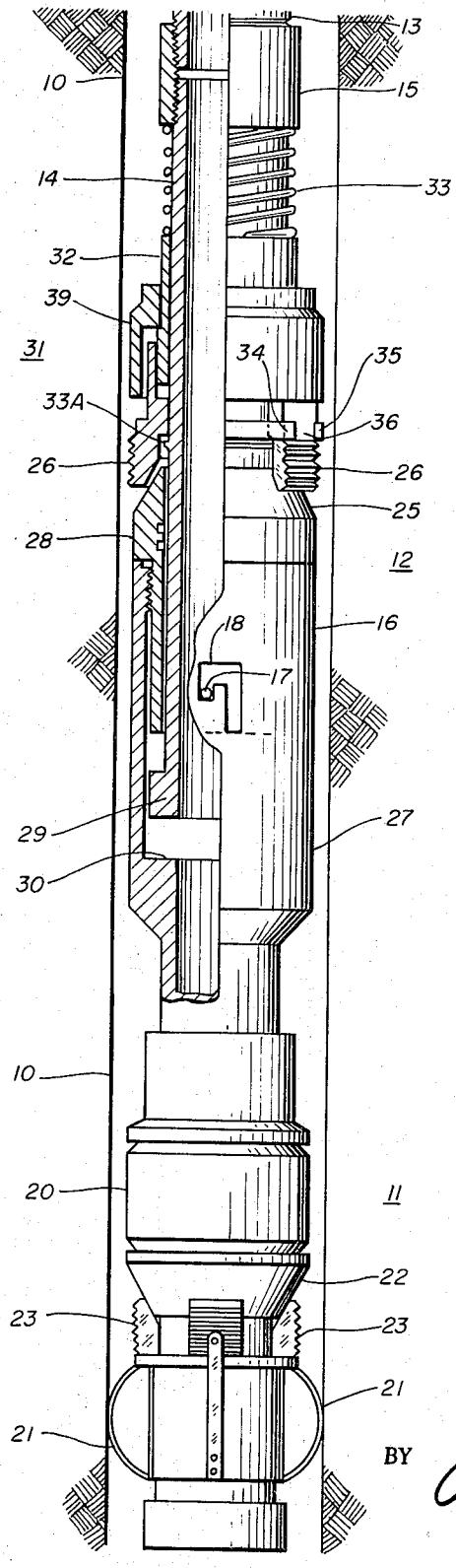


Fig. 1.

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OIL WELL HOLD-DOWN TOOL

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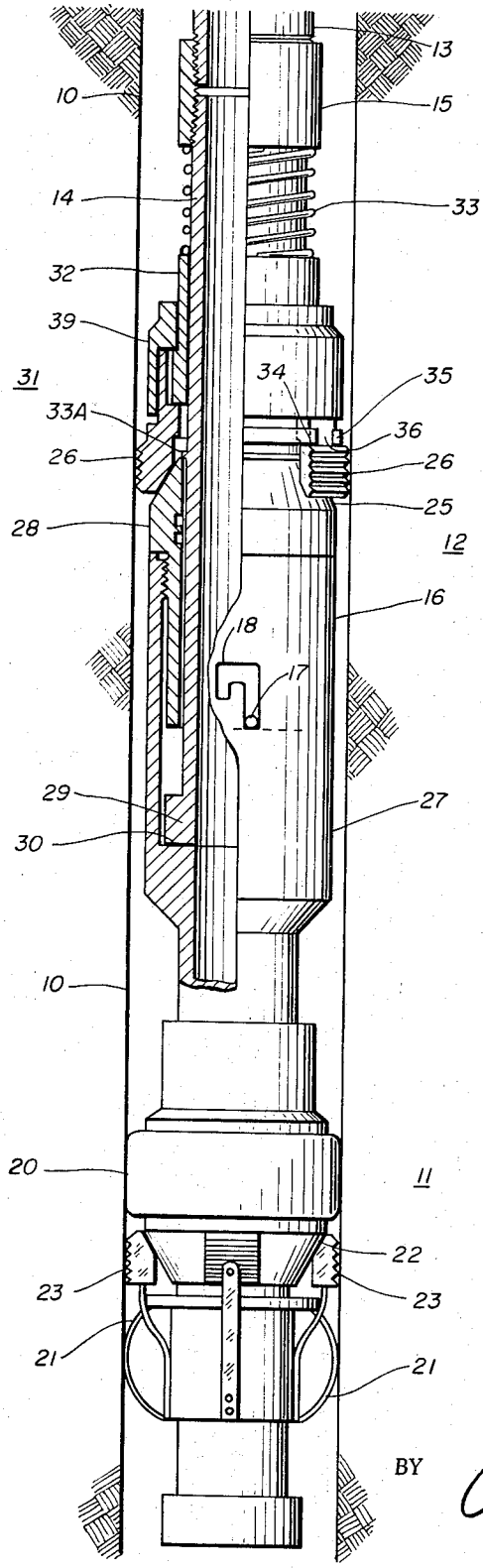


Fig. 2.

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OIL WELL HOLD-DOWN TOOL

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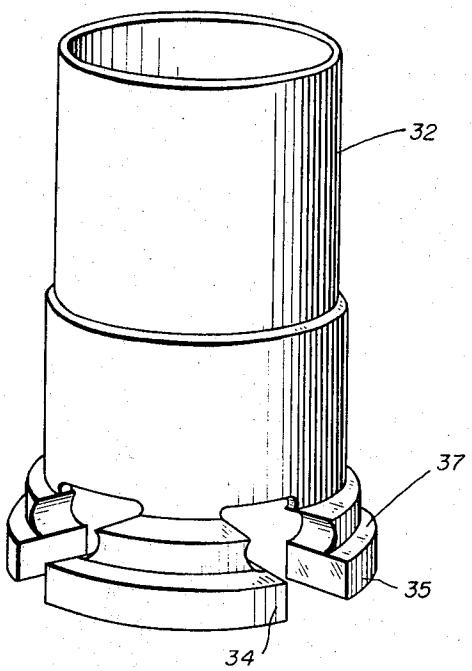


Fig. 3.

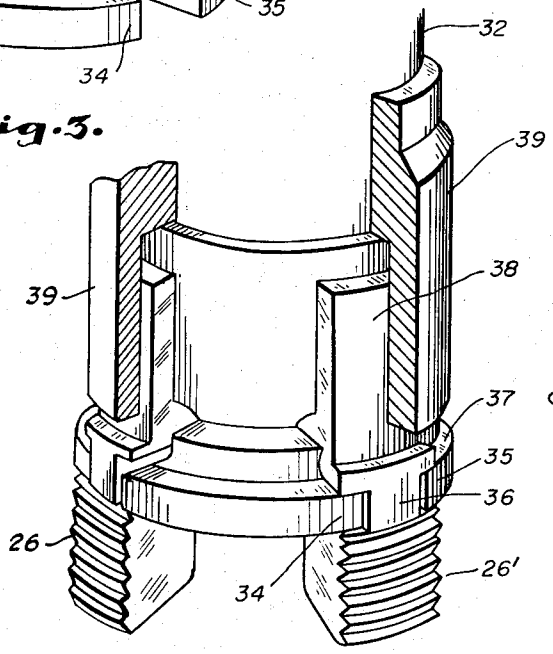


Fig. 4.

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OIL WELL HOLD-DOWN TOOL

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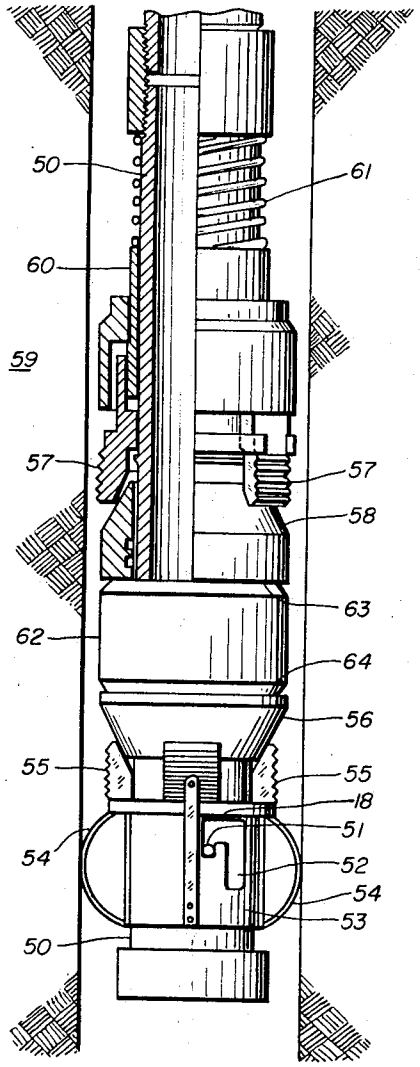


Fig. 5.

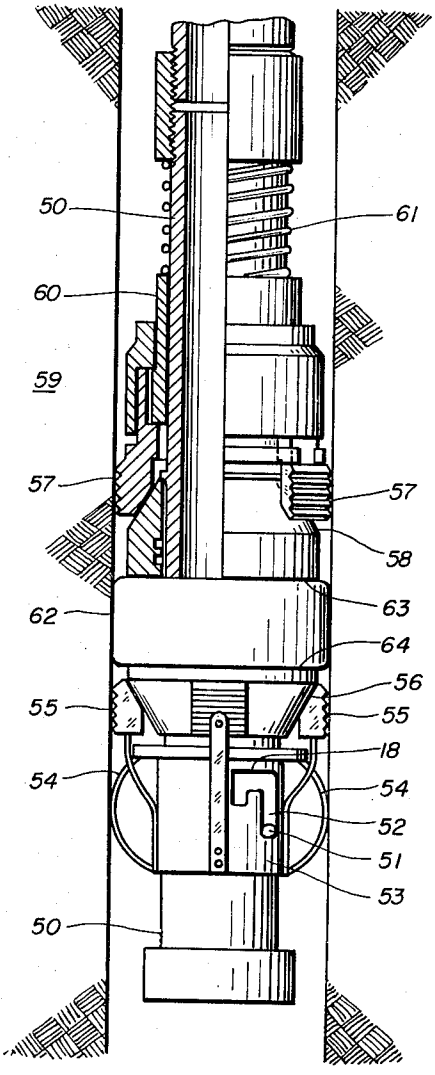


Fig. 6.

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OIL WELL HOLD-DOWN TOOL

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4 Claims. (Cl. 166—134)

ABSTRACT OF THE DISCLOSURE

A mechanical structure includes toothed slips which are held in a bracket on a mandrel which is locked to a cone. The mandrel is unlocked, the cone moved to actuate the slips into engagement with the well wall. The structure from the cone, the bracket disengaging the slips sequentially.

The present invention relates to oil well tools which keep packers down the hole in position against pressure. More particularly, the invention relates to a tool which will hook to the wall of an oil well hole by mechanical arrangement and be independent of pressure or weight in maintaining its position.

There are oil well tools run in the hole which must be maintained in a fixed, vertical location. Packers are a basic example of such tools. There are many arrangements for hooking these tools to the wall by slips with teeth. The slips are moved laterally for their teeth to bite into, or hook onto, the hole sides. Many arrangements have been developed to actuate the slips.

A set of slips above or below its tool will resist displacement of the tool by pressure from one direction. A set of slips above and a set of slips below their tool will resist displacement of the tool by pressure from either direction. A problem descends in providing a holding set of slips, and means for actuating the slips, connected to a packer which has a set of setting slips. How can a set of holding slips be actuated, and then maintain position, without the continued application of fluid pressure, or weight of the tubing string, on which the tools are run? Further, how can a set of holding slips which are mechanically set be disengaged by simply an upward pull with attached tubing?

An object of the present invention is to set holding slips connected to a well tool to resist the force of displacement pressure from one direction.

Another object is to maintain holding slips, connected to a well tool, in their set position without the use of fluid pressure within the well hole or the weight of a tubing string.

Another object is to sequentially disengage holding slips, connected to a well tool, by exertion of an upward force.

The present invention contemplates releasably locking a slidable mandrel to a well tool and mounting slips on the mandrel and slip-actuating structure on the tool. The set of slips on the tool are actuated and the tool set in the well hole in the conventional manner. The mandrel is unlocked from the tool and moved relative the tool to carry its set of connected slips onto actuating structure attached to the tool. Thereafter, any force in the hole which is applied to the tool, and which tends to displace the tool toward the holding slips, will be resisted by engagement between the teeth of the holding slips and the walls of the well hole. Therefore, the tubing string could be removed because the tool is prevented from displacement by forces in either direction on the tool. The hold-down structure, and connected tool, may subsequently be removed from its position in the well hole by exerting a force on the slips away from the connected tool and through a bracket which sequentially engages the individual slips.

Other objects, advantages and features of this invention will become apparent to one skilled in the art, upon the written specification, appended claims, and attached drawings, wherein:

FIG. 1 is a partially sectioned elevation of a well tool being placed in a hole, attached to a hold-down structure in which the invention is embodied;

FIG. 2 is the structure of FIG. 1, actuated at the desired position within the hole;

FIG. 3 is an isometric view of the holding ring for the slips of the hold-down;

FIG. 4 is an isometric view of slips in position on a fork of the ring of FIG. 3;

FIG. 5 is a partially sectioned elevation of a combination well tool and hold-down structure being placed in a hole in which the invention is embodied; and

FIG. 6 is the structure of FIG. 5, actuated at the desired position within the hole.

GENERAL ARRANGEMENT AND OPERATION

FIG. 1 illustrates a well tool, and hold-down structure connected to the tool, being lowered to a desired position within an oil well hole. The hole **10** is vertical, and the tool **11** and hold-down **12** are suspended from a string of run-in tubing **13**.

The end of the tubing **13** is threaded and joined to the upper threaded end of a mandrel **14** by a coupling **15**. Mandrel **14** is in the general form of an elongated cylinder which extends down and inside a cone assembly **16**. This mandrel and cone assembly are releasably and positively locked together through a pin **17** and J-slot **18**. Locked as shown in FIG. 1, the pin and J-slot hold the cone assembly and mandrel at a specified spacing between the lower end of the mandrel and an internal abutment of the cone assembly. When the pin is repositioned in the longer side of the J-slot, the mandrel is moved down until its lower end seats on the internal abutment of the cone assembly. This relative movement actuates the hold-down mechanism in which the invention is embodied.

The tool **11** is given the specific form of a packer. The expansible element **20** is moved out to engage the wall of hole **10** at a time selected by an operator at the top of hole **10**.

When it is desired to move element **20** out to the wall of the hole, a J-slot and pin lock, similar to pin **17** and J-slot **18**, between the sliding parts of the packer is positioned by turning tubing **13** so the parts will slide and bear upon the ends of element **20**. Springs **21** are attached to one of the sliding parts and they will bear upon the wall to provide enough force to resist movement of that part and enable the J-slot and pin lock of the packer to be actuated.

Once the tool J-slot and pin are unlocked, the cone **22** can be moved down against slips **23**. The teeth of slips **23** are moved laterally into engagement with the wall of hole **10**. Against this resistance of slips **23** engaged with the hole **10** wall, packing element **20** is squeezed into engagement with the wall of hole **10**. The invention then comes into play by holding the parts of the packer in their set position, the packing element sealingly engaging the wall of hole **10**. FIG. 2 illustrates this set position of the packer **11** and subsequent actuation of the hold-down structure connected from above to the packer.

Any force on packer **11**, in addition to that required for setting packer **11**, and exerted from above, will drive the teeth of slips **23** more firmly into the wall of hole **10**. However, upward force will act on the cone **22** of the tool and tend to move it away from the slips **23** and disengage them from the wall. Once the teeth of slips **23** are disengaged, the entire tool will be displaced from its desired position. The hold-down structure of the invention resists this displacing force from a position above the tool;

thus force from either direction will not be able to move tool **11** from its desired position.

THE HOLD-DOWN

General cone-slip action

Essentially, to carry out the invention, an elongated structure is connected to the tool, a cone is mounted on the elongated structure and slips are moved down upon the cone to force the slips in a lateral direction and engage their teeth with the wall of the hole. Then, any upward force on this hold-down structure will cause the cone to bite the slip teeth of the hold-down structure deeper into the wall of the hole **10**.

Both FIG. 1 and FIG. 2 illustrate the details of the hold-down structure **12** in bringing cone **25** and slips **26** together properly. Cone assembly **12** is comprised of an outer casing **27** which is connected positively to tool **11** and cone casing **28** which is fitted down into outer casing **27** to provide cone **25**. The two casings are threaded and sealed to each other as a cylindrical, elongated structure carrying a cone on the upper end of tool **11**.

One reason for forming cone assembly **16** in these two parts is to provide for engagement with the lower end of mandrel **14**. Mandrel **14** slides sealingly within the internal bore of cone casing **28**, carrying protuberance **29** on its lower end into engagement with shoulder **30** within the bore of outer casing **27**. Of course, this engagement between shoulder **30** and protuberance **29** takes place after pin **17** is rotated to the longer leg of J-slot **18**. In this relative movement between mandrel **14** and cone assembly **16**, slips **26** are carried into actuation by cone **25**.

Slips—common housing 31.—Slips **26** are mounted on mandrel **14** and moved down upon cone **25** for lateral movement into engagement with the wall of hole **10**. Slips **26** are carried within a housing **39** which is made in two parts. Slip housing base **32** is essentially a ring which slides along the external surface of mandrel **14**, urged by a spring **33**, against an abutment **33A** on the mandrel **14**. The lower end of this base ring **32** exerts a downward force upon slips **26** at the proper point in the downward movement of mandrel **14**.

The lower portion of base ring **32** is formed outward to provide a fork for each slip **26**. Arms **34**, **35** comprise one of these forks, as an example, fitting around neck **36** of the slip supported by this fork. FIG. 4 gives perhaps the clearer illustration of this particular assembly of slips and base **32**.

Slips **26** are carried loosely in their forks of base **32**. From their mountings they are readily moved laterally by cone **25** to engage their teeth with the hole wall. The lower surface of the base **32**, which is the end of base ring **32**, forces the slips downward, onto the actuating surface of cone **25**. The further movement of the mandrel **14** downward carries abutment **33A** away from this end of base ring **32** as can be seen in FIG. 2. Then, when the mandrel **14** and base ring **32** are moved upward, the slips are pulled upward by the upper surface **37** of the fork arms of the base ring.

Slips—their sequential disengagement.—To aid ready removal of the slips whose teeth have engaged the wall of the hole, the neck of one slip **26'** is made a finite length shorter than the others. Therefore, the force of the mandrel moving upward is first transmitted through the base surface **37** to the slip with the shorter neck. The full upward force on one slip has no difficulty in disengaging that slip **26'**. The force is then subsequently applied to the remaining slips and has little difficulty in disengaging them from the wall of the hole. Of course, it would be feasible to make the neck of each of the slips a different length so there would be sequential application of the upward force. However, it is usually adequate to break away one slip initially and the remainder will break away almost as readily.

Slips—retention in their fork arms.—Having provided for basic support of the slips by fork arms **34**, **35**—their movement upon the cone **25** by the lower surface of the arms—and their disengagement by the upper surface of the arms—it is additionally necessary that they be positively retained within these fork arms. The upper part of each slip has an extension **38** which fits into a housing **39** mounted on the upper part of slip housing base **32**. From another view, housing **39** extends down over slip extension **38** to limit its movement laterally. Therefore, none of the slips will fall from their respective forks yet will be provided with sufficient lateral movement to engage the wall of hole **10**. FIG. 2 illustrates this function clearly.

FIGS. 1 and 2 have disclosed the invention embodied in a hold-down structure separately identified from the well tool. That is, the hold-down is an attachment for any well tool on which a force tending to displace the well tool toward the hold-down structure requires resistance to prevent displacement of the tool. The tool is separately unlocked from its mandrel and its slips actuated; then the hold-down structure is unlocked from the tool and its slips are actuated. However, FIGS. 5 and 6 disclose how the tool and hold-down can be combined in a single unit. A single mandrel can serve as a mounting for both the tool and hold-down; a single lock will enable both sets of slips to be simultaneously actuated.

FIGS. 5 and 6 disclose a mandrel **50** with a pin **51** positioned in a J-slot **52** formed in a sleeve **53**. Sleeve **53** slides on mandrel **50** and has springs **54** mounted on it to bear against the wall of the hole to provide the resistance which will enable the J-slot **52** and pin **51** to be actuated.

A first set of slips **55** are mounted on sleeve **53** so they can be forced laterally into engagement with the wall of the hole. First cone **56** is slideable on mandrel **50** above slips **55**. When mandrel **50**, and this first cone **56**, are unlocked from sleeve **53** and moved toward the sleeve **53**, the cone **56** pushes the slips out against the wall in engagement.

When the first set of slips **55** are engaged with the wall of the hole, the unlocked mandrel **50** moves a second set of slips **57** outward to wall engagement by second cone **58**. Cone **58** is slideable upon mandrel **50** and slips **57** are mounted on mandrel **50** with a housing **59** having a base **60** urged along the mandrel **50** by spring **61**. Spring-urged base **60** forces second slips **57** down upon second cone **58** and this force both pushes the slips **57** out against the well wall and cone **58** down toward cone **56**. The expansible element **62** is about mandrel **50**, between the flat surfaces **63** and **64** of the cone structures. The movement of these surfaces toward each other sets the tool by expanding the element **62** into sealing engagement with the well wall.

FIG. 5 discloses the various structures **50–64** in their relationships when the pin **51** and slot **52** are locked. The hold-down and tool combination are lowered to the desired vertical position in the well hole. The only contact with the wall is through the resistance springs **54**.

FIG. 6 showed the pin **51** repositioned in slot **52**. Mandrel **50** has moved all the structure mounted on it toward the first set of slips **55**, forcing them into engagement with the well wall, the element **62** into sealing engagement with the well wall and the second set of slips **57** into engagement with the well wall.

Disengagement of the slips is accomplished just as it was with the arrangement of FIGS. 1–4. Base **60** picks up the second set of slips and the first cone **56** moves away from the first slips **55**. The hold-down and tool can then move up the hole for subsequent use.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the apparatus.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the in-

vention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted ast illustrative and not in a limiting sense.

The present invention, having been described, what is claimed is:

1. An actuating mechanism for a well tool, including,
a mandrel in the form of a cylinder mounted on the lower end of a run-in string of tubing,
a well tool with an elongated structure movable along the outside of the mandrel,
a structure mounted on the outside of the mandrel to support slips,
and a cone structure mounted on the elongated structure to engage the slips supported by the structure which is mounted on the mandrel,
said slips supported by the structure mounted on the outside of the mandrel having relative dimensions between the slips and their supporting structure so that the movement of the mandrel and supporting structure away from the cone will sequentially apply the force of the mandrel movement to the slips in disengaging the slips from the well wall.

2. The actuating mechanism of claim 1 whereby the relative dimensions between the slips and their supporting structure is provided by a different length of neck for at least one slip relative to the necks of the remainder of the slips, the supporting structure thereby contacting and pulling one slip from engagement with the well wall before the remaining slips are contacted for their disengagement.

3. A well tool and hold-down structure, including,
a mandrel adapted to be run in the bore of a well,
a sleeve slideable on the mandrel and locked to the mandrel by a pin and J-slot,
springs on the sleeve engaging the wall to give a measure of resistance to displacement of the sleeve,
a first set of slips mounted on the sleeve so as to be carried into engagement with the wall of the hole,
a first cone mounted on the mandrel so as to actuate the first slips when the mandrel and sleeve are unlocked and moved relative each other,
an expansible member about the mandrel on the side of the first cone away from the slips,
a second cone mounted on the mandrel to capture the expansible member between the second cone and the first cone,

a second set of slips mounted on the mandrel so as to be actuated by the second cone as the mandrel is unlocked from the sleeve and moved relative to each other,
and a bracket mounted on the outside of the mandrel to support the slips, there being provided relative dimensions between the slips and support bracket so that movement of the bracket by the mandrel away from the second cone will sequentially apply the force of the mandrel movement to the slips to disengage the slips from the well wall.

4. A hold-down structure for an oil well tool, including,
a mandrel in the form of a cylinder,
an upwardly and inwardly tapering cone mounted on the mandrel for movement relating thereto,
a bracket mounted on the mandrel wall above the cone and holding a plurality of slips for outward expansion by the cone into engagement with the wall of the well bore upon downward movement of the mandrel relative to the cone,
means for transmitting upward movement of the mandrel to the bracket,
and means on the bracket for engaging at least one slip before the other slips in the upward travel of the bracket to apply the force which moves the mandrel upwardly relative to said one slip prior to the other of said slips and thereby release the slips from their engagement with the well wall.

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