Dec. 19, 1967 E. R. LE BLANC 3,358,765

METHOD AND APPARATUS FOR FREEING A WELL TOOL AND CABLE

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Fig. 1

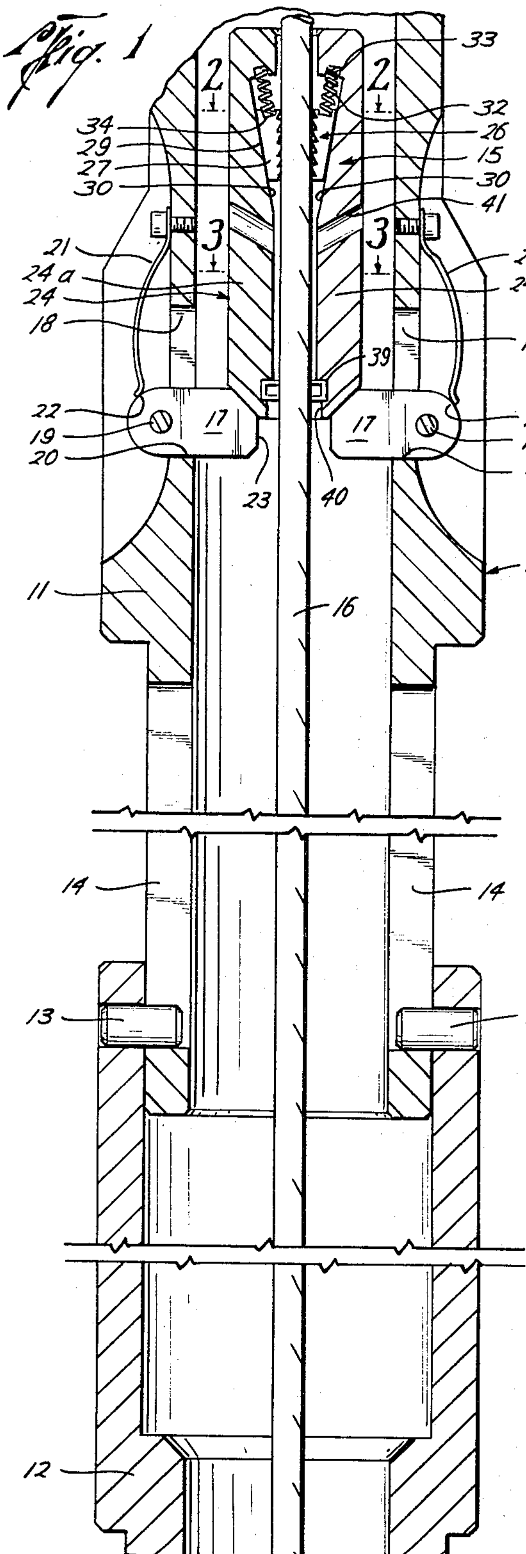



Fig. 2

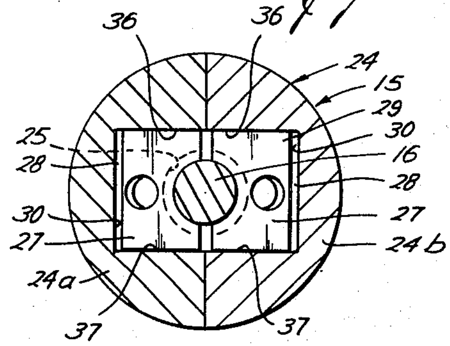



Fig. 3

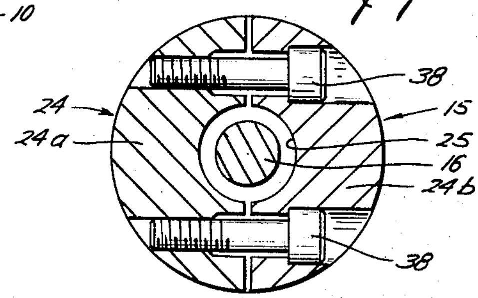
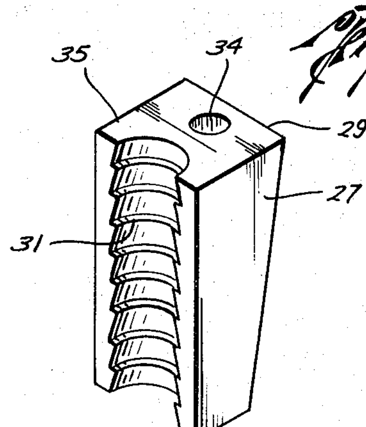



Fig. 4

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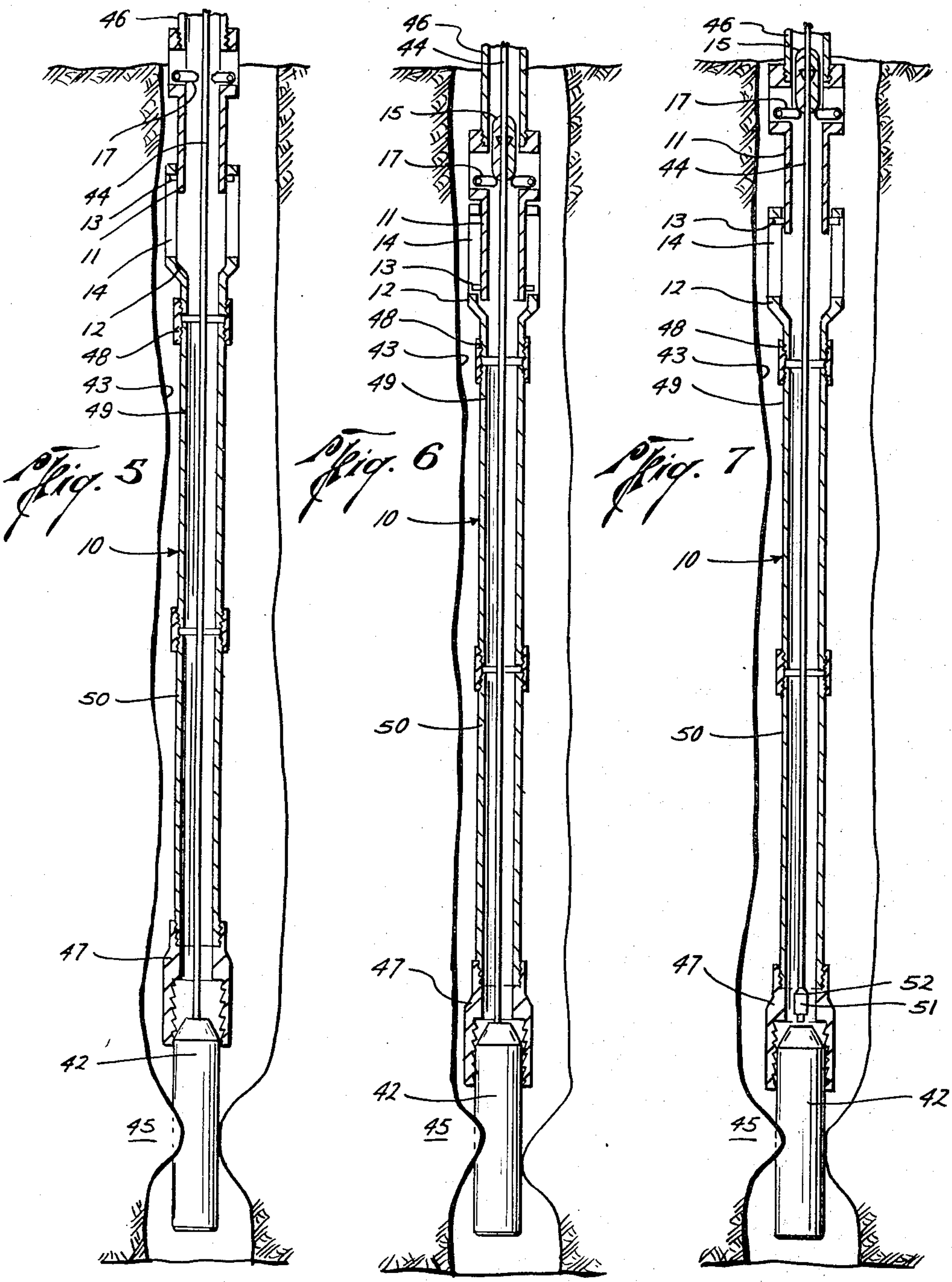


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# United States Patent Office

3,358,765
Patented Dec. 19, 1967

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3,358,765
METHOD AND APPARATUS FOR FREEING A WELL TOOL AND CABLE

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Filed Jan. 26, 1966, Ser. No. 523,226
10 Claims. (Cl. 166—46)

This invention relates to methods and apparatus for freeing tools that have become lodged in a well bore; and, more particularly, to methods and apparatus for releasing a tool-supporting cable from the tool and subsequently freeing the tool.

In those well completion operations conducted with a tool suspended from a wireline either with or without electrical conductors therein, it is not too uncommon for the tool to become lodged in some manner in the well bore during the operation. When this occurs and the tool cannot be dislodged by application of a reasonably safe tension to the cable, it becomes necessary to retrieve the tool and cable by a so-called "fishing" operation.

It will be appreciated that retrieval of a cable-suspended tool presents several considerations which must be taken into account. First of all, it is preferable to disconnect the cable at or as near as possible to the tool to avoid leaving a loose skein of cable on top of the tool which will interfere with its subsequent recovery. Secondly, it is obvious that as much of the cable should be recovered intact as is economically possible. Finally, it is desirable to connect a fishing tool to the stuck tool before disconnecting the cable to prevent the tool from possibly falling into an even more awkward position from which its extrication might be impossible.

Heretofore, in one manner of conducting such a fishing operation, it has been customary to employ a so-called "cut-and-thread" procedure to free a stuck cable-suspended tool. In this procedure (as described in greater detail on page 769 of the 1962–63 Composite Catalog of Oil Field Equipment and Services), the suspension cable is first severed at the surface and the free ends are passed through a joint of drill pipe having a so-called "overshot" on its lower end and temporarily reconnected. The joint and overshot are then lowered into the well around the cable and halted with the upper end of the joint near the rotary table. The cable is disconnected and its free ends are passed through a second joint of drill pipe before it is coupled to the first joint. The coupled joints are then lowered until the upper end of the second joint reaches the rotary table and the cable is again disconnected. Thus, by successively disconnecting and reconnecting the temporary cable connection, a drill string having the overshot on its lower end is progressively assembled and lowered around the cable. By continuing to add additional joints in this manner, it will be realized that when the overshot reaches the stuck tool, it can be manipulated to securely engage the tool and prevent its subsequent loss. It will be recognized, of course, that with the overshot firmly engaging it, the stuck tool can usually be dislodged and returned to the surface.

Recovery of the suspension cable is not quite so simple. For example, although such well tools are customarily connected by a so-called "weak-point" to the lower end of the cable, such weak points must be capable of supporting the static weight of the tool as well as any normal loads induced by drag in raising the tool or additional tension that may be reasonably applied in an effort to dislodge the tool if it becomes stuck. However, since the point of greatest cable stress is at or near the surface when a suspension cable is under tension, circumstances can be such that a pull on the cable otherwise sufficient to fail the weak-point will instead break the cable near

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the surface and thereby leave a substantial length of loose cable piled in the tubing string. For example, if a cable having an average tensile strength of 12,000-pounds is used in conjunction with a weak-point having an average tensile strength of 6,500-pounds and 6,000-pounds of cable is within the borehole when the tool is stuck, additional tension may quite possibly break the cable at or near the surface before the weak-point can be loaded beyond its tensile strength. Thus, it is generally risky, if not impossible, to use the weak-point if the tool becomes stuck at substantial depth.

Accordingly, when it is believed too risky to disconnect the cable from the stuck tool by breaking the weak-point, it has been necessary heretofore to remove the tubing string a section at a time (typically consisting of a "stand" of three 30-foot joints) and sever the cable at the rig floor each time a stand of tubing string is disconnected. Thus, although the tool is recovered, its suspension cable will be totally lost since it is impractical to resplice such short sections. Although this may not be of too great significance where the suspension member is only a steel cable, a considerable economic loss will be represented where the cable includes one or more electrical conductors covered by suitable fluid-resistant insulations and enclosed within an armor sheath and an outer cover.

Accordingly, it is an object of the present invention to provide methods and apparatus which permit the safe recovery of a stuck cable-suspension well tool as well as the recovery of its suspension cable in a fully usable condition.

This and other objects of the present invention are accomplished by coupling a first member to the stuck well tool, gripping the cable a short distance above the well tool with a second member and moving the two members apart to separate the cable from the well tool and permit the separate retrieval of the tool and cable. One embodiment of apparatus in accordance with the present invention is comprised of selectively operable cable-gripping means, a body adapted for dependent connection from a suspension member and having first means thereon adapted for engaging and supporting the cable-gripping means and second means dependently connected thereto adapted for engaging a well tool and imparting a downward force thereon as the suspension member is pulled upwardly.

The novel features of the present invention are set forth with particularity in the appended claims. The present invention, both as to its organization and manner of operation together with further objects and advantages thereof, may best be understood by way of illustration and example of certain embodiments when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a cross-sectional view showing one embodiment of apparatus arranged in accordance with the principles of the present invention;

FIGS. 2 and 3 are enlarged cross-sectional views taken respectively along the lines 2—2 and 3—3 of a portion of the apparatus shown in FIG. 1;

FIG. 4 is an isometric view in one of the elements depicted in FIG. 1; and

FIGS. 5–7 are successive views illustrating the practice of the present invention with modification of the apparatus of FIG. 1.

In practicing the methods of the present invention it is necessary only to have first means for securely engaging and imparting a downward force on the stuck well tool and second means for selectively gripping the suspension cable at a point a substantial distance below the surface of the ground and pulling upwardly thereon. Thus, by moving the first and second means apart with a combined force sufficient to break the weak-point (or part the cable at a point between the first and second means should there be no weak-point), all or at least a major portion of the suspension cable will be disconnected from the well tool. Then, after the suspension cable has been retrieved, the well tool can be recovered. It will be appreciated, of course, that the first means must be supported by a suspension member of sufficient strength to permit retrieval of the stuck well tool. Similarly, the second means must also be supported by a suspension member of sufficient strength to sustain the force necessary to break the weak-point or part the suspension cable.

In analyzing the combined forces necessary to break the weak-point or part the suspension cable, it must be considered that the well tool may remain fixed until after the cable is recovered or it may come free during the recovery operation. In the first instance, the downward force imparted to the well tool by the first means must be sufficient that the total of this force plus the weight of the tool and the restraining force holding the tool equal or exceed the breaking point of the weak-point (or suspension cable). Thus, with the tool being held against upward movement, the second means can pull the suspension cable upwardly with sufficient force to accomplish the separation. In the second instance, should the tool come free as the suspension cable is being tensioned, the summation of the downward force applied by the first means and free weight of the well tool must equal or exceed the breaking point of the weak-point (or suspension cable). In either event, however, it is necessary that, once the first and second means are respectively engaged with the well tool and suspension cable, the first and second means must be capable of independent movement away from one another a distance at least equal to the total elongation of the length of suspension cable between the second means and well tool which will result in failure of the weak-point or some portion of that length of cable.

Accordingly, in one manner of practicing the methods of the present invention, tool-securing means, such as a tool grapple or spear or even a strong magnet as may be determined by the particular circumstances, are lowered on a first cable and secured to the stuck well tool. By mounting the tool-securing means on a body of substantial weight, the necessary downward force will be imposed on the stuck tool. Then, suitable cable-gripping means, such as a solenoid-operated clamp or the like, are lowered into the well bore on a second cable to a position above the tool and firmly engaged to the suspension cable at a point above the stuck well tool. By pulling upwardly on the second cable with sufficient force to part or release it from the stuck well tool, the suspension cable is pulled free of the well tool and recovered. Then, the tool itself is pulled free by the tool-engaging means.

Turning now to FIG. 1, a preferred embodiment of one form of apparatus **10** for practicing the methods of the present invention is illustrated. As seen there, the tool-and-cable releasing apparatus **10** is comprised of first and second tubular members **11** and **12** telescopically arranged together at their adjacent ends for longitudinal movement relative to one another. To determine the extent of relative longitudinal movement between the tubular members **11** and **12**, one or more lateral pins **13** projecting inwardly from the outer member **12** are each confined within elongated longitudinal slots **14** in the inner member **11**. Thus, it will be appreciated that the pins **13** and slots **14** corotatively secure the members **11** and **12** to one another while permiting their relative longitudinal travel within the limits defined by the slots. It will be appreciated that the slots **14** and pins **13** can be reversed as shown in FIGS. 5–7.

The upper end of the inner tubular member **11** is suitably sized to receive a selectively operable cable-gripping tool **15** which, as will subsequently become apparent, is adapted to move freely down a suspension cable **16** passing through the inner and outer members **11** and **12** but resist upward movement thereon. Abutment means, such as one or more inwardly extending dogs **17** mounted within longitudinal apertures **18** around the wall of the inner tubular member **11**, are provided to engage and prevent further downward movement of the cable-gripping tool **15** through the tubular members **11** and **12**.



Although these dogs **17** could be fixed to the inner tubular member **11**, it is preferred to pivot the dogs on transverse pins **19** secured on opposite sides of the apertures **18**. By positioning the pivot pins **19** near the outer wall of the inner tubular member **11** and adjacent to the bottom surfaces **20** of the apertures **18**, the dogs **17** will be prevented from pivoting downwardly but will be free to swing upwardly from their extended position and back into their respective apertures. Biasing means, such as leaf springs **21** mounted along the outside of the inner tubular member **11** and urged against the outer ends **22** of the dogs **17** above their pivot pins **19**, maintain the dogs in their extended position but will yield to allow the dogs to swing upwardly and inwardly in response to an upward force on their inner ends **23**.

The cable-releasing tool **15** is comprised of an elongated rigid body **24** having a longitudinal bore **25** through which a suspension cable **16** may be passed. Cable-gripping means **26** are mounted within the body **24** and arranged to securely grasp the portion of cable **16** received in the longitudinal bore **25**. As best seen in FIGS. 2 and 4, the cable-gripping means **26** may take the form of one or more tandemly disposed pairs of opposed wedge-shaped blocks or slips **27** confined within inwardly facing recesses **28** on opposite sides of the longitudinal bore **25**, The outer face **29** of each slip **27** is tapered downwardly and inwardly for sliding engagement with a complementary tapered rear wall **30** of its respective recess **28**. To insure a more positive gripping of the cable **16**, teeth **31** may also be formed on the inner vertical face of each slip **27**. A compression spring **32** having its ends respectively confined within aligned recessed bores **33** and **34** in the top wall of each recess **28** and the upper face **35** of each slip **27** normally urges each slip downwardly and inwardly toward the cable **16**. It will be appreciated, of course, that the springs **32** are so selected that the cable-engaging slips **27** do not engage the cable **16** with sufficient force to prevent the relatively free travel of the cable-gripping tool **15** down the suspension cable.

As best seen in FIG. 2, these slips **27** are preferably closely confined between the opposed side walls **36** and **37** of the recesses **28** to prevent lateral tipping of the slips. As further seen in FIGS. 2 and 4, the inner vertical faces of the slips **27** are also preferably formed in a generally semi-circular concavity so the teeth **31** of the opposed slips can grip the cable **16** substantially around the full circumference of the cable.

To simplify the installation of the cable-gripping tool **15** around the cable **16**, the body **24** is made of separable longitudinal parts **24*a*** and **24*b***, with the plane of cutting being through the bore **25** and between the opposed slips **27**. As best seen in FIG. 3, longitudinally spaced pairs of bolts **38** straddling the longitudinal bore **25** may be used as necessary to fasten the separable body parts **24*a*** and **24*b*** together. Thus, it will be realized that the separable body parts **24*a*** and **24*b*** may be readily assembled and secured around the cable **16** without having to further sever the cable. If desired, a split wiping ring **39** may be disposed within a concentric counterbore **40** in the nose of the body **24** to wipe away mud on the cable **16** as the cable-gripping tool **15** is traveling downwardly thereon. Lateral fluid passages **41** may also be provided in the body **24** between the longitudinal bore **25** and the exterior of the body to permit well fluids to pass readily through the bore.

Turning now to FIGS. 5–7, a well tool **42** is shown dependently suspended in a borehole **43** from a suspension cable **44**. The well tool **42** has become inadvertently lodged in a reduced portion of the borehole **43** such as might be caused, for example, by a cave-in as at **45**. To illustrate the practice of the method of the present invention with the apparatus **10**, it is assumed that the well tool

42 is lodged with a force so great that the tool cannot be safely released by pulling without risking parting of the cable 44 near the surface of the ground.

Thus, briefly stated, once it has been determined that the tool 42 is firmly stuck, the tool-and-cable retrieving apparatus 10 is assembled around the cable 44 and lowered by a tubing string 46 into the borehole 43. As best seen in FIG. 5, once the tool-and-cable retrieving apparatus 10 has reached the stuck well tool 42, tool-engaging means, such as an overshot grapple 47 or the like, at the lower end of the retrieving apparatus are engaged onto the stuck well tool 42 to impose a downward force thereon and connect it to the tubing string 46. Then, as best seen in FIG. 6, the cable-gripping tool 15 is co-engaged between the cable 44 and the tool-and-cable retrieving apparatus 10. Once these tools 10 and 15 are co-engaged, the tubing string 46 is pulled upwardly with sufficient force to break the weak-point (not shown) within the stuck tool 42. With the weak-point broken, the lower end of the cable 44 will be freed from the well tool 42 to permit the cable to be reeled to the surface. Then, once the suspension cable 44 is out of the way, the tubing string 46 is manipulated with sufficient force to dislodge the stuck well tool 42 and return it to the surface.

Accordingly, when using the tool-and-cable releasing tool 10 of the present invention, a suitable well tool-securing device, such as an overshot grapple 47 that, if circumstances so require, may be the one shown on page 768 of the 1962–63 Composite Catalog of Oil Field Equipment and Services, is connected to the lower end of the outer member 12. Although the overshot 47 (FIGS. 5–7) may be coupled directly to threads 48 on the lower end of the outer tubular member 12, it is generally preferred to connect the overshot to the lower end of one or more drill collars 49 and 50 which are in turn dependently connected from the threads 48. In this manner, the weight of the drill collars 49 and 50 will impose a downward force on the stuck well tool 42 that is greater than the force necessary to part the cable 44 from the stuck well tool. By using the already-described cut-and-thread procedure, the overshot 47, drill collars 49 and 50, and the tool-and-cable releasing apparatus 10 are passed over the suspension cable 44 and lowered into the borehole 43 on the lower end of the tubing string 46 as the tubing string is progressively assembled at the surface of the ground and lowered into the borehole.

Then, as best seen in FIG. 5, whenever the overshot 47 has come into engagement with the upper end of the stuck well tool 42, it may be appropriately manipulated through the tubing string 46 to securely engage it with the upper end of the wall tool. It should be noted that the cooperative co-engagement of the lugs 13 and slots 14 will permit rotation to be transmitted to the overshot 47. Moreover, should it be necessary to impose a downward force on the well tool 42 greater than the weight of the drill collars 49 and 50, it is necessary only to lower the tubing string 46 until the lugs 13 rest on the shoulders at the lower end of the slots 14.

As the overshot 47 is being engaged with the stuck well tool 42, it may be preferred (by making suitable piping connections at the surface) to maintain fluid circulation down the tubing string 46 and out the open lower end of the overshot to remove any sediment or the like that may have become lodged on top of the well tool. Furthermore, it is also preferable to maintain a slight tension on the suspension cable 44 to prevent it from becoming entangled within the tubing string 46 or the tool-and-cable releasing apparatus 10.

As best seen in FIG. 6, once the overshot 47 has been firmly engaged with the upper end of the stuck well tool 42, the tubing string 46 is lowered slightly while maintaining a slight upward tension on the cable 44 to permit the inner tubular member 11 to telescope into the outer member 12 as far as the cooperative arrangement of the lugs 13 and slots 14 will permit. Then, either before the tubing string 46 is slacked-off or shortly thereafter, the



cable-gripping tool 15 is assembled around the suspension cable 44 and released and allowed to free-fall down the cable and come to rest on the extended dogs 17.

It will be appreciated that, at this point, the suspension cable 44 is being held taut and the cable-gripping slips 27 in the cable-gripping tool 15 are securely gripped thereto. Thus, as best seen in FIG. 7, by picking up on the tubing string 46 to at least the full length of travel permitted by the cooperative arrangement of lugs 13 and slots 14, the dogs 17 will pull the cable-gripping tool 15 upwardly therewith. Inasmuch as the cable-gripping tool 15 cannot move upwardly relative to the cable 44 it will be appreciated that this upward pull will progressively stretch the suspension cable until either the cable parts or, if such is provided, the weak-point 51 within the stuck well tool 42 will fail. This will, of course, release at least a major portion of the suspension cable 44 from the upper end of the stuck well tool 42. It should be appreciated that should the downward travel of the tubing string 46 as shown in FIG. 6 dislodge the stuck well tool 42 so that it falls free from the wall of the borehole 43, the suspension cable 44 will be similarly stretched and parted from the wall tool.

In any event, once the suspension cable 44 has been separated from the well tool 42, it is necessary only to reel the cable upwardly by its winch (not shown) at the surface of the ground. Should the terminal portion of the cable 44 be connected to a member 52 having a diameter too great to pass between the opposed free ends of the pivoted dogs 17, it will urge the dogs upwardly and outwardly into their apertures 18 so as to permit the free passage of the terminal portion 52 of the cable on up into the tubing string 46 and to the surface. Once the cable 44 has been removed from the tubing string 46, it is necessary only then to manipulate the well tool 42 with the tubing string 46 until the stuck well tool has been freed. Then, the tubing string 46 can be successively disconnected at the surface as the tool 42 is recovered without difficulty.

Accordingly, it will be appreciated that the new and improved methods of the present invention provide a positive approach for the separate recovery of the suspension cable as well as the tool itself where a cable-suspended tool has become stuck in a well bore. By first parting the cable at a point at least fairly close to the upper end of the well tool, the cable may be retrieved intact as well as removed from subsequent interference with the operation. Similarly, the new and improved apparatus of the present invention provides means for coupling a well tool-engaging or coupling member to the well tool and then moving the well tool and its suspension cable relative to one another and in opposite directions so as to part the cable from the tool and permit separate recovery of each.

While particular embodiments of the present invention have been shown and described, it is apparent that changes and modifications may be made without departing from this invention in its broader aspects; and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

What is claimed is:

1. A method for freeing a well tool dependently suspended from a suspension cable and lodged in a well bore comprising the steps of: coupling a first member to the well tool; coupling a second member to the suspension cable above said first member; moving said first and second members apart with sufficient force to separate at least a major portion of the suspension cable from the well tool; and retrieving the suspension cable and well tool.

2. Apparatus for freeing a well tool dependently connected to a suspension cable and lodged in a well bore comprising: first means adapted for connection to the well tool and imparting a downwardly directed force thereto; second means adapted for selectively gripping the suspension cable and immovable upwardly with respect thereto; and third means between said first and second means adapted for connection to a stronger suspension member and movable upwardly thereby from a

first position engaging said second means toward a second position with a force sufficient for moving said first and second means apart and separating at least a major portion of the suspension cable from the well tool.

3. The apparatus of claim 2 further including means connecting said first and third means for limited longitudinal movement at least as far as the distance between said first and second position.

4. The apparatus of claim 2 wherein said first means includes well tool-securing means dependently connected to one or more joints of pipe.

5. The apparatus of claim 2 wherein said second means includes a rigid body adapted for sliding downwardly along the suspension cable, and means on said body adapted for gripping the suspension cable and preventing upward movement of said body relative thereto.

6. The apparatus of claim 2 wherein said third means includes a body adapted for connection to the suspension member, and abutment means on said body adapted for engagement with said second means upon upward movement of said body relative to said second means toward said second position.

7. The apparatus of claim 2 wherein said first and third means are comprised of an inner tubular member and an outer tubular member telescoped together at their adjacent ends in said first position and longitudinally extendible relative to one another to at least said second position, well tool-securing means dependently connected by one or more joints of pipe to the lower free end of one of said tubular members, means on the upper free end of the other of said tubular members adapted for connection to a pipe string, and abutment means on said other tubular member for engaging said second means in said first position.



8. The apparatus of claim 7 further including a lateral member on a selected one of said tubular members slidably received in a longitudinal opening extending along the remaining one of said tubular members at least as far as the distance between said first and second positions.

9. The apparatus of claim 8 wherein said second means includes a rigid body adapted for sliding downwardly along the suspension cable into engagement with said abutment means, and means on said body adapted for gripping the suspension cable and preventing upward movement of said body relative thereto as said tubular members are extended in response to upward movement of the pipe string.

10. The apparatus of claim 9 wherein said abutment means is comprised of at least one member pivotally mounted to said other tubular member and arranged for pivoting between an inwardly directed position into the interior of said other tubular member and a retracted upright position, and spring means normally biasing said pivotal member toward its said inwardly directed position.

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