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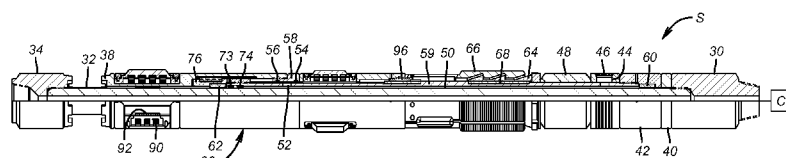
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(54) **Title:** TUBULAR CUTTING WITH DEBRIS FILTRATION

**FIG. 3**

(57) **Abstract:** A cut and pull spear is configured to obtain multiple grips in a tubular to be cut under tension. The slips are set mechanically with the aid of drag blocks to hold a portion of the assembly while a mandrel is manipulated. An annular seal is set in conjunction with the slips to provide well control during the cut. An internal bypass around the seal can be in the open position to allow circulation during the cut. The bypass can be closed to control a well kick with mechanical manipulation as the seal remains set. If the tubular will not release after an initial cut, the spear can be triggered to release and be reset at another location. The mandrel is open to circulation while the slips and seal are set and the cut is being made. Cuttings are filtered before entering the bypass to keep the cuttings out of the blowout preventers.



TUBULAR CUTTING WITH DEBRIS FILTRATION

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FIELD OF THE INVENTION

[0001] The field of the invention is tubular cutters that grip before the cut to put the string in tension and more particularly a resettable tool with the ability to isolate the tubular with a seal by closing a seal bypass while leaving the bypass open for circulation as the tubular is cut.

BACKGROUND OF THE INVENTION

[0002] When cutting and removing casing or tubulars, a rotary cutter is employed that is driven from the surface or downhole with a downhole motor. The cutting operation generates some debris and requires circulation of fluid for cooling and to a lesser extent debris removal purposes. One way to accommodate the need for circulation is to avoid sealing the tubular above the cutter as the cut is being made. In these cases also the tubular being cut can be in compression due to its own weight. Having the tubing in compression is not desirable as it can impede the cutting process making blade rotation more difficult as the cut progresses. Not actuating a seal until the cut is made as shown in USP 5,101,895 in order to allow for circulation during the cut leaves the well open so that if a kick occurs during the tubing cutting it becomes difficult to quickly get control of the well. Not gripping the cut casing until the cut is made so that the cut is made with the tubular in compression is shown in USP 6,357,528. In that tool there is circulation through the tool during cutting followed by dropping an object into the tool that allows the tool to be pressured up so that the spear can be set after the cut is made.

[0003] Sometimes the casing or tubular is cut in a region where it is cemented so that the portion above the cut cannot be removed. In these situations another cut has to be made further up the casing or tubular. Some known designs are set to engage for support with body lock rings so that there is but a single opportunity to deploy the tool in one trip. In the event the casing or tubular will not release, these tools have to be pulled from the wellbore and redressed for another trip.

[0004] While it is advantageous to have the opportunity for well control in the event of a kick the setting of a tubular isolator has in the past presented the associated problem of blocking fluid circulation as the cut is being made.

[0005] Another approach to making multiple cuts is to have multiple assemblies at predetermined spacing so that different cutters can be sequentially deployed. This design is shown in USP 7,762,330. It has the ability to sequentially cut and then grip two cut pieces of a tubular in a single trip and then remove the cut segments together.

[0006] USP 5,253,710 illustrates a hydraulically actuated grapple that puts the tubular to be cut in tension so that the cut can be made. USP4,047,568 shows gripping the tubular after the cut. Neither of the prior two references provide any well control capability.

[0007] Some designs set an inflatable packer but only after the cut is made so that there is no well control as the cut is undertaken. Other designs are limited by being settable only one time so that if the casing will not release where cut, making another cut requires a trip out of the well. Some designs set a packer against the stuck portion of the tubular as the resistive force which puts the tubular being cut in compression and makes cutting more difficult. Some designs use a stop ring which requires advance spacing of the cutter blades to the stop ring. In essence the stop ring is stopped by the top of a fish so that if the fish will not release when cut in that one location, the tool has to be tripped out and reconfigured for a cut at a different location.

[0008] The latter design is illustrated in FIG. 1. The cutter that is not shown is attached at thread **10** to rotating hub **12**. Mandrel **14** connects drive hub **16** to the rotating hub **12**. Stop ring **18** stops forward travel when it lands on the top of the fish that is also not shown. When that happens weight is set down to engage castellations **20** with castellations **22** to drive a cam assembly **24** so that a stop to travel of the cone **26** with respect to slips **28** can be moved out of the way so that a subsequent pickup force will allow the cone **26** to go under the slips **28** and grab the fish and hold it in tension while the cut is made. Again, the cut location is always at a single fixed distance to the location of the stop ring **18**.

[0009] Some designs allow a grip in the tubular to pull tension without the use of a stop ring but they can only be set one time at one location. Some examples are USP: 1,867,289 ; 2,203,011 and 2,991,834. USP 2,899,000 illustrates a multiple row cutter that is hydraulically actuated while leaving open the mandrel for circulation during cutting.

[0010] What is needed and provided by the present invention is the ability to make multiple cuts in a single trip while providing a spear that mechanically is set to grab inside the tubular being cut above the cut location. Additionally the packer can be already deployed before the cut is started to provide well control while also providing a bypass to allow circulation through the tool while cutting to operate other downhole equipment. The tubular to be removed is engaged before the cut and put in tension while the cut is taking place. These and other features of the present invention will be more apparent to those skilled in the art from a review of the detailed description and the associated drawings while understanding that the full scope of the invention is to be determined from the appended claims.

SUMMARY OF THE INVENTION

[0011] A cut and pull spear is configured to obtain multiple grips in a tubular to be cut under tension. The slips are set mechanically with the aid of drag blocks to hold a portion of the assembly while a mandrel is manipulated. An annular seal is set in conjunction with the slips to provide well control during the cut. An internal bypass around the seal can be in the open position to allow circulation during the cut. The bypass can be closed to control a well kick with mechanical manipulation as the seal remains set. If the tubular will not release after an initial cut, the spear can be triggered to release and be reset at another location. The mandrel is open to circulation while the slips and seal are set and the cut is being made. Cuttings are filtered before entering the bypass to keep the cuttings out of the blowout preventers.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 is a prior art spear design that uses a stop ring to land on the fish;

[0013] FIG. 2 is a multi-setting spear that is mechanically set to allow multiple cuts in a single trip;

[0014] FIG. 3 is the preferred embodiment of the cut and pull spear with the annular seal and the bypass for the seal in the closed position;

[0015] FIG. 4 is the view of FIG. 3 with the bypass for the seal shown in the open position.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0016] Referring to FIG. 3 the spear **S** has a bottom sub **30** to which the cutter schematically illustrated as **C** is attached for tandem rotation. A mandrel **32** connects the bottom sub to the drive sub **34**. An outer housing **36** extends from castellations **38** at the top end to the bearing **40** at the lower end. Bearing **40** is used because the bottom sub **30** will turn as a casing or tubular (not shown) is cut while sub **42** is stationary. Above the sub **42** are ports **44** covered by preferably a wire wrap screen **46**. Other filtration devices for cuttings when the tubular is cut are envisioned. A debris catcher can also be located below the bottom sub **30** that channels the return fluid flowing through the cutter **C** and back toward the surface from the region where the cutter **C** is operating. A variety of known rotary cutter designs can be used with the potential need to modify them for a flow through design to enable cutting removal flow. Several known debris catcher designs can be used such as those shown in USP 6176311; 6276452 ;6607031; 7,779,901 and 7,610,957 with or without the seal **48**. While the seal **48** is preferably an annular shape that is axially compressed to a sealing position alternative designs with a debris catcher can involve a diverter for the debris laden fluid that either doesn't fully seal or that seals in one direction such as a packer cup. Alternatively a debris catcher with a diverter can be used in conjunction with as seal such as **48** while operating with the bypass **50** in the open position.

[0017] Ports **44** lead to an annular space **50** that extends to ports **52** which are shown as closed in FIG. 3 because the o-rings **54** and **56** on sub **58** straddle the ports **52**. A support sleeve **59** extends between bearings **60** and **62** and circumscribes the mandrel **32**. Support sleeve **59** supports the seal **48** and the cone **64** and the slips **66**. A key **68** locks the cone **64** to the sleeve **59**. Sleeve **59** does not turn. Slips **66** are preferably segments with multiple drive ramps such as **70** and **72** that engage similarly sloped surfaces on the cone **64** to drive out the slips **66** evenly and distribute the reaction load from them when they

are set. Sleeve **59** has chevron seals **73** and **74** near the upper end by bearing **62** to seal against the rotating mandrel **32**. End cap **76** is secured to sleeve **59** while providing support to the bearing **62**. A key **78** in end cap **76** extends into a longitudinal groove **80** in top sub **82**. Top sub **82** is threaded at **84** to sub **58** for tandem axial movement without rotation.

[0018] Upper drag block segments **86** and lower drag block segments **88** hold the outer non-rotating assembly fixed against an applied force so that mechanical manipulation of the mandrel **32** can actuate the spear **S** as will be described below. In between the spaced drag block segments **86** is an automatic nut **90** that is also a series of spaced segments that have a thread pattern facing and selectively engaging with a thread **92** on the mandrel **32**. The automatic nut **90** is a ratchet type device so that when the mandrel **32** is rotated to the right the segments of the automatic nut just jump over the thread **92**. However, if the mandrel **32** is rotated to the left the automatic nut **90** engages the threads **92** and the top sub **82** and sub **58** being constrained by the key **78** from rotation wind up moving axially so that the o-ring seals **54** and **56** no longer straddle ports **52** now shown in the open position in FIG. 4. Simply setting down weight on the mandrel **32** will reclose the ports **52** in the event of a well kick.

[0019] In order to set the slips **66** and the seal **48** weight is set down during run in so that the castellations **94** engage the castellations **38** and the drive sub is turned to the right about 40 degrees. Using a combination lock/j-slot mechanism **96** these movements enable upon subsequent picking up to bring the cone **64** under the slips **66** with continued pulling force compressing the seal **48** against the surrounding tubular to be cut. At this point the relative motion between the sleeve **59** and the cone **64** are selectively locked. The tensile force on mandrel **32** can be maintained when cutting by turning mandrel **32** to the right when picked up. The ports **52** can be opened before cutting while picked up and turning mandrel **32** to the left. When ports **52** are open the automatic nut **90** is no longer affected by mandrel **32** rotation to the right. As stated before, the ports **52** are closed with setting down weight but the slips **66** and the seal **48** remain set even with the weight being set down to close the ports **52** in the event of a well kick. Eventually the slips **66** and seal

48 can be released by axial opposed movements of the mandrel **32** caused by physical force or pressure cycles that further reconfigures the combination lock/j-slot mechanism **96** so that a setting down force will pull the cone **64** out from under the slips **66** while letting the seal **48** grow axially while retracting radially. The spear **S** can be reset in other locations in the surrounding tubular to be cut any number of times and at any number of locations.

[0020] It should be noted that in FIG. 2 the seal **48** is not used and neither is the annular space **50**. In this configuration a single row of drag blocks **98** is used. The other operations remain the same.

[0021] Those skilled in the art will appreciate that the spear **S** offers several unique and independent advantages. It allows the ability to set and cut in multiple locations with the tubular to be cut under tension while retaining an ability to circulate through the mandrel **32** to power the cutter **C** or/and to remove cuttings. The tool has the facility to collect cuttings and prevent them from reaching a blowout preventer where they can do some damage. The cuttings can be retained in the FIGS. 3 and 4 configuration using the screen **46** leading to the ports **44** with the seal **48** set so that the return flow is fully directed to the screen **46**. In another embodiment such as FIG. 2 a junk or debris catcher can be incorporated at the lower end that has a flow diverter to direct cuttings into the device where they can be retained and screened and the clean fluid returned to the annular space above the diverter for the trip to the surface. Another advantage is the ability to have the annulus sealed with a bypass for returns as it provides options when the well kicks of closing the bypass quickly while the seal **48** is still actuated. In the preferred embodiment this is done with setting down to close the ports **52**. Note that no all jobs will require the bypass **50** around the seal **48** to be open during the cutting.

[0022] The above description is illustrative of the preferred embodiment and many modifications may be made by those skilled in the art without departing from the invention whose scope is to be determined from the literal and equivalent scope of the claims below.

We claim:

1. A spear and tubular cutter combination, comprising:
 - a mandrel rotatably mounted in an outer assembly, said mandrel supporting a tubular cutter and having a flow passage therethrough;
 - an anchor mounted to said outer assembly and configured to allow said outer assembly to enter the tubular so that said cutter can cut the tubular with a tensile force on the tubular;
 - a debris retention device supported by one of said mandrel and said outer assembly through which fluid delivered through said flow passage to said cutter returns with cuttings retained by said debris retention device.
2. The combination of claim 1, wherein:
 - said outer assembly further comprises a drag assembly to support at least a portion of said outer assembly as said mandrel is moved relative to said outer assembly.
3. The combination of claim 2, wherein:
 - said outer assembly comprises a cone to actuate said anchor when said cone is advanced with respect to said anchor.
4. The combination of claim 3, wherein:
 - said anchor comprises at least one slip;
 - said outer assembly comprises a lock assembly to prevent relative axial movement of said cone with respect to said slip until selectively released.
5. The combination of claim 4, wherein:
 - said mandrel selectively engageable to said outer assembly for tandem rotation to defeat said lock, whereupon application of a tensile force to said mandrel said cone moves under said slip to engage said slip to the tubular.
6. The combination of claim 5, wherein:
 - said lock assembly continues to retain said slip to the tubular upon a removal of said tensile force to said mandrel;
 - said lock assembly, upon a predetermined number of opposed axial mandrel movements allowing said cone to be moved out from under said slip so that the spear can be repositioned in the tubular.

7. The combination of claim **1**, further comprising:
said flow passage remains open for fluid flow as said mandrel rotates said tubular cutter;
said anchor is mechanically operated and operable for multiple deployments and releases of said anchor with respect to the tubular in a single trip.
8. The combination of claim **1**, further comprising:
an annular seal on said outer assembly selectively engaging the tubular when said anchor is moved against the tubular to close off against the tubular when said cutter cuts the tubular.
9. The combination of claim **8**, further comprising:
a bypass passage around said seal through said outer assembly.
10. The combination of claim **9**, further comprising:
said bypass passage comprising a screen at an inlet thereof to exclude cuttings from operation of said cutter.
11. The combination of claim **9**, further comprising:
said bypass passage is selectively closeable.
12. The combination of claim **11**, further comprising:
said bypass passage is closed with set down weight on said mandrel.
13. The combination of claim **12**, further comprising:
said bypass passage is opened by mandrel rotation to raise a sleeve to uncover at least one outlet port in said bypass passage.
14. The combination of claim **13**, further comprising:
said sleeve is raised with mandrel rotation to the left to engage a thread on said mandrel with a nut on said outer assembly, wherein mandrel rotation moves said sleeve axially to uncover said port.
15. A method of cutting and removing a tubular from a subterranean location, comprising:
running into the tubular a cutter mounted on a mandrel of a spear;
deploying an anchor on an outer assembly of said spear to selectively engage a first desired location within the tubular;
pulling tension on the tubular through said anchor as said mandrel is rotated to cut the tubular;

removing cuttings from flowing fluid initially delivered through said mandrel as said flowing fluid returns from the cut made by said cutter.

16. The method of claim **15**, comprising:

configuring said anchor for redeployment at at least one other desired location in the tubular in the same trip so that if the cut tubular will not release after an initial cut another cut can be made in a different location

redeploying said anchor at a second location in the tubular for a second cut.

17. The method of claim **16**, comprising:

mechanically deploying said anchor.

18. The method of claim **15**, comprising:

sealing off an annular space with a seal around said outer assembly when the tubular is cut.

19. The method of claim **18**, comprising:

providing a selectively open bypass around said seal when the tubular is being cut.

20. The method of claim **19**, comprising:

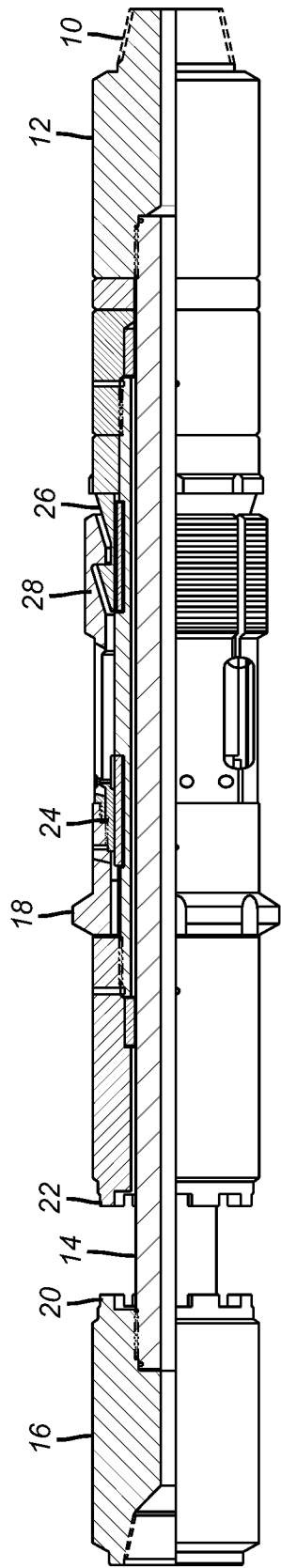
screening cuttings to retain at least some of the cuttings out of said bypass.

21. The method of claim **19**, comprising:

closing said bypass in event of a well kick by setting down weight on said mandrel.

22. The method of claim **19**, comprising:

maintaining said seal and anchor set against the tubular as said bypass is opened or closed.



(PRIOR ART)
FIG. 1

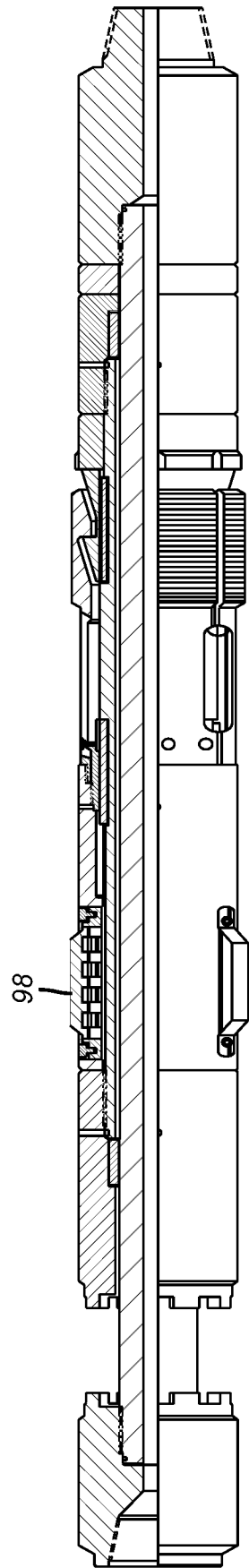


FIG. 2

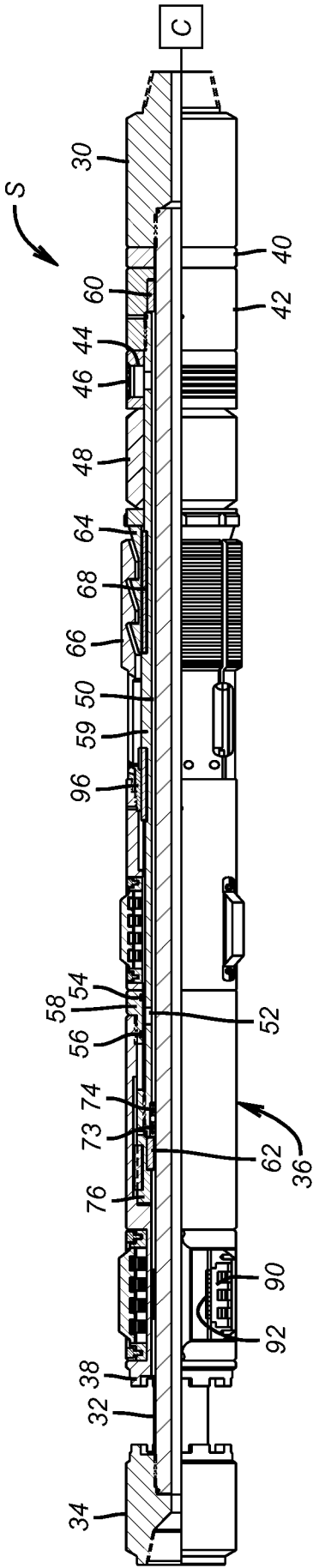


FIG. 3

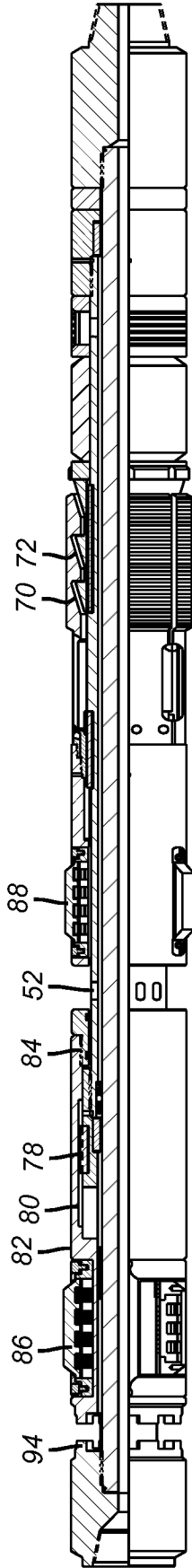


FIG. 4