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Murray

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[54] **METHOD FOR CUTTING AND RETRIEVING PIPE FROM A FLOATING DRILL SHIP**

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[52] **U.S. Cl.** **166/.5**, 166/55.6

[51] **Int. Cl.** **E21b 29/00**

[58] **Field of Search** ..... 166/.5, .6, 55.6, 166/98, 298, 301

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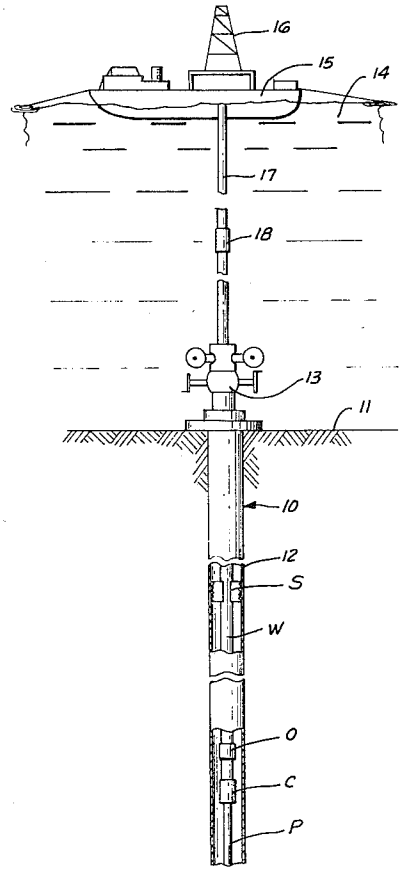
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[57] **ABSTRACT**

A method and apparatus for cutting and retrieving a well pipe (having connecting collars and disposed within a well bore) from a floating drill ship utilizing a drill string, slack joint, downhole swivel, washover pipe, overshot and outside cutter; wherein the cutter is lowered into the well bore by means of the drill string until the cutter is in cutting relationship with the pipe and spaced longitudinally from one of the collars, the drill string is anchored in the well bore at a point between the cutter and the slack joint, the cutter is operated to sever the pipe, and the severed pipe section is retrieved by means of the drill string.

This abstract is neither intended to define the invention of the application, which of course is measured by the claims, nor is it intended to be limiting as to the scope of the invention in any way.

15 Claims, 12 Drawing Figures



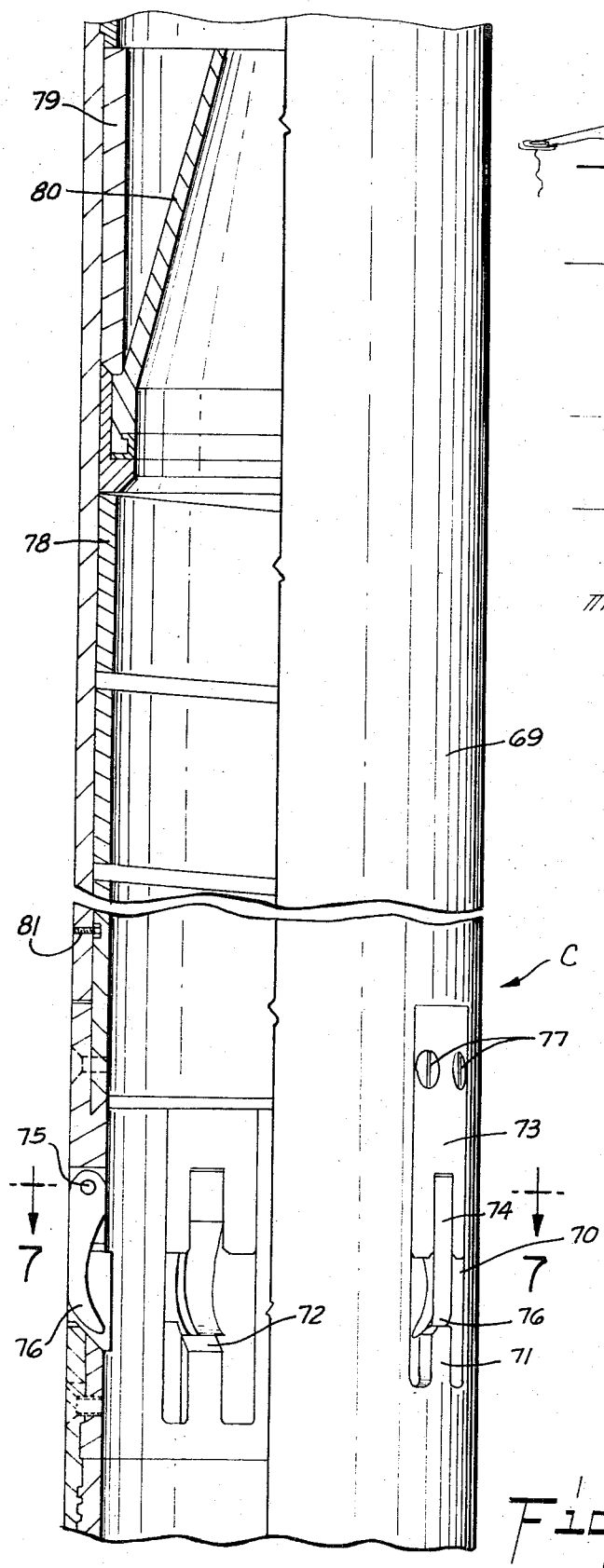


Fig-5

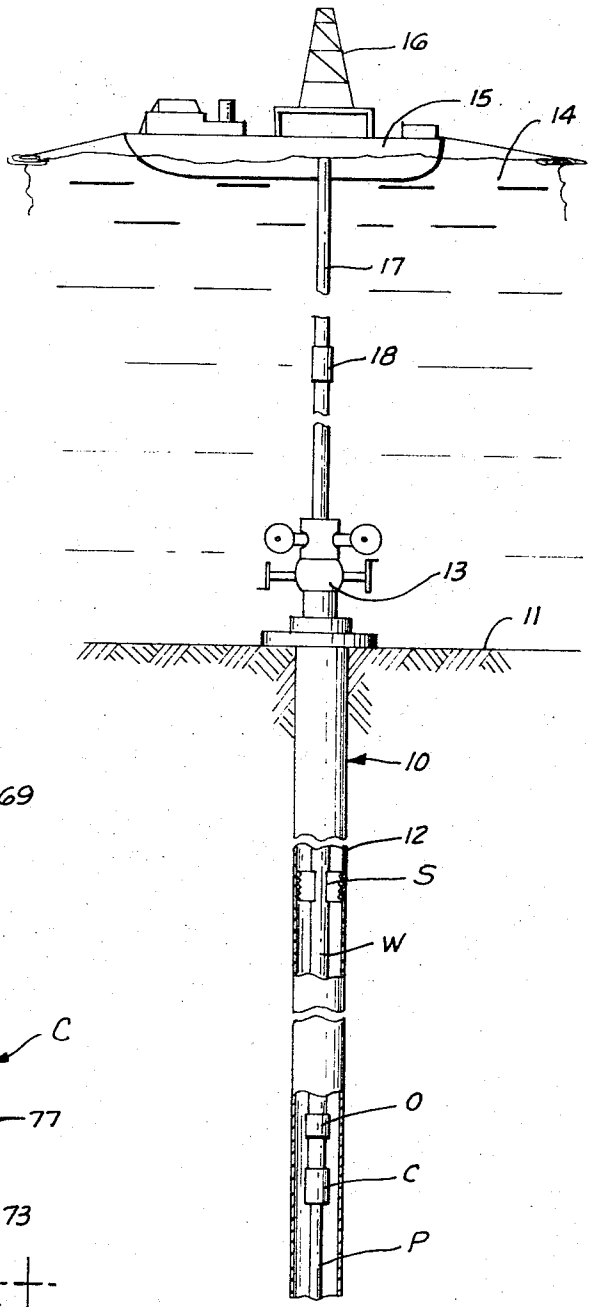


Fig-1

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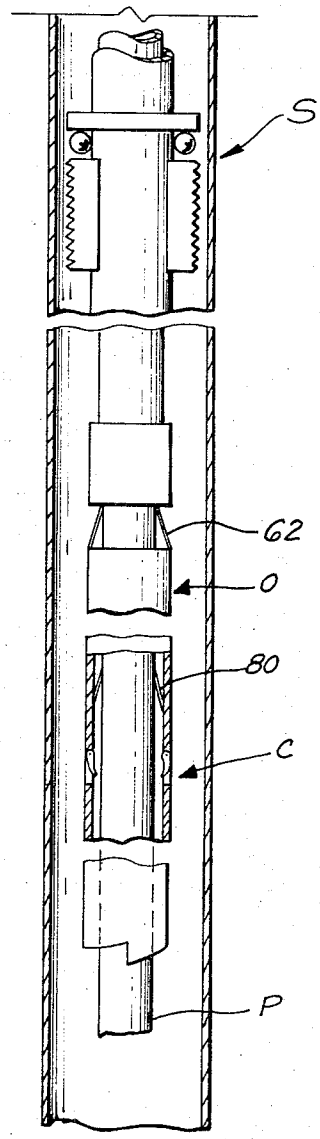


Fig. 2A

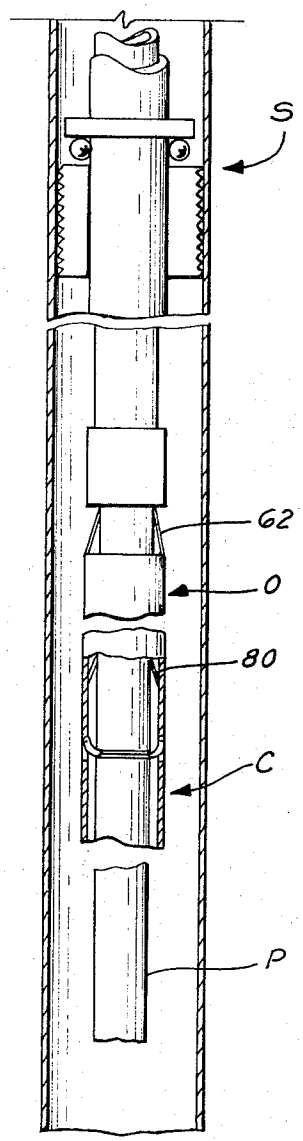


Fig. 2B

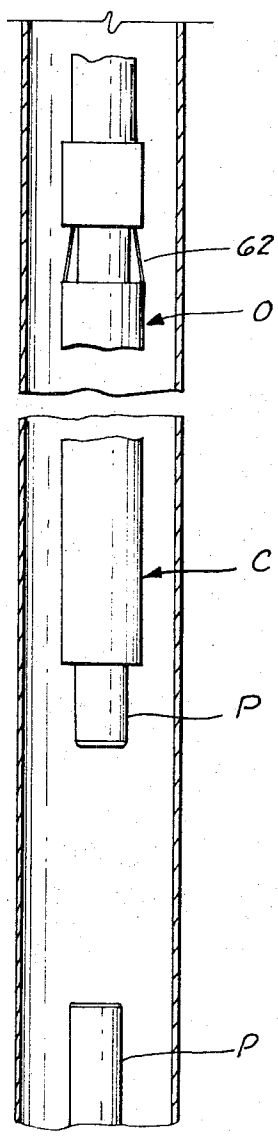


Fig. 2C

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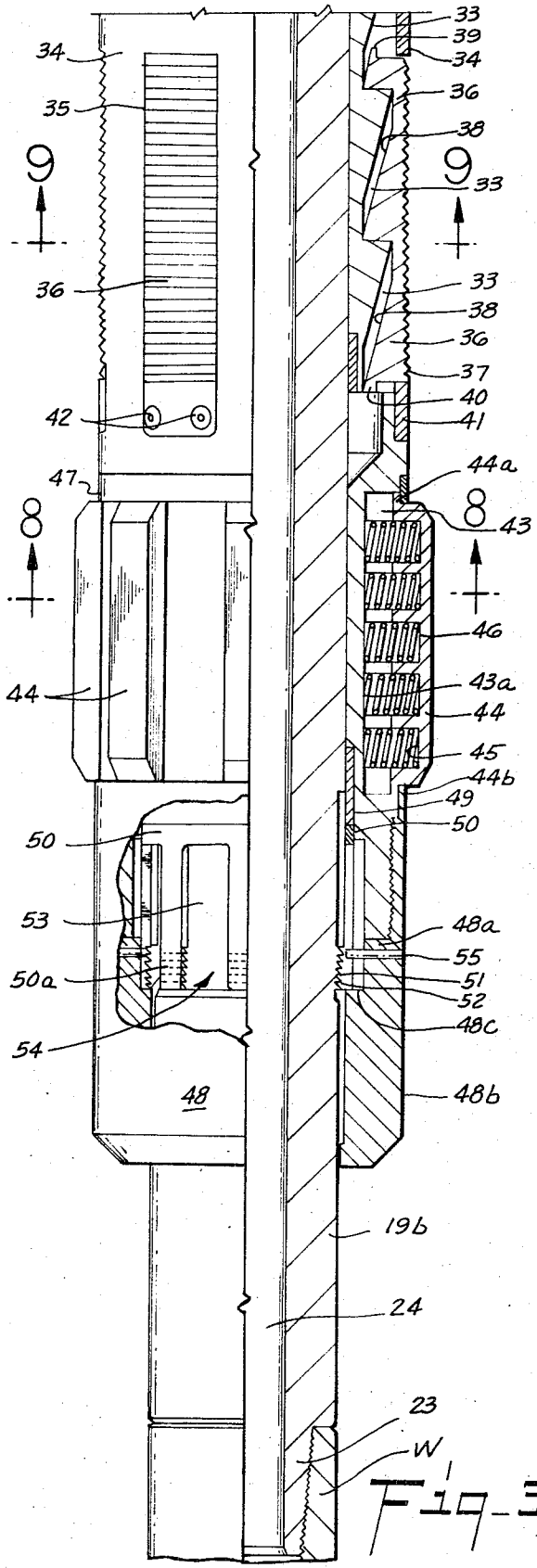


Fig. 3B

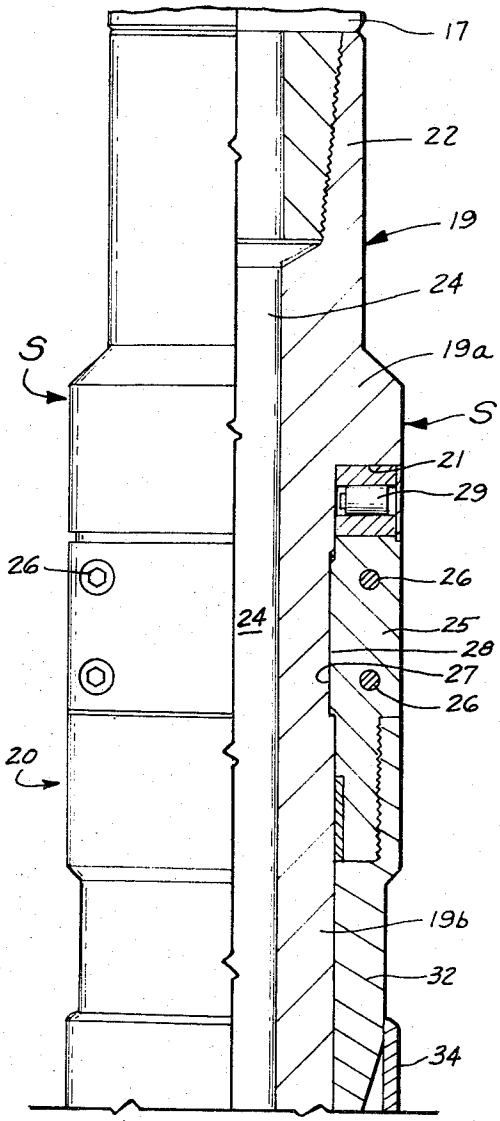


Fig. 3A

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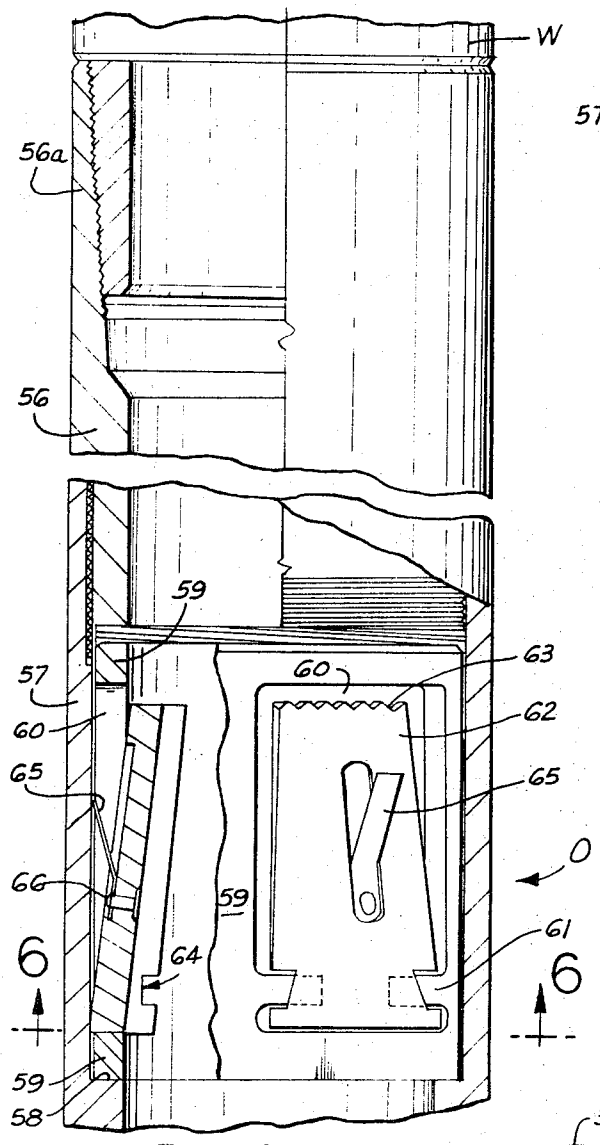


Fig 4

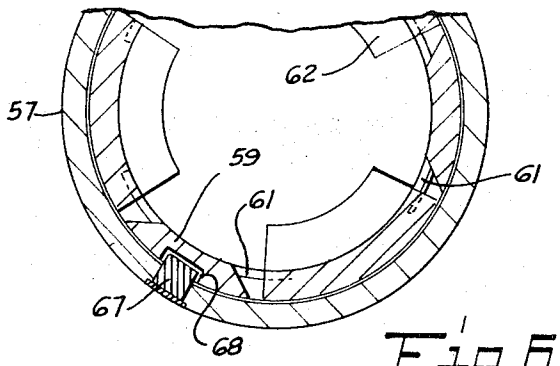


Fig 6

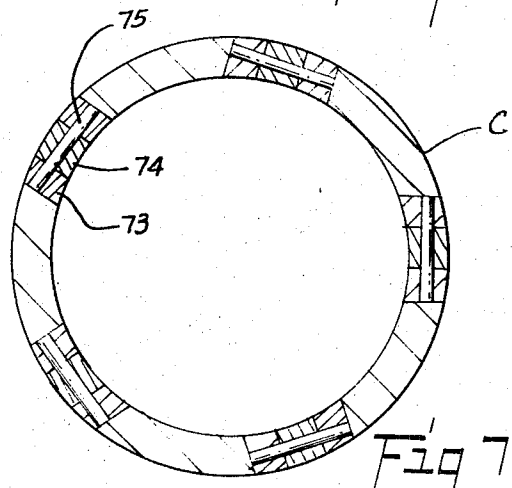


Fig 7

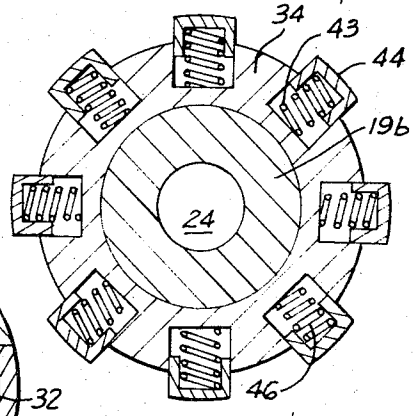


Fig 8

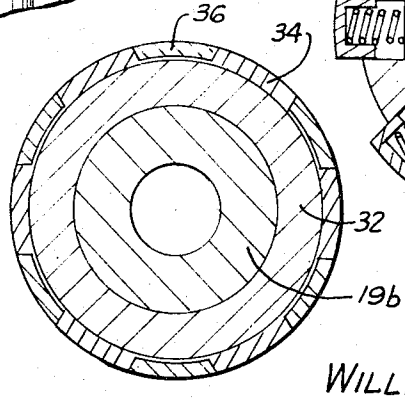


Fig 9

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METHOD FOR CUTTING AND RETRIEVING PIPE FROM A FLOATING DRILL SHIP

SUMMARY OF THE INVENTION

This invention relates to the field of underwater drilling from a floating ship, and more particularly to an improved method and apparatus for performing a cut on a well pipe within a well bore from a floating drill ship.

Recent years have seen an increasing proportion of oil and gas exploration and production activity conducted on submerged lands, especially the offshore areas of the continental shelf. Such activity was originally conducted from fixed or movable platforms which rigidly engaged the ocean floor during drilling operations. However, as activity moved farther offshore, it became necessary to operate from floating drill ships having no means of rigid connection with the ocean floor.

In offshore drilling, including that conducted from floating drill ships, just as in onshore operations, it is sometimes necessary to sever and remove a portion of a pipe which has become stuck within the well bore. When drilling from a floating ship, this operation is especially difficult because of wave action which is constantly changing the vertical distance between the drill ship and the well. Thus, a cutter on a tubing string does not remain stationary long enough to make the cut.

The provision of a drilling slack joint, or telescoping joint, in the drill string above the cutter will compensate for this vertical displacement, but only if means are provided below the telescoping joint for retaining the cutter against vertical displacement while permitting rotation so that all relative vertical movement is absorbed by the telescoping joint.

It is, accordingly, the primary object of the present invention to provide a method for making cuts on a pipe within a well bore which overcomes the disadvantages found in the prior art methods.

A further object is to provide such a method employing a swivel to anchor the tubing string at any point within the well casing, rather than at a predetermined point.

Another object is to provide such a method which may economically be used to cut pipes at a point deep within the well bore.

A more specific object is to provide such a method wherein there is no possibility that a cut may inadvertently be taken at a connecting collar.

An additional object is to provide an apparatus adapted for use in carrying out the foregoing objects.

DESCRIPTION OF THE DRAWINGS AND THE PREFERRED EMBODIMENT

These and other objects and advantages of the present invention will become apparent from the drawings, the specification and the claims.

in the accompanying drawings, which illustrate the preferred embodiment of the present invention, and in which like numerals indicate like parts:

FIG. 1 is a diagrammatic view, partly in elevation and partly in section, of an offshore well installation including a floating drill ship, and illustrating a cutting tool being used in accordance with the method of the present invention to cut a pipe located within the bore of a well in the ocean floor.

FIG. 2A is a diagrammatic view, partly in elevation and partly in section, illustrating a step in the method of the present invention, wherein a tubular cutter is disposed about a pipe to be cut.

FIG. 2B is a view similar and sequential to FIG. 2A, showing the cutter being operated to make a cut in the pipe.

FIG. 2C is a view similar and sequential to FIG. 2B, showing the tubing string and cutter being withdrawn to retrieve the pipe section.

FIG. 3A is an enlarged detail view, partly in elevation and partly in section, of the upper portion of the downhole swivel utilized in the cutting method of the present invention.

FIG. 3B is a continuation of FIG. 3A, illustrating the lower portion of the swivel, including the anchor means.

FIG. 4 is an enlarged detail view, partly in elevation and partly in section, of the collar locater, or overshot, used in performing the method of the present invention.

FIG. 5 is an enlarged detail view, partly in elevation and partly in section, of a tubular cutter used in performing the method of the present invention.

FIG. 6 is a sectional view, taken along line 6—6 of FIG. 4, showing the overshot dogs.

FIG. 7 is a sectionl view, taken along line 7—7 of FIG. 5, showing the cutter knives.

FIG. 8 is a sectional view, taken along line 8—8 of FIG. 3B, showing the friction blocks used in connection with the anchor means.

FIG. 9 is a sectional view, taken along line 9—9 of FIG. 3B, showing the anchor means.

Referring now to FIG. 1, there is shown a well bore 10 in the ocean floor 11. A casing 12 lines the well bore and is capped by the usual wellhead installation including blowout preventer 13. A pipe P which is to be cut is disposed within the lower end of casing 12, or in open hole.

Floating above well 10 on the surface of water 14 is a drill ship 15. On the deck of the drill ship 15 a drilling rig 16 is provided which supports a drill string 17 extending downwardly from the drill ship, through blowout preventer 13, and into the bore of the well casing 12. Means for compensating for relative vertical movement between the ship and well bore is provided by a telescoping or slack joint 18 in drill string 17, preferably at a point just above the downhole swivel S. The telescoping joint serves to compensate for vertical movements of the drill ship 15 relative to the ocean floor due to wave and tide action. The details of construction and operation of the telescoping joint 18 are conventional and are well known to those skilled in the art.

Spaced downwardly along tubing string 17 from telescoping joint 18, and within the bore of well 10, is a downhole swivel S which, as hereinafter explained, when actuated serves to anchor the portion of tubing string 17 below telescoping joint 18 against vertical displacement while permitting its free rotation. Below swivel S is provided a tubular collar locater, or overshot O, which, as hereinafter explained, serves to space the cutter C longitudinally from a collar of pipe P, thus assuring that the cut will be made in the body of the pipe section and not at a collar connecting two such sections. The tubular cutter C is below the overshot O and is adapted to surroundingly engage and cut pipe P.

Referring now to FIGS. 3A and 3B, there is shown the preferred form of downhole swivel S for use in carrying out the method of the present invention. The swivel provides means for anchoring the portion of drill string **17** below telescoping joint **18** against vertical displacement, while permitting its free rotation. It comprises two tubular body sections indicated generally at **19** and **20.** Upper body section **19** provides the means for connecting the swivel into the drill string **17,** and is the portion of the swivel which continues to rotate with the drill string during the cutting operation. Section **19** includes an upper portion **19***a* of enlarged diameter and an elongated lower portion **19***b* of reduced diameter, with downwardly facing annular shoulder **21** formed between the two. Reduced diameter portion **19***b* is adapted to fit within the central bore of lower body section **20** and extends downwardly below the lower end thereof. A threaded box portion **22** on the upper end of body section **19,** and a threaded pin **23** on the lower end provides means for connecting the swivel S to adjacent sections of the drill string **17,** and a central bore **24** therethrough provides a fluid passageway through the tool.

The lower swivel body section **20** has means for anchoring the swivel within the well bore and for rotatably supporting the upper swivel body section **19** and the apparatus attached thereto. It includes at its upper end a split nut **25** comprising two sections joined by bolts **26.** Split nut **25** has an annular portion **27** of reduced inner diameter which fits within a groove **28** on upper swivel body section **19** so as to retain the upper and lower swivel sections against relative longitudinal movement.

Suitable bearing means **29** are provided between the top of split nut **25** and horizontal shoulder **21** on upper swivel section **19** so that, as will be hereinafter explained, when the lower swivel section **20** is anchored within the well bore, bearing means **29** rotatably support the upper swivel body section **19.**

Threadedly connected to the lower end of split nut **25** is slip-expanding mandrel **32** which has multiple downwardly and inwardly tapering cam surfaces **33.** A cylindrical slip body **34** is slidably disposed about the exterior of mandrel **32** and has in its upper portion multiple longitudinal slots **35** (six being shown) in which are disposed the individual slips **36.** Slips **36** have on their outer edges multiple downwardly facing teeth **37** which are adpated to grip the inner surface of well casing **12.** The inner edges of slips **36** have downwardly and inwardly tapering cam surfaces **38** which are adapted, upon relatively vertical movement of the slips and mandrel, to coact with cam surfaces **33** on slip expander mandrel **32** so as to force slips **36** radially outwardly into engagement with casing **12.** The slips are retained against complete outward displacement by upper and lower dogs **39** and **40** on slips **36.**

A plurality of vertical recesses **43** (eight being shown) are provided in the lower portion of slip body **34.** In each recess **43** is mounted a friction block **44.** A plurality of circular recesses **45** is provided in the back of each friction block **44** with a compression coil spring **46** being mounted in each recess **45** and having its inner end bearing against the back **43***a* of vertical recess **43,** so that friction blocks **44** are at all times urged radially outwardly into engagement with the inner surface of well casing **12.** Complete outward displacement of friction blocks **44** is prevented by upper and lower dogs **44***a* and **44***b*, respectively. Upper dogs **44***a* are held by keeper ring **47** while lower dogs **44***b* are held by the upper portion of a lower tubular extension **48** which is threadedly connected to the lower end of slip body **34.**

Tubular extension **48** has an upper portion **48***a* wherein the central bore is of enlarged diameter, and a lower portion **48***b* wherein the bore is of decreased diameter, with an upwardly facing annular shoulder **48***c* being formed between the two. Located between shoulder **48***c* and the lower edge of a wear bushing **49** carried by slip body **34** is a retainer nut **50** which, as hereinafter shown, serves to keep the slips **36** from setting, and which may be selectively released to permit the slips to set. Retainer nut **50** has on the lower portion of its inner surface upwardly facing threads **51** which are adapted to engage downwardly facing threads **52** on the surface of lower portion **19***b* of swivel section **19.** Extending upwardly from the bottom of retainer nut **50** are a plurality of longitudinal slots **53,** so that the threaded portion **51** of nut **50** actually comprises a plurality of discontinuous thread sections **54,** each carried at the end of a spring finger portion **50***a* of retainer nut **50,** the purpose of which will be hereinafter explained. A pin **55** carried by lower tubular extension **48** fits within a slot **53** of retainer nut **50,** to thereby prevent nut **50** from rotating relative to tubular extension **48** and slip body **34.**

Spaced downwardly along drill string **17** from swivel S is a collar locater, or overshot O shown in detail in FIGS. **4** and **6.** It includes two tubular body sections **56** and **57** threadedly connected. Upper section **56** has at its upper end a threaded box portion **56***a* for connection to a washover string W. Lower section **57** has at its lower end a threaded pin portion **57***a* for connection to the washover string. The bore through both tubular sections **56** and **57** provides fluid communication through the tool.

Lower overshot section **57** has formed in its bore an upwardly facing annular shoulder **58.** Confined between shoulder **58** and the lower end of upper overshot section **56** is a collar **59** having a plurality (three being shown) of openings, or windows, **60** therein. Extending into each window **60** are two lugs **61** formed from the collar **29;** one lug **61** being on each vertical side of the window near the lower edge thereof. The lugs **61** are preferably of less thickness than the wall of collar **59.**

Disposed within each window **60** of collar **59** is an arcuate overshot dog **62** having serrations **63** along its upper edge. On the inner face of each dog **62** are formed two recesses **64** adapted to coact with the lugs **61** of window **60,** so that in its assembled position each dog **62** is retained between the lugs **61** and the inner surface of lower overshot section **57.** A leaf spring **65** is attached to the back of each dog **62** by bolt **66** and bears with its free end against the inner surface of overshot section **57.** Each dog **62** is thereby resiliently urged radially inwardly at its upper end, tending to pivot about lug **61.** A key **67** fits through overshot section **57** and into a recess **68** in collar **69** to prevent the collar from rotating relative to the remainder of the tool.

Referring now to FIGS. **5** and **7,** there is shown the cutter C preferably used in performing the method of the present invention. As shown, cutter C is tubular, being adapted to surround the pipe to be cut, and cut from the outside of the pipe inward. Therefore, the

bore of the cutter is of sufficient internal diameter to accommodate the pipe to be cut, including connecting collars.

The cutter includes a tubular body **69** having a plurality of longitudinal openings **70** therein. At the lower end of each opening **70** is an upstanding lug **71** having formed on its inner surface downwardly and inwardly tapering cam surface **72.** Disposed within the upper end of each opening **70** is a slide **73** having at its lower end a curved cutting knife **74** pivotally mounted on the slide **73** by a pin **75.** The lower rear portion **76** of each cutting knife **74** tapers downwardly and inwardly so as to coact with cams **72** of lugs **71** to pivot the knives radially inwardly about pins **75** as slides **73** move downwardly relative to the cutter body **69.**

Each slide **73** is attached at its upper end by means of screws **77** to square-cut coil spring **78** disposed within the bore of cutter body **69.** Above spring **78** is a slidable sleeve **79** having thereon a conical seal element **80.** As hereinafter explained, the seal **80** is adapted to seal between a pipe P disposed within the bore of cutter C and the sleeve **79,** whereby pressurizing fluid may be retained above seal **80** to exert a downward force on the sleeve **79** and spring **78.** A shear pin **81** initially retains the lower end of spring **78** against downward movement.

The manipulation of the above described apparatus to perform the cutting method of the present invention is indicated diagramatically in FIGS. **2A, 2C** and is as follows: The operating string, including the cutter C, overshot O, washover pipe W, swivel S, telescoping joint **18** and connecting drill string **17,** is made up on the drill ship **15** and is run into the well bore by drilling rig **16.** As the string is lowered, the top of pipe P enters the lower end of the bore of cutter C and thereafter the cutter is lowered in surrounding relationship to pipe P. As the pipe moves relatively upwardly in the bore of cutter C, it engages the annular seal **80.** Thereafter, the flexible annular seal **80** maintains a seal between the pipe P and sleeve **79.**

As the drilling string is lowered further, pipe P enters the bore of overshot O and the upper ends of overshot dogs **62** bear against the outside of pipe P. The dogs pivot outwardly to accommodate a collar on the pipe as they pass down around it, but leaf springs **65** cause the dogs to snap back against the body of the pipe section as the collar is cleared. The parts are shown in this relationship in FIG. **2A** with the cutter and overshot surroundingly engaging the pipe P.

When the cutter has been lowered to the approximate cut point, an upward pull is taken with the drill string **17** which causes the cutter and overshot to move upwardly until dogs **62** engage the lower edge of a collar in pipe P which stops further upward movement. Since the overshot O is a fixed distance above the cutter C, this automatically spaces the cutter from a collar and assures that the cut is taken in the body of the pipe P.

Next, the downhole swivel S is set by rotating the drill string **17** to the right and lowering slightly. As the string is rotated to the right, upper swivel body section **19** also rotates, while lower section **20** tends to remain stationary by virtue of friction blocks **44** dragging on the inner surface of the well casing **12.** This causes the threads **52** on upper swivel member **19** to disengage from threads **53** on retainer nut **50.** After disengagement, threads **52** are below threads **53.** Then, as the tubing string **17** is lowered, slip mandrel **32** also moves downwardly while slip body **34** remains stationary due to friction blocks **44.** Continued downward movement causes cams **33** on the slip mandrel **32** to engage cams **38** on the slips **36,** and thereby urge the slips **36** radially outwardly into gripping engagement with the well casing.

As the slips set, the entire weight of the string suspended from the swivel is carried by lower swivel section **20** through bearings **29.** Thus, the setting of the downhole swivel will be indicated on the drill ship **15** by a loss of weight in the string approximately equal to the weight of the tools below the swivel. The drill string above the swivel is then lowered a distance equal to approximately one-half the travel of the telescoping joint to position it to compensate for the ship's vertical movements.

Once the swivel is set and the telescoping joint is positioned, the cutter C remains vertically stationary, and movements of the drill ship **15** are absorbed by the telescoping joint **18.** However, the tubing string and cutter remain rotatable by virtue of resting on bearings **29** in the swivel S.

Next, the tubing string **17** is rotated to rotate the cutter C and hydraulic fluid is pumped down through the string to actuate the cutter knives. The hydraulic fluid is trapped above the seal **80** in cutter C and, as pressure increases, forces the sleeve **79** downwardly, compressing spring **78** until shear pin **81** is severed. The combined actions of spring **78** and the hydraulic pressure acting on sleeve **79** then force slides **73** downwardly relative to the cutter body **69,** causing cutter knives **74** to pivot about pin **75** and engage and cut the outer surface of the pipe P. As the cut progresses, knives **74** pivot further inwardly until the pipe is completely severed. The parts are shown in this configuration in FIG. **2B** with the slips **36** of swivel S engaging the inner wall of well casing **12** and with a cut being made in the pipe P.

After the cut is completed, the drill string **17** is raised to disengage slips **36.** Threads **51** and **52** on the retainer nut **50** and swivel section **19,** respectively, may, by virtue of their shape and the flexible spring-finger sections **50***a* which carry the thread segments **54** of retainer nut **50,** be snapped into place without relative rotation.

After the swivel is released, the string **17** may be raised until the dogs **62** in the overshot O again engage a collar on the pipe P. This retains the pipe against further downward movement relative to the cutter so that the severed pipe section may be withdrawn supported within the string, as shown in FIG. **2C.**

Thus, it is seen that a method and apparatus have been provided for making a cut on a pipe within a well bore from a floating drill ship. Moreover, the disadvantages present in the prior art are overcome in that means are provided for rotatably supporting the drill string at a point within the well bore and for assuring that the cut is taken in the body of the pipe and not at a connecting collar.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims without departing from the spirit of the invention.

What is claimed is:

1. A method for cutting and retrieving, from a floating drill ship, a well pipe disposed within a well bore and including connecting collars, wherein a cutter is utilized mounted on a drill string, said string including means for compensating for relative vertical movements between said ship and the well bore, said method comprising:

lowering said drill string into the well bore to position said cutter in cutting relationship to said pipe,

locating said cutter in spaced longitudinal relationship with respect to one of said collars in said pipe,

anchoring said drill string, at a point between the cutter and the compensating means, at any desired depth within the well bore so as to prevent longitudinal displacement of said cutter while permitting rotation thereof,

lowering said drill string from said ship to operatively position said compensating means,

operating said cutter to sever said pipe,

releasing said drill string from its anchored position, and

utilizing said drill string to remove the severed pipe from the well bore.

2. The method of claim 1 wherein said drill string includes an overshot and the locating of said cutter in spaced longitudinal relationship with respect to one of said collars in said pipe is accomplished by raising said drill pipe to contact one of said collars with said overshot.

3. The method of claim 1 wherein the anchoring of said drill string is accomplished by rotating said drill string to the right and lowering slightly to actuate swivel means and anchor means carried by said drill string.

4. The method of claim 1 wherein said cutter includes seal means to seal between said pipe and said cutter and wherein the operation of said cutter includes rotating said drill string to rotate said cutter and supplying pressurizing fluid to one side of said seal means.

5. The method of claim 3 wherein said drill string is raised to release the drill string from its anchored position by releasing said anchor means.

6. An apparatus for use with a floating drill ship for making an outside cut on a pipe having connecting collars and disposed within a well bore and for retrieving the severed pipe section, comprising:

a drill string adapted to be suspended from said drill ship,

an outside cutter at the lower end of said drill string having at least one movable knife adapted to engage and cut said pipe, and being adapted to be actuated by pressurizing fluid supplied through said drill string,

locater means carried by the drill string above said cutter for engaging a collar on said pipe to locate said cutter a spaced distance from said collar,

swivel means for rotatably supporting said cutter and locater means within the well bore,

said swivel means including anchor means for releasably anchoring said cutter and locater means at any desired depth to the wall of the well bore against lateral and longitudinal displacement within the well bore, and

a telescoping joint in said drill string between said drill ship and said swivel means for compensating for vertical movement of said drill ship relative to said well bore.

7. A method for making an outside cut from a floating drill ship on a well pipe having connecting collars and disposed within a well bore, employing an outside cutter mounted on a drill string including a telescoping joint, said method comprising the steps of:

lowering said drill string into the well bore to locate said cutter in surrounding relationship to said pipe,

locating said cutter in spaced longitudinal relationship with respect to one of said collars,

rotatably anchoring the drill string at any desired depth within the well bore against lateral and longitudinal displacement,

lowering the drill string to operatively position said telescoping joint,

operating the outside cutter to sever said pipe,

releasing the drill string from its anchored position, and

utilizing the drill string to remove the severed pipe from the well bore.

8. The method of claim 7 wherein said cutter is lowered in spaced longitudinal relationship with respect to one of said collars by raising said drill string to contact said collar with an overshot carried by said drill string.

9. The method of claim 7 wherein said drill string is rotatably anchored within the well bore by rotating said drill string to the right and lowering to actuate anchor means and swivel means carried by the drill string.

10. The method of claim 7 wherein said outside cutter is operated by rotating said drill string to rotate said cutter and supplying pressurizing fluid to said cutter through said drill string to act on seal means carried by said cutter and sealing between said cutter and said pipe.

11. The method of claim 9 wherein said drill string is released from its anchored position by raising it to release said anchor means.

12. An apparatus for use with a floating drill ship, for cutting and retrieving a pipe having connecting collars and disposed within a well bore, comprising:

a drill string adapted to be suspended from said drill ship,

means for compensating for relative vertical movement between said drill ship and the well bore,

a cutter on said drill string having at least one movable knife adapted to engage and cut said pipe,

locater means carried by the drill string for locating and engaging a collar on said pipe to locate said cutter a spaced distance from said collar,

swivel means for rotatably supporting said cutter and locater means within the well bore, and

anchor means on the swivel means for engaging the well wall at any desired depth for releasably anchoring said cutter, locater means and swivel against lateral and longitudinal displacement within the well bore.

13. The apparatus according to claim 12 wherein said cutter is an outside cutter adapted to surroundingly engage said pipe.

14. The apparatus according to claim 13 wherein said cutter is hydraulically actuated.

15. The apparatus according to claim 12 wherein said locater means comprise an overshot.

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