Dec. 31, 1968 L. SANFORD 3,419,077

WELL CUTTING TOOL

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Fig. 1

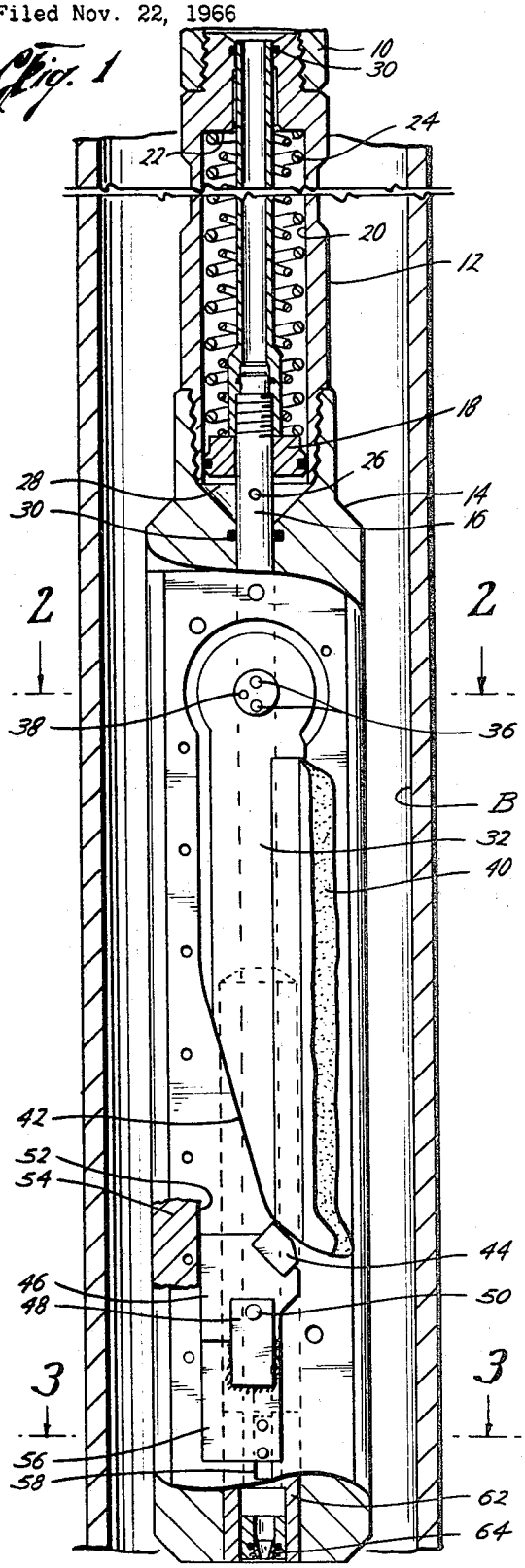

Fig. 2

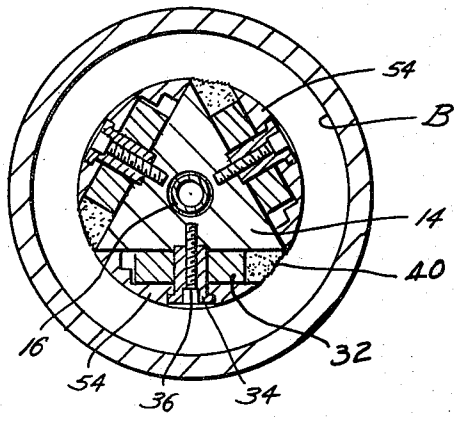

Fig. 3

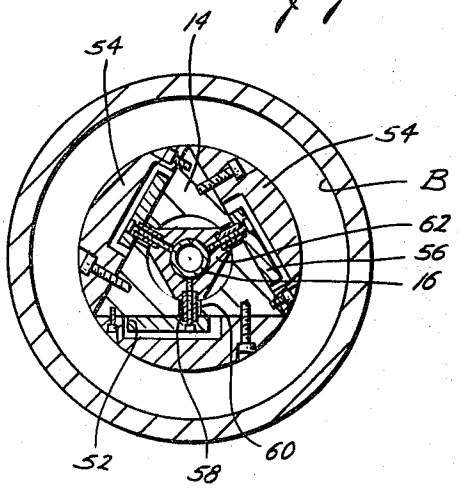

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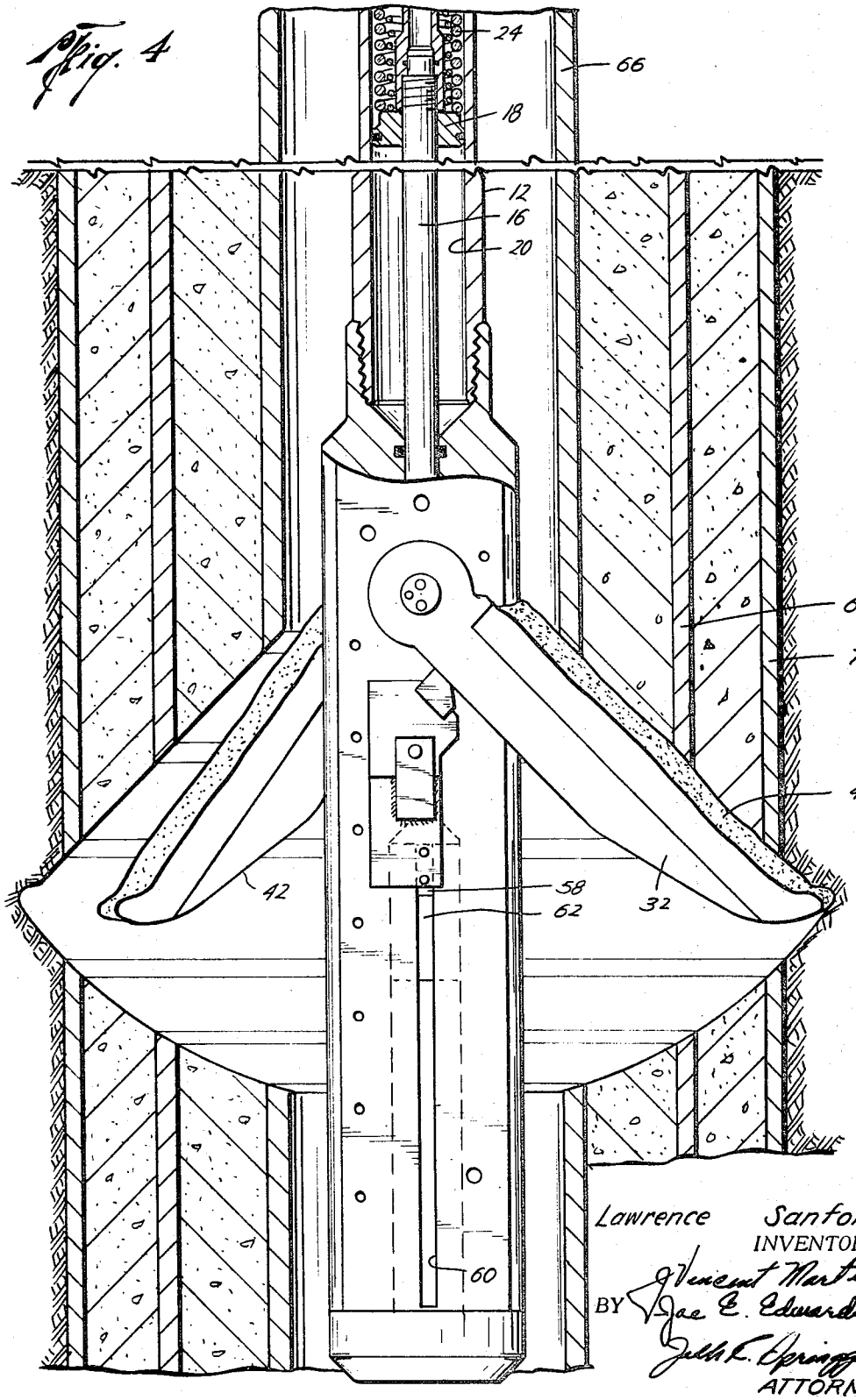
Fig. 4



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WELL CUTTING TOOL

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ABSTRACT OF THE DISCLOSURE

A well cutting tool adapted to cut a casing in a well bore and having a body and at least one cutting arm pivotally mounted to the side of the body and including means to transmit cutting forces directly between the body and the cutting arm.

Summary

The present invention relates to an improved cutting tool for use in well bores. This improved cutting tool provides for the direct transmission of cutting or rotary forces between the body and the cutting arm and also provides for pivotal movement of the arm which lies in a plane parallel to the side of the body to which the arm is mounted.

Many times a casing string which has been set in a well bore is required to be cut below the surface. For example, it is a requirement in marine operations that to abandon a well, the well casing must be removed at least fifteen feet below the mudline to assure that it does not present a future hazard.

Prior cutters have been used for cutting casing in a well bore but have had disadvantages of not cutting a sufficiently large diameter to be used in cutting multiple casings, of not cutting properly because of eccentricity of the casing being cut and of introducing stresses in the drill string supporting the cutter because the cutter did not center itself in the casing string.

It is therefore an object of the present invention to provide an improved well cutting tool which remains centralized in the well bore during cutting, which cuts multiple strings smoothly and which cuts a large diameter relative to the diameter of the cutter as it is run into the well bore.

Another object is to provide an improved well cutting tool having cutting arms which expand responsive to fluid pressure and retract when the tool is lifted after the fluid pressure is relieved.

A further object is to provide an improved well cutting tool having three cutting arms adapted to be moved simultaneously outward from the tool body for cutting.

A still further object is to provide an improved well cutting tool having three cutting arms, each of which has substantial support.

These and other objects and advantages of the present invention are hereinafter set forth in detail with reference to the drawings which show the preferred form of the present invention and wherein:

FIGURE 1 is a longitudinal sectional view of the preferred form of the well cutting tool of the present invention being run into a well bore supported on a suitable well string.

FIGURE 2 is a transverse sectional view taken along line 2—2 in FIGURE 1 and illustrating the pivotal connection of the cutting arms to the body.

FIGURE 3 is another transverse sectional view taken along line 3—3 in FIGURE 1 to illustrate the details of structure of the means for actuating the cutter arms.

FIGURE 4 is another longitudinal sectional view of the cutting tool of FIGURE 1 illustrating its cutting position.

Referring more in detail to FIGURE 1, the preferred

form of cutting tool illustrated is connected to the well string 10 for lowering into the well bore B. The cutting tool includes the upper cylinder 12 which connects directly to well string 10 and the body 14 connected to and extending below the upper cylinder 12. The tubular member 16 extends substantially through the interior of cylinder 12 and the interior of body 14 and is provided with the annular piston 18 secured thereto and engaging within the lower end of the bore 20 defined by the cylinder 12. The upper end of bore 20 terminates in the downwardly facing shoulder 22. Means, such as the springs 24, are provided to urge the tubular member 16 in a downward direction. As shown, the springs 24 engage the upper surface of the annular piston 18 and the shoulder 22. Immediately below the annular piston 18, the tubular member 16 defines a port 26 which provides communication from the interior of the tubular member 16 to the pressure chamber 28 surrounding the tubular member 16 below the annular piston 18. The upper end of the tubular member is in communication with the interior of the well string 10 whereby fluid pressure in the well string is communicated to the tubular member 16. Also, suitable seals 30, such as, O-rings are provided for sealing around the exterior of the tubular member 16 at the upper interior of the cylinder 12 and the upper interior of body 14.

To accommodate three cutting arms, the body 14 has an external triangular shape as clearly shown in FIGURES 2 and 3 and is provided with a central bore extending longitudinally therethrough in which the tubular member 16 is positioned. The cutting arms 32 are pivotally connected to the body 14 by the bushing 34 which is secured to the body by the screws 36. As shown, in FIGURE 1, the bushing 34 is provided with the lubricating fitting 38 so that the pivotal connection of the cutting arms 32 may be lubricated. Each of the cutting arms 32 is provided with the cutting surface 40 which may be any suitable cutting material but is generally preferred to be provided by a matrix with a suitable material embedded therein. The opposite side of cutting arm 32 defines the surface 42 which is contoured for engagement by suitable wedging means to pivot the cutting arm 32 outwardly and upwardly into cutting position.

The wedging means for each of the cutting arms 32 includes a wedge block 44 adapted to engage the surface 42 of the cutting arm 32, a means for moving the wedge block 44 and a means for transmitting the reaction of the cutting arm 32 during cutting to the body 14. The wedge block 44 is secured in the reaction block 46. Reaction block 46 is loosely secured to block 48 by the pin 50. Reaction block 46 is adapted to transmit reaction forces of the cutting arm 32 and the wedge block 44 to the shoulder 52 of the cover 54 and thus prevent such reaction loading from being concentrated on the means moving the wedging means. Such moving means includes the surface block 56 to which the block 48 is secured, and which engages the reaction block 46 to move the wedge blocks 44, the guide block 58 which extends through the slot 60 defined in body 14 and provides a connection between surface block 56 and drive block 62.

Tubular member 16 is secured to the drive block 62 as by welding or other suitable means and the interior of drive block 62 includes the orifice insert 64. Fluid pressure exerted in the well string 10 is conducted through tubular member 16 and exhausted out the lower end of the cutting tool through the restriction provided by the orifice insert 64 in the drive block 62. Pressure is maintained within the tubular member 16 and such pressure is conducted into the pressure chamber 28 to be exerted on the underside of the annular piston 18. This pressure exerted on the annular piston 18, when sufficient to overcome the

force of the spring **24**, lifts the tubular member **16** and the drive block **62** upwardly whereby the wedge block **44** wedges the cutter arm **32** into cutting position as shown in FIGURE 4.

As seen in FIGURES 2 and 3, each side of the body **14** is provided with a cover **54** adapted to provide an opening through which the cutter arms **32** move in pivoting to cutting position. The covers **54** are secured to the body **14** in covering relation to the wedging means and the cutter arms **32**.

In operation, the cutting tool is lowered into a well bore B supported on a well string **10**, such as a drill pipe, in a position illustrated in FIGURE 1 with the cutting arms substantially wholly contained within the exterior of the cutter as defined by the body **14** and the cover **54**. When the cutting tool has reached the level in the well bore B at which it is desired to cut a casing, the well string **10** is rotated while fluid pressure is supplied to the interior thereof. Pressure fluids are conducted through tubular member **16** and the port **26** to the pressure chamber **28**. The restriction of the orifice insert **64** allows the fluid pressure in the chamber **28** to be controlled. As the pressure of the fluid builds up in the chamber **28** urging piston **18** upwardly, the cutting arms **32** are wedged or cammed outwardly toward the cutting position illustrated in FIGURE. 4.

As cutting is commenced, the lower tip of the cutting surface **40** on each of the cutting arms **32** first engages the interior of the first well string to be cut. Since three arms are provided and since the wedging means for each arm is connected to the drive block **62**, all of the arms are moved outwardly the same distance thereby assuring that the cutting tool remains centralized within the casing string being cut.

As cutting proceeds, the well string **10** is rotated at the surface and pressure is maintained thereon, it being understood that some pressure bleeds out through the lower end of the cutting tool, that is, out through the restriction provided by the orifice insert **64**. As each casing is cut, the cutting arms **32** maintain their cutting surface **40** inwardly from the tip in engagement with the first casing that is cut. This is clearly illustrated in FIGURE 4, the casing **66** having been first cut is still in engagement and being cut by the cutting surface **40** on the cutting arms **32** even though the outer cutting edge of the cutting arm has proceeded to cut through the casing **68** and the casing **70**.

The position illustrated in FIGURE 4 shows approximately the outermost position of the cutting arms **32**. It should be noticed that the wedging means including the guide block **58** has moved upwardly in the slot **60** and the drive block **62** has moved upwardly in the lower bore of body **14**. The upward movement of the wedging means is caused by the movement of the piston **18** and the tubular member **16** upwardly and such upper position of piston **18** is clearly illustrated in the upper portion of FIGURE 4.

As can be seen from FIGURE 4, the cutting arms **32** have a substantial amount of supporting surface held in engagement between covers **54** and the sides of body **14**. The large amount of support of the cutter arms provided by the structure is one of the particular advantages of the present invention. With this extended support, sufficient forces may be transmitted to achieve reasonable drilling rates without fear of overloading the structure of the cutting tool.

From the foregoing, it can be seen that the present invention provides an improved well cutting tool which provides rapid arnd smooth cutting of multiple strings in a well bore and is suitable for cutting diameters substantially larger than the diameter of the cutting tool. Also, this improved cutting tool provides a means by which it maintains its centralized position in the well bore and thereby avoids imparting stresses to the well string on which it is supported.

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 well cutting tool, comprising
a cutter body adapted to be connected to a well string,
said cutter body having a plurality of substantially flat sides,
a cutter arm having a cutting surface,
said cutter arm being pivotally secured to one of the sides of said body to pivot in a plane substantially parallel to the side to which it is secured,
pressure responsive means being movable longitudinally of said cutter body responsive to fluid pressure in said well string,
wedge means adapted to engage said cutter arm to wedge it outwardly to cutting position, and
means connecting said wedge means to said pressure responsive means whereby said cutter arm is moved to cutting position responsive to fluid pressure.

2. A well cutting tool according to claim **1**, including
means associated with said wedge means to transmit reaction force from said cutter arm to said cutter body.

3. A well cutting tool according to claim **1**, wherein
said cutter body has a generally triangular external sectional shape and a cutter arm is pivotally mounted on each of the external surfaces of said cutter body whereby three cutter arms centralize said body during drilling.

4. A well cutting tool according to claim **1**, including
a cover adapted to be secured to said body,
said cover and said body defining slots in which said cutter arms are positioned.

5. A well tool according to claim **1**, including
a plurality of said cutter arms,
each of said arms being pivotally secured to one of the sides of said body to pivot in a plane substantially parallel to the side to which it is secured.

6. A well cutting tool according to claim **1**, wherein
said body defines three sides, and
a cutter arm is pivotally secured to each of said sides.

7. A well cutting tool, comprising
a cutter body adapted to be connected to a well string,
a cutter arm having a cutting surface and being pivotally secured to said cutter body,
pressure responsive means being movable longitudinally of said cutter body responsive to fluid pressure in said well string,
wedge means adapted to engage said cutter arm to wedge it outwardly to cutting position.
means connecting said wedge means to said pressure responsive means whereby said cutter arm is moved to cutting position responsive to fluid pressure,
means loosely connecting said wedge means to said connecting means, and
a shoulder connected to said body and positioned for engagement by said wedge means whereby the reaction force of cutting is transmitted to said body.

8. A well cutting tool, comprising
a tubular support adapted to be connected to a well string,
a cutter body connected to said tubular support,
three cutter arms pivotally secured to said cutter body,
pressure responsive means being movable longitudinally of said cutter body and said tubular support responsive to fluid pressure in said well string,
wedge means adapted to engage said cutter arms to move them outwardly to cutting position,
means connecting said wedge means to said pressure responsive means whereby said cutting arms are

moved into cutting position by fluid pressure in said well string, and

a cover adapted to be secured to said body,

said cover and said body defining slots in which said cutter arms are positioned,

said cover defines a shoulder adapted to support said wedge means whereby drilling forces on said wedge means are transmitted by said cover to said body.

9. A well cutting tool, comprising

a tubular support adapted to be connected to a well spring,

said tubular support defining an internal bore,

a cutter body connected to said tubular support and defining an internal bore,

a cutter arm having a cutting surface,

means pivotally mounting said cutter arm to said body,

a tubular member adapted to be positioned within said internal bores of said tubular support and said body,

an annular piston secured to said tubular member and adapted to reciprocate, within said bore of said tubular support,

a port defined in said tubular member below said annular piston to conduct pressure fluid from within said tubular member to the lower side of said piston whereby said piston and said tubular member are urged upwardly by said fluid pressure,

spring means urging said tubular member downwardly,

wedging means adapted to engage said cutting arm,

means connecting said wedging means to said tubular member whereby upward movement of said tubular member moves said wedging means upward to force said cutting arm to cutting position, and

means transmitting cutting forces on said wedging means to said body.

10. A well cutting tool, comprising

a cutter body adapted to be connected to a drill string and defining a plurality of flat sides,

a cutter arm having a cutting surface,

means pivotally mounting said cutter arm to one of said flat sides of said body so that said arm pivots about said mounting means in a plane substantially parallel to said flat side on which said arm is mounted, and

means for moving said arm about said mounting means responsive to pressure delivered to said body,

said arm when moved having at least a portion of its cutting surface extending beyond the exterior of said body for cutting.

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U.S. Cl. X.R.

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