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2,690,218

METHOD OF SEVERING AND MILLING A WELL CASING

Original Filed April 22, 1950

2 Sheets-Sheet 1

Fig. 1

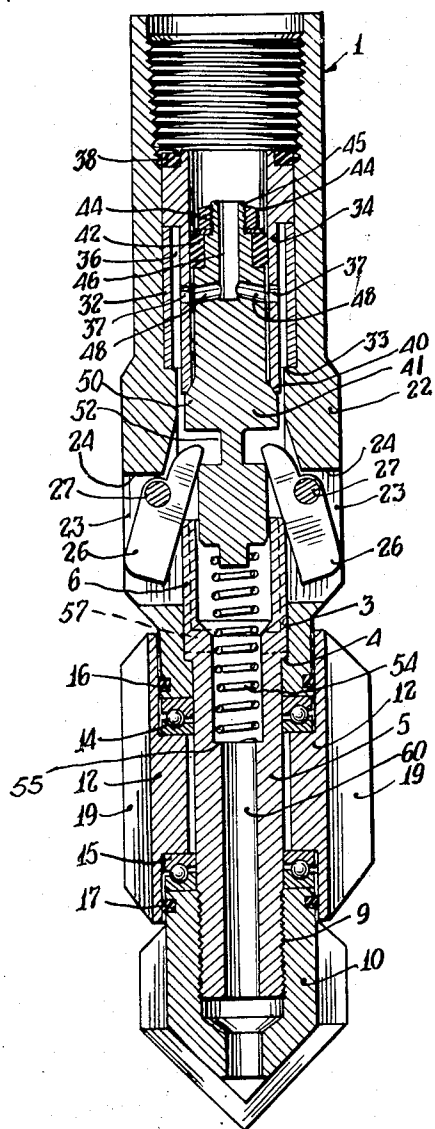
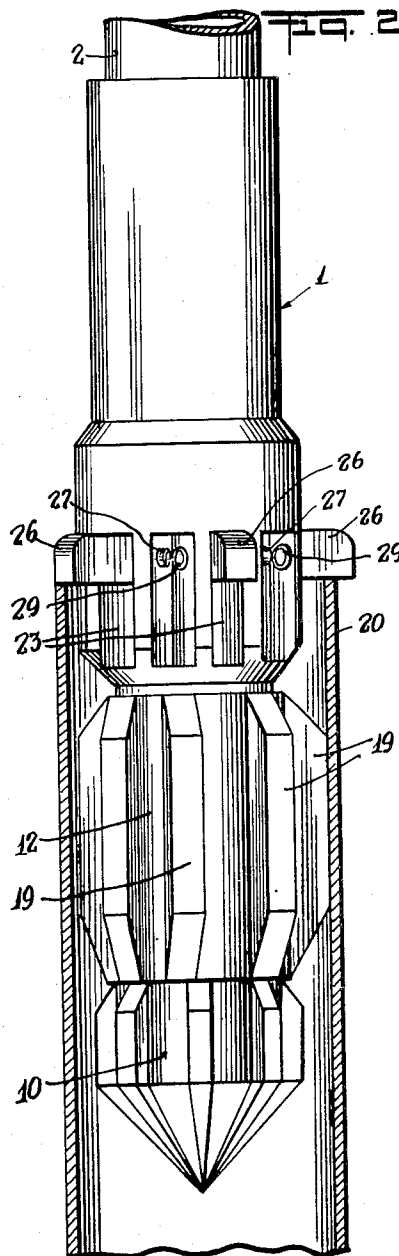


Fig. 2



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Fig. 3

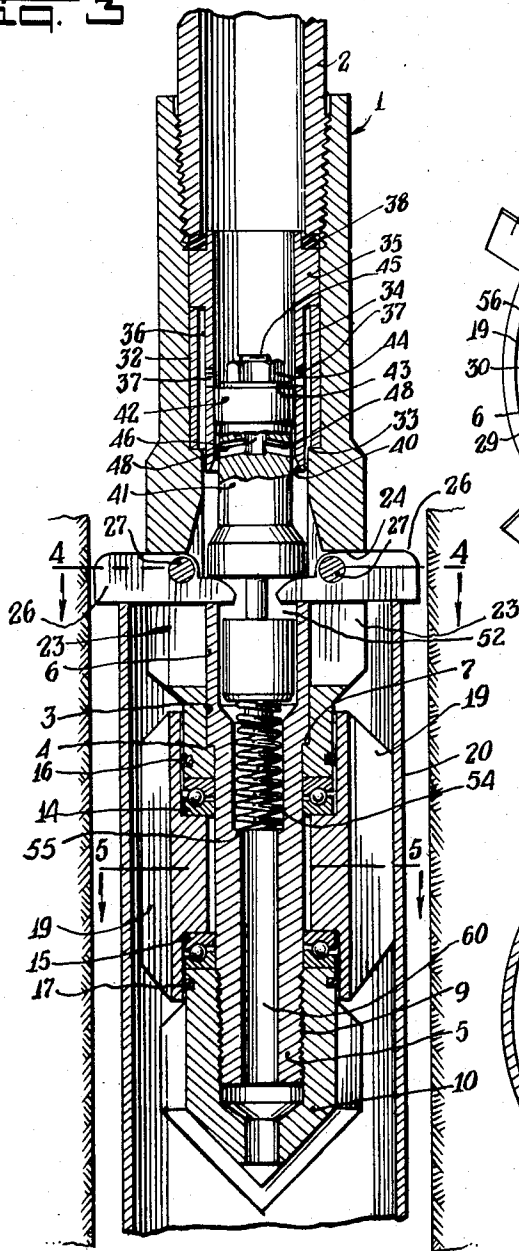


Fig. 4

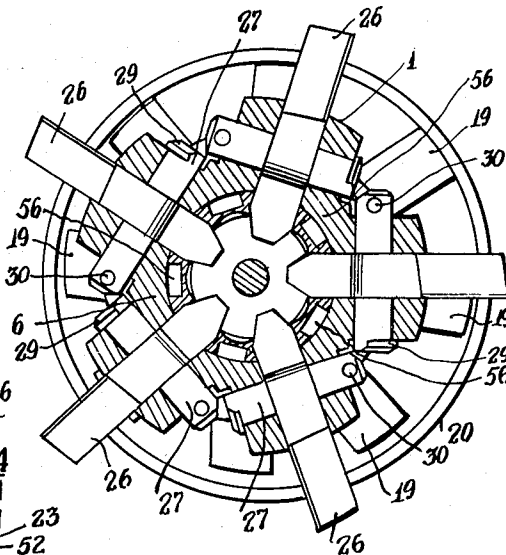
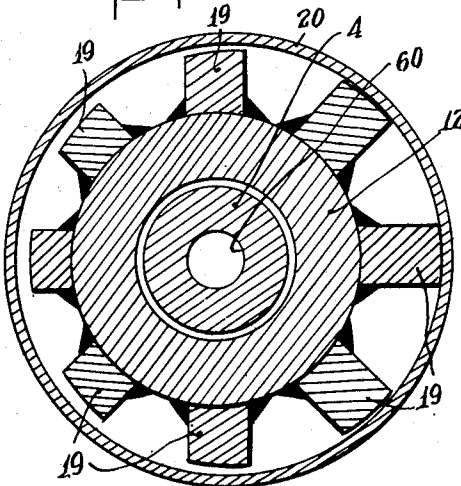


Fig. 5



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METHOD OF SEVERING AND MILLING
A WELL CASING

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Original application April 22, 1950, Serial No.
157,533. Divided and this application October
6, 1952, Serial No. 313,238

2 Claims. (Cl. 164—17)

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This invention relates to a well casing milling device, and more particularly to an improved milling tool adapted for use in cutting and removing pipe from the bore of a well. This application is a division of the copending application of Earl J. Robishaw, Serial No. 157,533, filed April 22, 1950.

In the production and operation of wells, and particularly oil wells, it is frequently necessary to remove a portion of the casing in the well at some predetermined location for side tracking operations, or to expose a portion of the casing in the well at some predetermined location for side tracking operations, or to expose a producing stratum, or for other purposes. Thus, it may be desirable to remove a section of the casing to allow a whipstock to be set in an open window, or the casing may be cut away to expose a sand stratum or other potentially productive formation which has been previously cased off.

Such operations must frequently be conducted at great depths in the well which presents serious problems in the character of the tools employed as well as in the manner in which the operation is carried out, because of the great weight of the operating string by which such tools are operated and frequent deviation of the bore of the well from the vertical.

Some of the serious problems above mentioned are caused by the inability of the milling tool to quickly and efficiently mill away the casing to provide the window therein for the purpose above mentioned. The tools now in use perform such milling operation by rotation of the cutters provided on the tool by rotation of the string to which the tool is attached. This straight rotation causes the cutters to groove and this grooving stops the milling or cutting of the casing, and damages the cutters. Therefore, it is very important to prevent such grooving and, in lieu thereof, to cause them to wear straight across the casing being milled.

It is an object of the present invention, therefore, to provide a milling tool for severing and milling a well casing, which tool has cutters that are adapted to be extended across the severed end of the casing and also to embody means for engagement with the casing to cause such cutters to move laterally back and forth across the end of the casing as the tool is rotated thereon. By the employment of such means the life of the cutters is greatly increased and more casing can be cut or milled in a shorter period of time and, in addition thereto, such means makes possible the cutting of pipe that otherwise could not be

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cut by tools now in use. Thus, this invention now makes it possible to have windows milled in well casings where otherwise it would have been uneconomical to have attempted to do so.

A more specific object of this invention is to provide removable eccentric means rotatably mounted or attached to a milling tool to maintain the tool off center or eccentric of the well bore so that upon rotation of the tool it will rotate close to one side of the wall casing to be severed and away from the opposite wall whereby a simultaneous lateral and rotation action will be imparted to the knives or blades on the milling tool.

The above and other objects and advantages of the invention will appear from the following detailed description of a preferred embodiment of the same, when considered in conjunction with the drawings annexed, wherein—

Figure 1 is a vertical, central, cross-sectional view of the invention with the knives in retracted position;

Figure 2 is a side elevational view of the invention operatively positioned in a well casing;

Figure 3 is a vertical, central, cross-sectional view of the invention operatively positioned in the casing with the knives in extended cutting position;

Figure 4 is a cross-sectional view taken along the line 4—4 of Figure 3, looking in the direction indicated by the arrows; and

Figure 5 is a cross-sectional view taken along the line 5—5 of Figure 3, looking in the direction indicated by the arrows.

Referring to the drawings in greater detail, the numeral 1 indicates a tubular cutter body or mill body having an internally threaded upper end for attachment to the lower end of an operating string indicated at 2. The body 1 has an internal bore 3 forming an internal shoulder 4 near its lower end, and a tubular stem 5, having an enlarged portion 6 forming an external shoulder 7, fits in the body and is supported therein on the shoulder 4, with the lower end of the stem extending below the body. The lower end of the stem 5 is externally threaded as at 9 to receive the internally threaded conical guide nut 10 provided to hold the eccentric guide assembly in position, as hereinafter described.

An eccentric guide assembly, having a tubular body 12, formed internally to fit over the reduced end portion of body 1 and about the lower end of the stem 5, is provided to cause the blades, hereinafter described, to move laterally at the same times they are being rotated and, thus, to produce

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a simultaneous cutting and sawing action which materially increases the milling speed of the tool, and also enables it to cut pipe that otherwise could not, due to its hardness, be severed by the standard milling tool now in use.

The tubular body 12, as stated above, is held in place on the lower end of the milling tool by the conical guide nut 10. The internal facing shoulders of the lower end of the body 1 and the upper end of the conical nut are provided, respectively, with the anti-friction bearings 14 and 15. Packing or seal rings 16 and 17 are provided between the body 1 and the guide body 12 and between the guide nut 10 and said guide body, respectively, to prevent entrance of foreign matter into the bearings 14 and 15.

The outwardly extending, spaced, members, or ribs 19 are provided on the periphery of the body 12 for engagement with the inside of the well casing as that shown at 20. These ribs or radially extending members may be formed integrally with the body or shaped in any preferred manner to accomplish the desired purpose. As shown in Figure 5, these ribs 19 are progressively widened, or extended outwardly, radially of the body 12, thereby providing an outside diameter for the assembly that is off center or eccentric with the axial bore of the body 12 through which the stem 5 is extended.

The cutter body 1 has an outwardly thickened portion 22 located approximately centrally of the body, and a reduced lower end portion, the portion 22 being provided with side slots 23, whose upper margins extend out at substantially right angles to the axis of the body forming shoulders 24. Pivotaly mounted in the slots 23 are the cutter blades 26, pivoted on pivot pins 27, each of which has a head 29 at one end and a hole 30 at the other end for the reception of a cotter pin or other securing means.

The slots 23 are sufficiently long to permit the blades 26 to be retracted into them in inactive position, as seen in Figure 1. The blades are extended inwardly beyond their pivots and the inner ends are reduced in width in order to provide clearance sufficient to permit the outer cutting portions of the blades to be retracted into the slots when in inactive position, as shown in Figure 1.

A bushing 32 is disposed in the body 1 in engagement with a shoulder 33 therein, and a cylinder 34 is carried on the upper end of the bushing by an enlarged portion 35, so that the cylinder is spaced somewhat from the bushing to provide an annular passage 36. Openings 37 are provided in the cylinder communicating with the passage 36 and the interior of the cylinder. The cylinder is spaced at its lower end from the inside of the body to form a continuation of the passage, as will be seen in Figures 1 and 3. Packing material 38 may also be provided on the cylinder 34 so that the cylinder is retained securely in place when the body is attached to the string 2. The cylinder 34 is also provided with a beveled seat 40 at its lower end.

Mounted in the cylinder 34 is a piston 41, carrying a piston ring 42 held on the upper end of the piston by a washer 43 and nut 44 secured to the threaded extension 45. The piston has a passage 46 opening into the interior of the cylinder above the piston, and leading into side passages 48, which open laterally into the cylinder below the piston ring 42, as seen in Figures 1 and 3.

The piston has a tapering shoulder 50 which

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fits against the beveled seat 40 when the piston is in its upper position.

An annular recess 52 is provided in the piston for the reception of the inward ends of the cutter blades 26 to operate the knives when the piston moves up or down, and the lower end of the piston forms a seat for a spring 54 which bears on an internal shoulder 55 in the stem 5 to urge the piston upwardly in the cylinder.

Vertical grooves 56 are formed about the periphery of the enlarged portion 6 of the stem 5, as seen in Figure 4, to permit the passage of fluid between the body and the stem and these grooves communicate with the interior of the tubular stem by passages 57 as indicated in dotted lines in Figure 1.

From an examination of the drawings it will be seen that in the condition of the device shown in Figure 1, fluid from the string may pass through the passages 46 and 48, into passage 36 and downwardly through grooves 56 and passages 57 into the passage 60 of the stem and thence into the casing below the tool. In this condition of the tool the piston 41 is in its upper position, and the bottom of the cylinder is closed by the tapered shoulder 50 so that flow of fluid is restricted and the piston may be forced downwardly by an increase of pressure in the string.

When the piston is moved downwardly, by the pressure of fluid in the string, overcoming the force of the spring 54 to occupy the position seen in Figure 3, fluid from the string may flow through holes 37 and take the course previously described, and fluid also flows through passages 46, 48 and out of the bottom of the cylinder 34, so that the flow will be greater in the condition of the device shown in Figure 3, than in that shown in Figure 1.

In using the milling device, the same is attached to an operating string and lowered into the well, in the condition seen in Figure 1, wherein the knives 26 are retracted and the piston 41 is in its upper position. When the tool has reached the desired location opposite the portion of the casing 20 to be milled, the fluid pressure in the string can be suitably increased, moving piston 41 downwardly and forcing the knives into cutting engagement with the casing. Rotation of the string then results in cutting through the casing at the selected location. After the casing has been severed, the knives 26 will be extended through the opening formed and brought into cutting relation with the severed end of the casing. The knives then bear against the shoulders 24 at the upper extremities of the slots 23, and the pressure exerted by the blades in milling the casing may be regulated by controlling the weight applied thereon through the operating string. Subsequent rotation of the string will then cause the knives to mill away the casing to the extent desired.

It is to be noted that the engagement of the spaced members or ribs 19 with the casing below the blades 26 maintains the vertical axis of the tool off center with relation to the vertical axis of the casing or bore of the well. Upon rotation of the string the body 12 of the eccentric guide assembly remains substantially stationary by the extended ribs 19 contacting one side of the wall of the casing. However, the body 1 is permitted to rotate relative to the body 12 by the bearings 14 being located between such bodies. Thus, the body 1 of the tool rotates close to one side of the wall casing and away from the opposite wall to

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produce the simultaneous cutting action of the blades as hereinabove explained.

As previously explained, when the device is in the condition shown in Figure 1, and during the operation of severing the casing, fluid may pass down through the tool and on down into the casing, whence it flows upwardly about the eccentric guide 12 and passes up out of the well carrying with it any cuttings or other material.

In the condition of the device seen in Figure 3, however, with the knives fully extended, and the piston in its down position, a full circulation of fluid through the tool takes place, thus providing for the disposal of the relatively greater quantity of cuttings formed during the milling operation.

Upon completion of the milling the tool can be removed from the well by withdrawing the operating string, and the blades will be retracted for this purpose by operation of the spring 54 urging the piston 41 upwardly to the position illustrated in Figure 1. Should the blades fail to retract they will be pressed inwardly to retracted position by engagement with the casing above the milled-out portion as the tool moves upwardly out of the well.

By suitably regulating the pressure exerted on the cutters, by controlling the weight applied by the operating string, the speed of the milling operation can be adjusted to satisfy particular operating conditions, such as the hardness of the material of the casing.

I claim:

1. The method of operating a milling tool to mill away a section of severed casing in a cased bore hole wherein the tool comprises a body attachable to an operating string for rotation thereby and at least one cutter blade mounted on

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the body for movement from a position substantially confined within the peripheral outline of the body to a substantially radial position wherein the blade is engageable with a severed end edge of the casing, the steps comprising: rotating the tool within the casing with the cutter blade in its radial position and in sweeping engagement with the entire circumference of the severed casing end edge; and maintaining the axis of rotation of the tool substantially fixed and eccentric with respect to the axis of the casing.

2. The method of operating a milling tool to mill away a section of severed casing in a cased bore hole wherein the tool comprises a body attachable to an operating string for rotation thereby and a plurality of equi-length cutter blades mounted on the body for movement from positions substantially confined within the peripheral outline of the body to substantially radial positions wherein the blades are engageable with a severed end edge of the casing, the steps comprising: rotating the tool within the casing with the cutter blades in their radial positions; maintaining the axis of rotation of the tool substantially fixed and eccentric with respect to the casing axis; and advancing the tool relative to the casing with each cutter blade in sweeping engagement with the entire circumference of the severed casing end edge.

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