

- 1 -

TUBING CUTTING TOOL

This invention relates to a tubing cutting tool, and in the preferred embodiment provides a cutting tool suitable for use in an oil or gas well or the like.

In drilling and operating an oil or gas well it is occasionally necessary to cut tubing located within the well, for example one of the elements of a tubing string located within the well or the casing of the well. The tubing cutting tool of the present invention is particularly suitable for cutting a tubing string located within a well, but the invention may be embodied in forms suitable for cutting other tubular elements whether or not forming part of an oil or gas well installation.

According to one aspect of the present invention there is provided a tubing cutting tool comprising a fluid powered rotary motor having a body and a rotary output member; fluid pressure responsive means for locking the body to the tubing to be cut when the pressure of the motor operating fluid exceeds a predetermined value; a rotary cutter connected to the rotary output member of the motor for rotation therewith, the rotary cutter having at least one cutting element which is normally located at a first radial distance from the longitudinal axis of the tool; and fluid pressure responsive means operable in response to the pressure of the motor operating fluid exceeding a second predetermined value to move the or each cutting element

radially outwardly from its normal position to engage the tubing to be cut.

In the preferred embodiment of the invention the fluid pressure responsive means for locking the body to the tubing is responsive to fluid pressure upstream of the rotary motor, and the fluid pressure responsive means for moving the or each cutting element is responsive to fluid pressure downstream of the rotary motor. The fluid flow path for the motor operating fluid incorporates a restriction downstream of the second fluid pressure responsive means whereby an increase in fluid flow rate results in an increase in fluid pressure at both the first fluid pressure responsive means and the second fluid pressure responsive means.

The preferred embodiment of the invention also includes a scraping or milling head which is connected to the rotary output member of the rotary motor and which may be rotated by the rotary motor for the purpose of cleaning the internal surface of the tubing within which the tool is located. In this case, the motor may be operated by fluid at a pressure less than the second predetermined pressure with the result that rotation of the motor will cause rotation of the scraping or milling tool, but will not cause the cutting elements to be moved radially outwardly into engagement with the tubing. In a particularly preferred embodiment of the invention the motor may be operated at a pressure less than the first predetermined pressure so that the scraping/milling tool may be rotated as the tool is moved through the tubing. For this purpose it is necessary to restrain the body of the motor against rotation, and this can conveniently be effected by connecting the motor body to a suitable tubing string which is used for the purpose of moving the tool through the tubing to be cleaned and for communicating operating fluid to the motor.

The invention will be better understood from the following description of a preferred embodiment thereof, given by way of example only, reference being had to the accompanying drawings which schematically illustrate a preferred embodiment of the invention and wherein:

Figure 1 is a half-section illustrating an embodiment of the invention located within a length of tubing; and

Figure 2 illustrates in detail a portion of the embodiment of Figure 1.

Referring to the drawings there is illustrated a tubing cutting tool 1 located within a length of tubing 2, for example a tubing string which itself is located within a well bore. The tool 1 comprises a plurality of interconnected subs and is connected at its upper end to a tubing string 3 by means of which the tool may be run through the tubing 2. The central bore 4 of the tubing string is used to carry an operating fluid, for example a mud, to the tool 1.

The tool 2 comprises a rotary motor 5 which, in use, is driven by the flow of operating fluid therethrough. The body of the motor 5 is connected to an upper sub 6 which has mounted thereon a multiplicity of plungers 7. The plungers 7 are normally biased radially inwardly by suitable springs (not shown) so that the radially outer extremity of the plungers is flush with the surface of the sub 6. The radially inner ends of the plungers 7 are exposed via radial bores 8 to the fluid pressure within the sub 6 so that if the fluid pressure exceeds a first predetermined value the plungers 7 are moved radially outwardly to engage the tubing 2. The radially outer ends of the plungers may be provided with suitable teeth or serrations, and may be hardened. When the plungers 7 are biased radially outwardly into engagement with the tubing 2 the upper sub 6 and the body of

the motor 5 are locked against movement relative to the tubing 2.

The motor 5 includes a rotary output member 9 which is connected to a rotary cutter 10. The rotary cutter 10 is shown in more detail in Figure 2 and comprises a pair of cutting elements 11,12 which are pivotally mounted on a pin 13 which is secured to the body 14 of the rotary cutter.

The radially outer extremity of each cutting element 11,12 is suitably protected, e.g. by means of inserts or crushed particles of suitable hardening material, e.g. tungsten carbide or cubic boron nitride. In the normal position of the cutting elements (illustrated on the left-hand side of Figure 2) the cutting elements are located such that the radially outermost extremity of each cutting element is located within the body 14 of the rotary cutter. Each cutting element may, however, be pivoted to move the cutting edge thereof radially outwardly to engage the internal surface 15 of the tubing within which the tool is located. The radially outwardly extreme position of the cutting element 12 is illustrated on the right-hand side of Figure 2, and in this position the outermost point of the cutting element will have cut through the wall of the tubing 2.

For the purpose of shifting the cutter elements 11,12 between the extreme positions described above a fluid pressure responsive device is provided in the form of a piston 16 working in a cylinder 17. Seals 18,19 are provided between the piston 16 and the cylinder 17 and the piston is normally biased upwardly to the position illustrated on the right-hand half of Figure 2 by a spring 20. Further upward movement of the piston 16 is prevented by a spring clip 21 located within a groove in the cylinder wall.

In use, operating fluid exiting from the motor 5 is communicated through the central bore of the tool to the chamber 22 defined within the cylinder 17 above the piston 16. This fluid pressure acts downwardly on the piston 16. Fluid may leave the chamber 22 via passages 23 and may then flow through an annular passage 24 formed between the cylinder 17 and the body 14 to passages 25 located below the level of the cutting elements 11,12. The passages 23,25 provide a restriction to the flow of fluid whereby the pressure within the chamber 22 increases as flow rate of working fluid increases. Seals 26,27 are located between the cylinder 17 and the body 14 of the rotary cutter.

The rotary cutter 10 is connected by a sub 28 to a scraping or milling tool 29 having an outside diameter 30 substantially corresponding to the internal diameter of the tubing 2.

In use, the tool 1 is run through the tubing 2 by means of a suitable tubing string. If it is desired to clean the internal surface 15 of the tubing a suitable working fluid, for example a mud, is pumped through the string to which the tool 1 is connected to flow through the motor 5 at a predetermined rate. This predetermined rate is sufficient to operate the motor and thereby rotate the rotary cutter 10 and with it the scraping/milling tool 30 to clean the interior surface of the tubing.

If it is desired to cut the tubing 2 the tool is located at a suitable position and the flow rate of working fluid is increased. The increased flow rate causes the motor to operate at a faster speed and, due to the flow restriction provided by the motor itself and the passages 23,25 causes the fluid pressure within the tool to increase both upstream and downstream of the motor. The increased fluid pressure upstream of the motor is communicated via the passages 8 to the plungers 7, causing the plungers to move

radially outwardly to grip the tubing to fix the motor body relative to the tubing. The fluid pressure downstream of the motor 5 operates within the chamber 22 to bias the piston 16 downwardly and thereby move the cutters 11,12 radially outwardly to engage the internal wall of the tubing. Since the entire rotary cutter is rotating the cutting elements will cut the tubing and will be held in engagement with the tubing as cutting proceeds by the piston 16. When the cut has been completed the piston 16 will be in the extreme lower position illustrated on the left-hand side of Figure 2. Flow of operating fluid may then be stopped allowing the piston 16 to return to its uppermost position, thereby allowing the cutters 11,12 to return to their radially inner position. The plungers 7 will also return to their retracted position under the influence of the associated springs. The tool may then be moved to a fresh location for a further cutting operation, or may be used in the cleaning mode described above.

It will be appreciated that the tool described above may perform either a tube cleaning operation or a tube cutting operation, or a combination of these operations. The tool is relatively simple in construction and does not require withdrawal from the tubing for resetting after each cut has been made.

In another embodiment the cylinder 17 may be integral with the body 14 and the chambers 22 and passages 23,25 bored accordingly. Plugs would be fitted to seal the upper end of the passage 24 running the length of the body connecting passages 23 and 25.



CLAIMS

1. A tubing cutting tool comprising a fluid powered rotary motor having a body and a rotary output member; first fluid pressure responsive means for locking the body to the tubing to be cut when the pressure of the motor operating fluid exceeds a first predetermined value; a rotary cutter connected to the rotary output member of the motor for rotation therewith, the rotary cutter having at least one cutting element which is normally located at a first radial distance from the longitudinal axis of the tool; and second fluid pressure responsive means operable, in response to the pressure of the motor operating fluid exceeding a second predetermined value, to move the or each cutting element radially outwardly from its normal position to engage the tubing to be cut.
2. A tool according to claim 1, wherein the first fluid pressure responsive means is responsive to fluid pressure upstream of the rotary motor, and the second fluid pressure responsive means is responsive to fluid pressure downstream of the rotary motor.
3. A tool according to claims 1 or claim 2, wherein the fluid flow path for the motor operating fluid incorporates a restriction downstream of the second fluid pressure responsive means whereby an increase in fluid flow rate results in an increase in fluid pressure at both the first fluid pressure responsive means and the second fluid pressure responsive means.
4. A tool according to any preceding claim, wherein the rotary cutter has a cutter body and the or each cutting element is pivotally mounted on a pin secured to the cutter body.



5. A tool according to any preceding claim, wherein the first fluid pressure responsive means comprises a plurality of radially operable, spring-biased plungers.
 6. A tool according to any preceding claim, wherein the second fluid pressure responsive means comprises a spring-biased piston.
 7. A tool according to claim 6, wherein the piston is longitudinally operable, in response to the pressure of the motor operating fluid exceeding the second predetermined value, to pivot the or each cutting element radially outwardly from its normal position to engage the tubing to be cut.
 8. A tool according to any preceding claim, further comprising a scraping or milling head connected to the rotary output member of the rotary motor and rotatable by the rotary motor for the purpose of cleaning the internal surface of the tubing within which the tool is located.
 9. A tool according to claim 8, wherein the motor is operable by fluid at a pressure less than the second predetermined pressure to cause rotation of the scraping or milling head, such that rotation of the motor at this operating pressure will not cause the or each cutting element to be moved radially outwardly into engagement with the tubing.
 10. A tool according to claim 8 or claim 9, wherein the motor is operable at a pressure less than the first predetermined pressure to rotate the scraping/milling head as the tool is moved through the tubing.
 11. A tool substantially as hereinbefore described with reference to the accompanying drawings.
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