

Nov. 20, 1945.

W. C. HARRISON
ROTARY MILLING TOOL

2,389,235

Filed Nov. 8, 1944

2 Sheets-Sheet 1

Fig. 1.

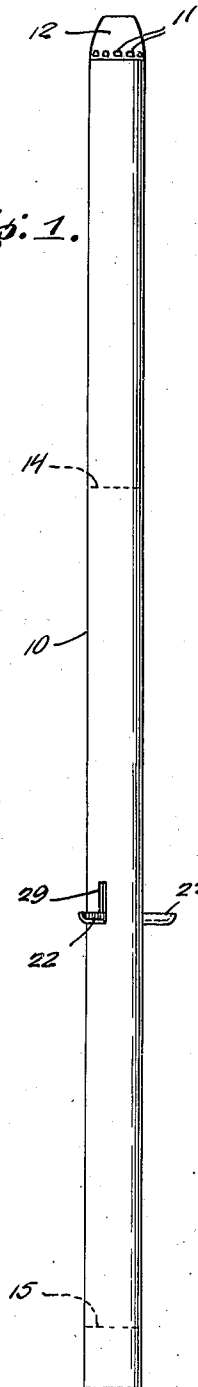


Fig. 3.

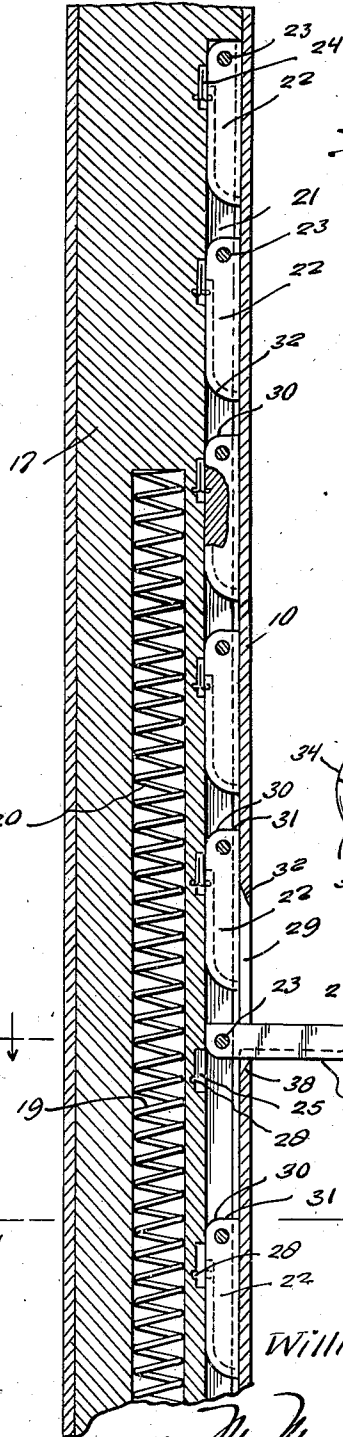


Fig. 6.

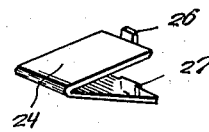
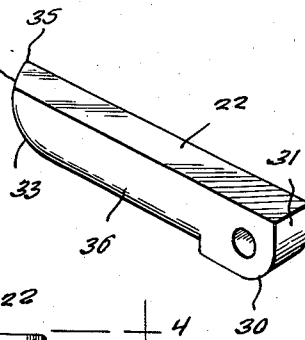


Fig. 7.



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2 Sheets-Sheet 2

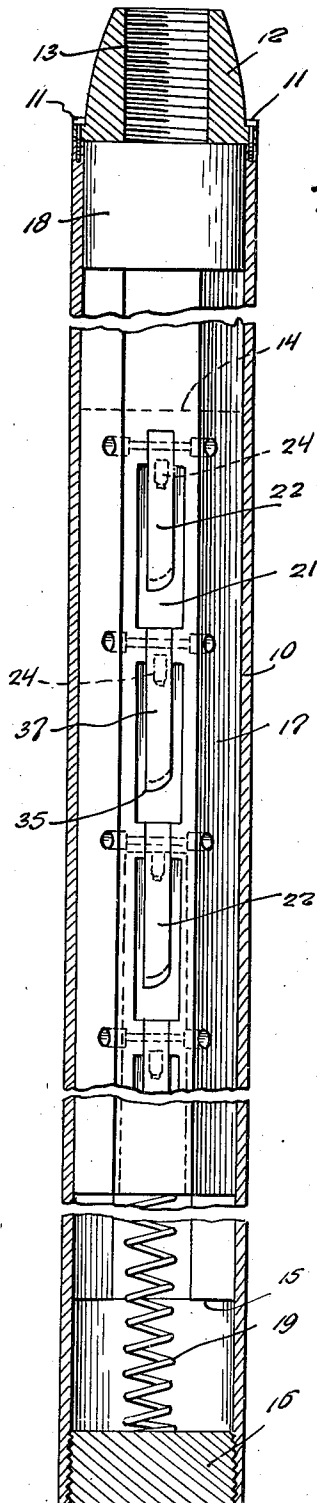


Fig. 2.

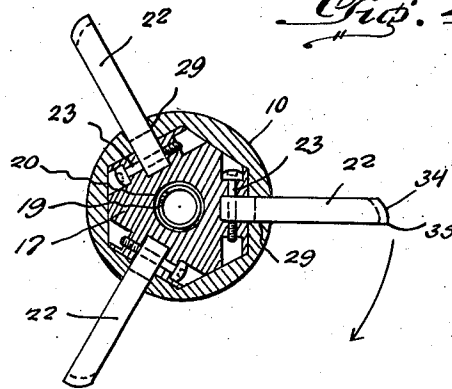


Fig. 4.

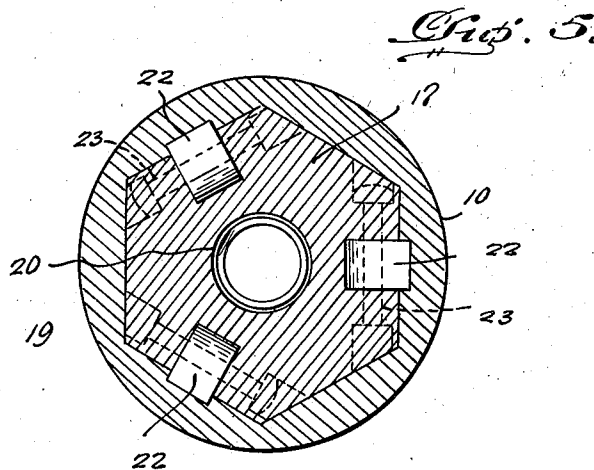


Fig. 5.

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UNITED STATES PATENT OFFICE

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ROTARY MILLING TOOL

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5 Claims. (Cl. 164—0.8)

This invention relates to milling cutters of the rotary type for cutting and reaming bored openings in pieces of work and the interior areas of tube sections. It is adaptable for tools of this character in general in machine shop practice but is primarily intended and has to do with the cutting and reaming of the interiors of tube sections in oil well installation and the like.

Heretofore, the usual practice has been to use a cutting and reaming tool having a single cutter element or single series of the same, which necessitates withdrawal of the tool from the well tubing each time it is necessary to replace the dulled cutting tool or the cutting element thereof. This not only involves considerable loss of time but is expensive.

The prime object of the invention is to minimize the cost and operation of such a tool and consists essentially in the provision of a multiplicity of cutting elements arranged and adapted to be brought successively into operating position, at will, after one of the cutting members of the series or a particular cooperative set thereof has become dull.

An illustrative but non-limiting adaptation of the invention is illustrated in the accompanying drawings, in which:

Figure 1 is a side elevation of the entire tool assembly;

Figure 2 is a view on an enlarged scale, partly in longitudinal section and partly in side elevation, with intermediate portions broken away to foreshorten the view;

Figure 3 is a detailed sectional view of a portion of the tool in the immediate region of the longitudinal series of cutter elements;

Figure 4 is a cross section on the line 4—4 of Figure 3;

Figure 5 is a section on the line 5—5 of Figure 3;

Figure 6 is a detail perspective view of one of the ejector springs detached; and

Figure 7 is a detail perspective view of one of the cutter elements detached.

Referring now to the drawings in detail, the numeral 10 designates generally the tubular outer casing of the tool of the present invention. Bolted annularly, as at 11, to the upper end of the tubular casing 10 is a pressure head 12 having a screw threaded axial bore 13 therein for the attachment of a tubular operating stem (not shown) by which the tool is lowered into the well bore for operation. The interior of the tubular casing 10 is cylindrical from the head 12 throughout a considerable distance therefrom

and approximately to the point designated at a transverse dotted line 14, while throughout the remainder of the length of the casing 10 the interior of the casing is polygonal (preferably hexagonal) in cross section, this polygonal portion terminating adjacent the lower end of the tubing at the point designated by the transverse dotted line 15 in Figure 1 and shown structurally in Figure 2. The lower end of the casing 10 is closed by a plug member 16 (see Figure 2).

Slidable longitudinally in the casing 10 is a plunger element 17. Externally, the plunger element 17 is of polygonal form corresponding to the polygonal portion of the tube 10. A part of the upper end portion of the plunger 17 is formed cylindrically, as at 18, thereby providing a piston head which works in the cylindrical upper portion of the tubing 10. With the plunger 17 thus formed, its polygonal portion slides longitudinally in the counterpart portion of the tube 10 without turning, movement of the plunger in one direction being under the influence of fluid pressure admitted through the bore 13 of the cylinder head 12 and against the piston portion 18. Reverse travel of the piston is effected by reaction of a spring element 19 which is compressed during the downward travel of the plunger under fluid pressure above the piston head 18. The spring element 19, which is of considerable length, has its upper portion contained within an internal axial bore in the plunger, as at 20 (see Figure 3), while the lower end of the spring abuts the plug 16 at the bottom of the casing 10 (see Figure 2).

The plunger 17 is recessed or grooved longitudinally in one or more of its polygonal faces, as at 21, in which a series of cutter elements 22 are hinged mounted on transverse pins or bolts 23. The elements 22 are of thickness corresponding substantially to the distance between the bottom of the groove 21 and opposed adjacent face of the tubing 10. In the normal, folded in position of the cutter elements 22, the plunger 17 is slidable freely lengthwise of the tubing 10. Interposed between the bottom of the groove 21 and adjacent inner face portions of the cutter elements 22 are substantially V-shaped ejector springs 24, said springs 24 when compressed being received in depressions 25 provided therefor in the bottom of the groove 21. At one end of each spring 24 is an outturned lug 26 which is received loosely in a cavity provided therefor in the cutter element 22, and at the opposite end of the spring is a corresponding lug 27 that is received in a notch 28 formed in the bottom of the recess 25. The

spring members 24 being compressed in the folded in position of the cutter elements 22, and thus placed under tension, react to press the cutter elements against the wall of the tube 10 and force the elements 22 outwardly through longitudinal openings 29 provided in the tube 10 (see Figure 3), said openings 29 being arranged annularly of the tube 10 and in number corresponding to the number of series of said cutter elements 22. As shown more clearly in Figure 4, there are three series of the cutter elements 22, in a triangular arrangement.

One corner of the hinged end portion of each cutter element 22 is rounded off arcuately, as at 30, to permit the element 22 to swing outwardly on its pivot 23, the other corner portion being angular so as to provide a square shoulder 31 which abuts the bottom of the groove 21 and limits the outturned position of the element 22 to a right angular or perpendicular position, as shown in Figure 3.

The longitudinal openings 29 in the casing 10 are each of a length to permit the cutter element 22 to swing out therethrough as the element 22 is brought into registration therewith and under the influence of the spring element 24, which latter, after the cutter element 22 has moved approximately to its full open position, is released from its engagement with the cutter element and the recess 28, and drops into the space below in the longitudinal groove 21 of the plunger 17. To minimize the length of the opening 29 and facilitate the opening of the cutter element 22, the upper end portion of the opening 29 is beveled off, as at 32. To further facilitate the opening of the cutter element 22 the free end portion of the element is undercut arcuately, as at 33, this form of the end portion of the cutter element serving to deflect the element outwardly with a cam effect as the same engages and rides on the lower end of the opening 29.

The free end portion of the cutter element 22 is also rounded off in top plan, as at 34, thus producing a sharp corner 35 at the leading side of the element. The cutter element 22 is further undercut, roundly on its under rear portion, as at 36, thus producing a longitudinal cutting edge 37 at the bottom of the element and along its leading side. In the normal lifted position of the plunger element 17, all of the cutter elements 22 are retracted within the tubular casing 10, this position of the plunger element being governed and maintained by the spring element 19. When fluid pressure is exerted on the piston head 18 the plunger element 17 is forced downwardly against the reaction of the spring element 19 and as the first set of cutter elements 22 ride into registration with the respective openings 29 in the casing 10, said elements 22 are forced outwardly through the openings 29 and into cutting position, as shown in the illustrated position of the cutters of the second series, Figure 3. When the projected cutter element 22 has become dulled in the use thereof, and while the tool is kept in the working position in which the dull cutter element 22 has been operating, the plunger element 17 is relieved of the fluid pressure thereabove, whereupon the spring element 19 lifts the plunger element and retracts the projected and dulled cutter element. Thereafter, when fluid pressure is again applied to the plunger element 17, the latter is forced downwardly against the tension of the spring element 19 and the cutter element or elements 22 which have become dull and now have no spring elements 24 behind them,

the same ride downwardly past the opening 29 in the casing 10, but the next succeeding sharpened cutter element 22 is forced outwardly through the opening 29 by its confined spring element 24 as the cutter element rides into registration with the opening 29. Then, as with the preceding cutter elements 22 which have been used and become dulled, the spring element 24 becomes disengaged from this last projected cutter element and the recess 28 of the plunger element and drops into the space below in the groove 21.

Normally, the used and dulled cutter elements 22 being free of the action of any spring elements 24, said cutter elements will ride past the opening 29. This is because said used elements hang vertically by gravity, but to assure passage of the lower end portion of the cutter elements past the bottom end of the opening 29, said end portion is beveled off, as at 38, to provide an inwardly and downwardly inclined cam surface and eliminate any abrupt shoulder to obstruct the travel of the cutter element 22 should the latter swing slightly outward but not to the outside of the casing 10.

From the foregoing description of the illustrative structural exemplification of the invention, a practical and efficient rotary tool is produced for cutting and reaming bores in pieces of work and the same is particularly advantageous for use in the cutting and reaming of tubing in oil well installations and the like. The illustrated structure is but one practical embodiment of the invention. Considerable modification of the structure is contemplated within the purview of the invention as defined in the appended claims, and the invention, therefore, is not limited to its specific construction and arrangement shown.

Having thus described the invention, what is claimed is:

1. A rotary milling tool of the character described, the same comprising a tubular body casing, said casing having a longitudinal opening in the wall thereof; a plunger element slidably mounted longitudinally in said body casing but held against rotation therein, means for yieldably holding said plunger element in a normal raised position and for restoring said element to such position; and means for moving said plunger element downwardly in said body casing against the action of said means for upward movement of said plunger element, a longitudinal series of cutter elements movably mounted on said plunger element, said cutter elements being held normally within said body casing in the normal raised position of said plunger element, means interposed between said plunger element and the respective cutter elements, for projecting said cutter elements outwardly through the longitudinal opening in the body casing, when said cutter elements are successively brought into registration with said opening of the casing, the successive projection of the cutter elements being effected intermittently after an intermittent retraction of preceding cutter elements that have been projected, used and become dull.

2. A rotary milling tool structure as set forth in claim 1, the projecting means for the cutter elements comprising a detachable spring element interposed between each cutter element and the plunger element of the tool, said spring element being compressed in the normal position of the cutter element and reacting to project the cutter element into extended cutting position through the opening in the body casing, as the plunger element is moved to bring the cutting ele-

ment into registration with said opening, said spring element, after projection of the cutter element, becoming disengaged from the cutter element and the plunger element and dropping into space within the body casing below the projected cutter element.

3. A rotary milling tool of the character described, the same comprising a tubular body casing having a pressure head at the upper end thereof, said pressure head having an axial bore and provision for its attachment to the lower end of a tubular operating stem, pressure fluid being controlled and admitted through said stem and pressure head into the upper portion of said body casing, the upper portion of the body casing constituting a pressure chamber, an elongated plunger element slidably fitted in said body casing, said plunger element having a piston head at its upper end working in the pressure chamber of said body casing, means for holding the plunger element from rotation but permitting longitudinal reciprocation of the plunger element within the body casing, a spring element interposed between the bottom of the body casing and said plunger element, said spring element holding the plunger element yieldably in a normally raised position and restoring said element to such position, said spring element yielding to downward movement of the plunger element under pressure of the fluid applied thereabove but reacting to lift the plunger element when relieved of the fluid pressure thereon, said plunger element having at least one longitudinal groove therein, a longitudinal series of separate cutter elements hingedly mounted on said plunger element and normally suspended from their respective hinge mountings and located within the groove of the plunger element, detachable spring

elements interposed between the respective cutter elements and adjacent bottom portion of the groove in the plunger element, the body casing having a longitudinal opening in the wall thereof through which the several cutter elements are projected in succession as they are respectively brought into registration with said opening in the body casing, the respective spring elements becoming detached and disengaged from each cutter element and dropping into the space below the cutter element in said longitudinally grooved portion of the plunger element after the directly associated cutter element is projected through the opening in the body casing.

4. A rotary milling tool as set forth in claim 3, and further specifying more specifically that one corner of the hinged portion of the cutter element is cutaway to permit outward swinging of the element, the opposite corner portion of the element being angular and providing a shoulder to abut the bottom of the longitudinal groove in the plunger element whereby to limit and maintain the projected position of the cutter element, and the working position of the cutter element longitudinally of the tool being determined by contact of the underside of the cutter element with the bottom end of the opening in the body casing.

5. A rotary milling tool as set forth in claim 3, and further specifying more specifically that the pressure chamber of the body casing is of cylindrical form, but the remainder of the casing is of polygonal form and the major portion of the plunger element is of a counter-part form and fitted to said polygonal portion of the body casing whereby the plunger element is capable of longitudinal reciprocation within the casing but held from rotation therein.

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