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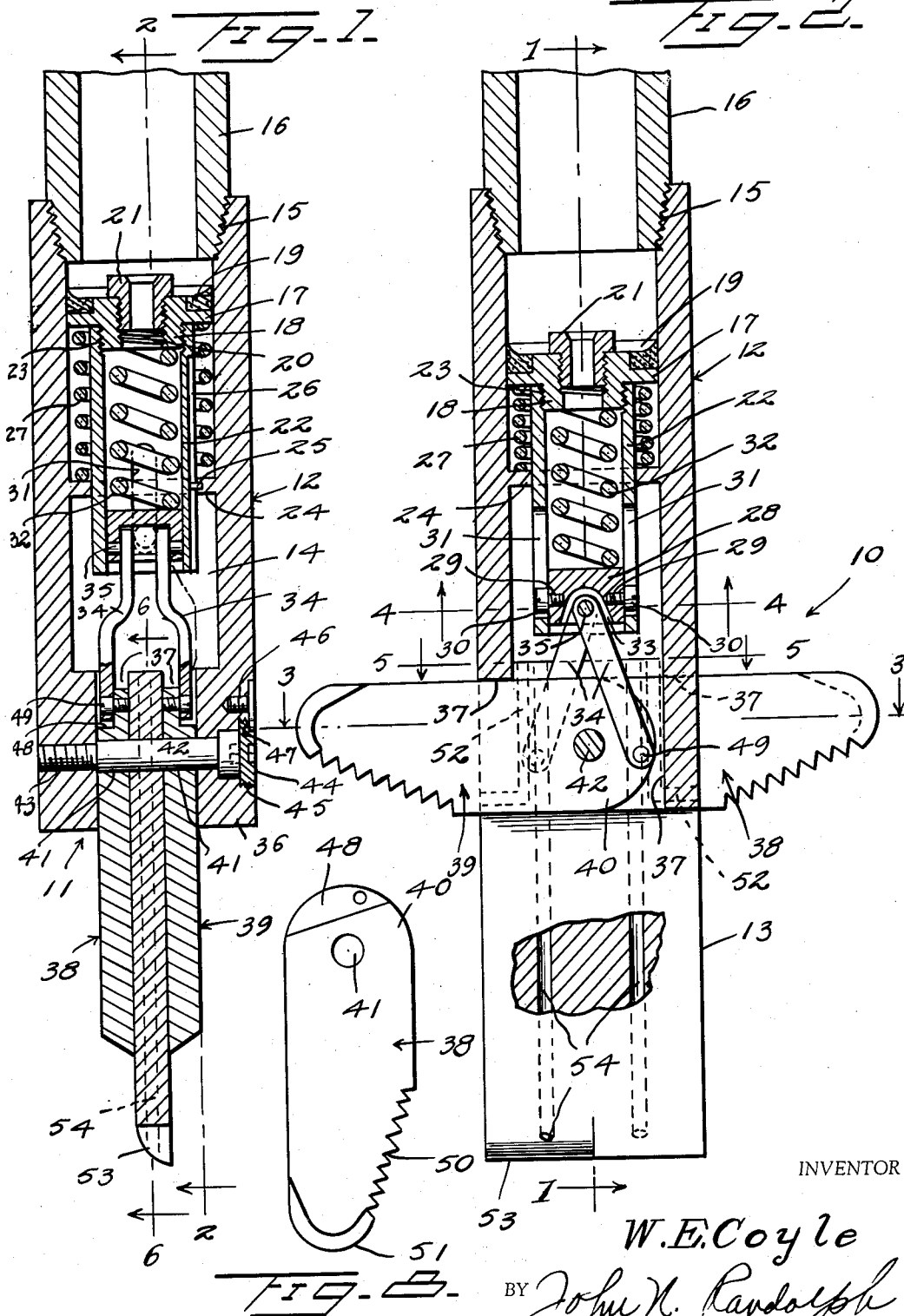
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HYDRAULIC UNDERREAMER

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2 Sheets-Sheet 1



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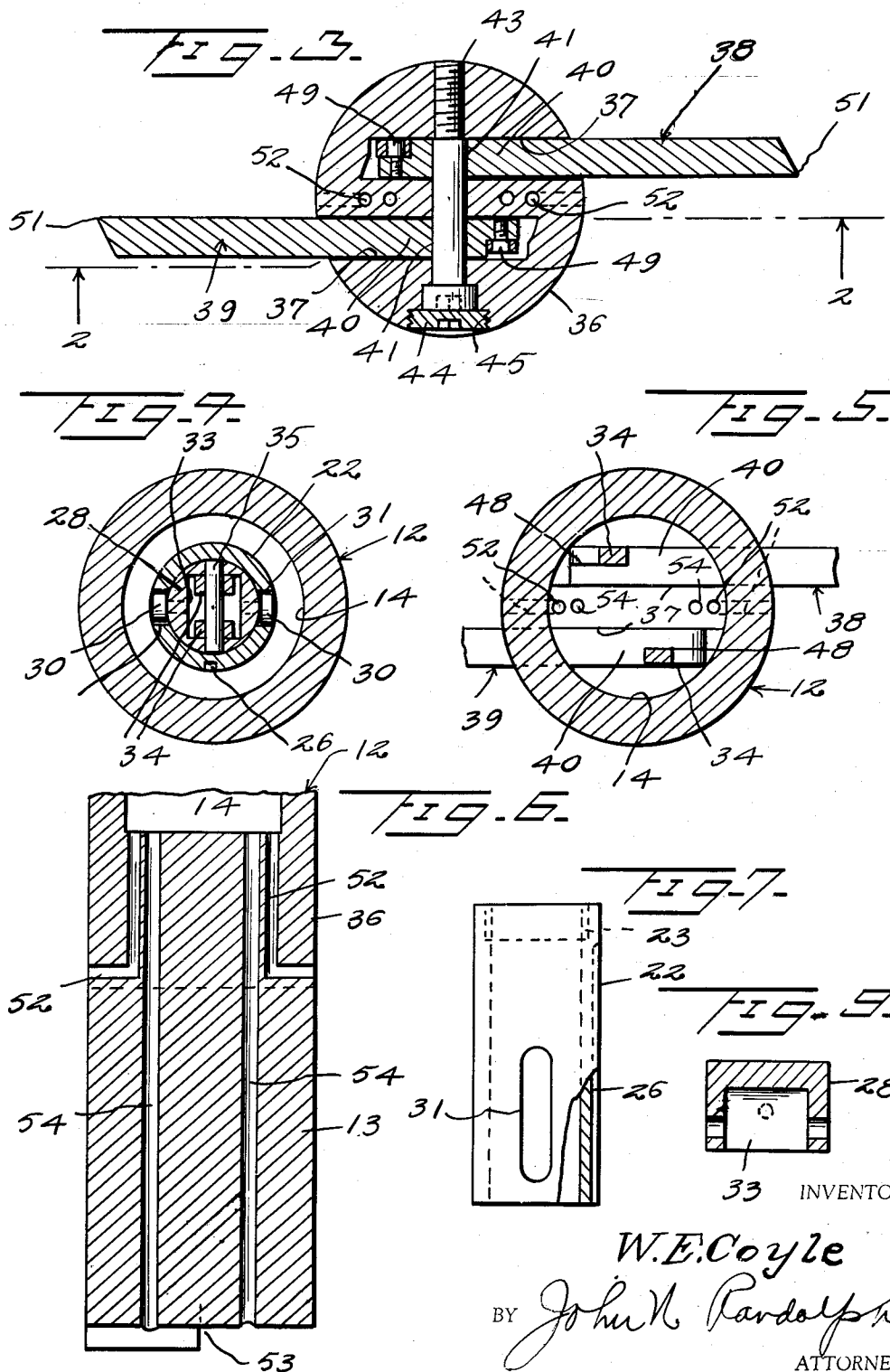
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HYDRAULIC UNDERREAMER

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4 Claims. (Cl. 255—74)

This invention relates to a hydraulic underreamer for enlarging a well hole and has for its primary object to provide a novel tool the reamer blades of which are opened by hydraulic pressure and spring pressure.

Another object of the invention is to provide a hydraulic underreamer having means for effectively supporting the blades and whereby the use of slots in a tool barrel through which the free ends of the blades swing is eliminated, so that should the blades be bent by striking an obstruction the blades would still be able to resume a closed or inoperative position enabling the tool to be withdrawn from the well hole.

Another object of the invention is to provide a tool which may be readily adjusted to vary the opening pressure applied to the reamer blades depending upon the character of the hole to be reamed so that a greater opening pressure may be applied for hard formations than where the tool is expected to be operated in soft formations.

Various other objects and advantages of the invention will hereinafter become more fully apparent from the following description of the drawings, illustrating a presently preferred embodiment thereof, and wherein:

Figure 1 is a longitudinal substantially central sectional view through the underreamer tool taken substantially along a plane as indicated by the line 1—1 of Figure 2;

Figure 2 is a longitudinal sectional view, partly in side elevation, taken substantially along planes as indicated by the lines 2—2 of Figures 1 and 3;

Figures 3, 4 and 5 are cross sectional views of the tool taken substantially along planes as indicated by the lines 3—3, 4—4, and 5—5, respectively, of Figure 2;

Figure 6 is a longitudinal sectional view taken substantially along a plane as indicated by the line 6—6 of Figure 1;

Figure 7 is a side elevational view, partly in section, of one element of the tool;

Figure 8 is a side elevational view of one of the reamer blades, and

Figure 9 is a substantially central sectional view of another element of the tool.

Referring more specifically to the drawings, the novel underreamer tool in its entirety is designated generally 10 and includes a body member, designated generally 11, having an upper portion of substantially cylindrical cross section defining a barrel 12 and a lower portion forming a fixed blade 13.

The barrel 12 is provided with a bore 14 the upper end 15 of which is flared and internally threaded and adapted to be threadedly connected to the lower end of a drill stem or pipe 16 by which the tool is supported and rotated.

A piston 17 is reciprocally mounted in the upper portion of the bore 14 and has a depending externally threaded boss 18. A cup-shaped resilient ring or washer 19 fits around the upper portion of the piston 17 and contacts the wall of the bore 14 to provide a seal between said

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piston and the bore wall. The piston 17 has a threaded bore 20 extending therethrough in which is threadedly mounted a choke or flow restrictor 21. A sleeve 22 has an internally threaded upper end 23 which threadedly engages the boss 18 for supporting said sleeve beneath the piston 17. The sleeve 22 is substantially smaller in diameter externally than the piston 17 and extends slidably through an annular restriction or collar 24 formed in the barrel 12 intermediate of the ends of the bore 14 and which collar forms a guide for the sleeve 22. Said internal collar or restriction 24 is provided with a key 25 which slidably engages a longitudinally extending groove or keyway 26 formed in the outer side of the sleeve 22 and which opens outwardly of the lower end thereof. The restriction 24 also forms a seat for the lower end of an expansion coil spring 27 which is disposed between the sleeve 22 and the wall of the bore 14 and the upper end of which bears against the underside of a portion of the piston 17 which is disposed above the upper end of the sleeve 22, for urging said piston and the sleeve upwardly in the barrel 12.

A block 28 of circular cross section slidably fits in the sleeve 22 and has a pair of diametrically aligned screws 29 threadedly secured therein and provided with circular heads 30 which are disposed externally of the periphery of the block 28. Said screw heads 30 slidably engage longitudinally extending slots 31 formed in said sleeve 22 whereby the block 28 is prevented from turning in the sleeve 22 and limited in its sliding movement longitudinally of said sleeve. An expansion coil spring 32 is disposed in the sleeve 22 between the lower end of the boss 18 and the upper end of the block 28 for urging said block toward the lower end of the sleeve 22. The bottom portion of the block 28 is provided with a downwardly opening recess 33 in which are loosely disposed the upper ends of a pair of connecting bars or links 34. A pin 35 extends diametrically through the block 28 and loosely through the upper ends of said links 34 for swingably connecting the links to the block 28. Said pin 35 is disposed at an angle to the screws 29.

The lower end 36 of the barrel 12 is provided with a pair of slots 37, the upper ends of which open into the lower end of the bore 14. Said slots 37 open outwardly of the lower end of the barrel portion 36 and likewise extend radially in opposite directions to open outwardly of substantially opposite portions of the periphery of the lower barrel portion 36, as best illustrated in Figure 3. The upper end of the blade 13 is suitably secured to or formed integral with the lower barrel portion 36 and is disposed between and separates the slots 37. Said blade 13 is of a width approximately equal to but no greater than the diameter of the barrel 12 and of a length to extend substantially below the barrel portion 36.

A pair of corresponding reamer blades 38 and 39 have rounded inner ends 40 each provided with an opening 41. Said inner blade ends 40 are loosely disposed in the slots 37. A headed pivot pin 42 extends diametrically through the barrel portion 36 and transversely through the slots 37 and blade 13. Portions of the pivot pin 42 loosely engage in the openings 41 for swingably mounting the blades 38 and 39. The pivot pin 42 has a restricted end 43 which is threadedly secured in the barrel portion 36 and the head of said pivot pin 42, as seen in Figure 1, is countersunk in the barrel portion 36. The pin 42 is retained in an applied position by a threaded plug 44 which threadedly fits into a recess 45 in the periphery of the barrel portion 36 and which plug bears against the outer end of the pivot pin head. A headed screw 46 is threaded and countersunk in the barrel portion 36 and has a portion seating in a recess 47 of the plug 44 to prevent the plug from turning in the recess 45 until said retaining screw 46 is removed.

The inner blade ends 49 have recessed remote sides 48 in which outwardly offset lower ends of the links 34 loosely fit. Pivot elements 49 threadably engage in the blade ends 40 and have outer ends extending into the recesses 48 and which are pivotally connected to the lower ends of the links 34. Said pivot elements 49 are offset relatively to the longitudinal centers or axes of the blades 38 and 39 and to the openings 41 thereof, so that torque will be imparted to the blades by the links 34 when said links are displaced downwardly of the barrel 12.

The blades 38 and 39 have corresponding outwardly tapered toothed edges 50 and corresponding beveled and sharpened outer ends 51.

A pair of passages 52 are formed in the blade 13 and have upper ends opening into the bore 14 and outturned lower ends which open outwardly of side edges of said blade 13 in advance of the blades 38 and 39. The lower end of the blade 13 is split midway of its side edges and beveled on opposite sides of the blade adjacent its two side edges to form a drill bit 53. A pair of passages 54 extend longitudinally through the blade 13 and barrel portion 36 having upper ends opening into the bore 14 and lower ends opening through the oppositely beveled faces of the drill bit 53.

Assuming that the tool 10 is attached to the lower end of the drill pipe 16, the spring 27 will normally maintain the piston 17 in its position of Figure 1 for retaining the reamer blades 38 and 39 in their retracted positions of Figure 1 longitudinally of the body member 11 and against opposite sides of the blade 13. In order to move the reamer blades 38 and 39 to operative extended positions as illustrated in Figures 2 and 3, a circulating fluid, not shown, is supplied under pressure to the upper end of the barrel 12 from the drill pipe 16. The bore of the restrictor or choke 21 is of sufficiently restricted size so that the fluid will maintain a pressure on the piston 17 to force said piston and the sleeve 22 downwardly to its position of Figure 2 thereby compressing the spring 27. Should the formation around the body member 11 be relatively hard so that the blades 38 and 39 may not readily swing outward to their positions of Figure 2, the block 28 will be forced upwardly in the sleeve 22 as said sleeve slides downwardly with the piston 17, thus compressing the spring 32. Upward displacement of the block 28 in the sleeve 22 will reduce the area of the portions of the slots 31 which communicate with the interior of the sleeve 22 above the block 28 and, accordingly, the size of these ports from which the circulation fluid can escape from the sleeve 22. Thus, the circulating fluid will exert a pressure on the blades 38 and 39 through the block 28 and links 34 to urge the blades to extended positions. This pressure varies in ratio to the hardness of the formation in which the tool is disposed. Thus, as the tool 10 is rotated with the drill pipe 16 the blades 38 and 39 will gradually swing outwardly to their fully extended positions of Figure 2 under the pressure exerted by the compressed spring 32 and by the circulating fluid each of which exerts a downward thrust on the block 28 and links 34 tending to force the blades 38 and 39 to swing in opposite directions about the pivot 42. The amount of pressure exerted, tending to move the blades 38 and 39 to extended positions, may be varied by employing chokes having bores of different diameters and by employing springs 27 and 32 of different strengths. The sharpened outer ends 51 enable the blades 38 and 39 to more readily penetrate the formation surrounding the tool 10 so that the blades can assume the positions of Figure 2. The tool 10 is revolved clockwise as seen in Figure 3 and the extended blades 38 and 39 accomplish their reaming operation by their toothed cutting edges 50 which are inclined outwardly and upwardly and thus tend to direct the cuttings of the blades outwardly and upwardly therefrom. Additionally, a portion of the circulating fluid which passes through the choke 21 also passes under pressure through the passages 52 and is discharged radially therefrom in

advance of the cutting edges 50 for washing away the cuttings.

The upwardly inclined toothed edges 50 will tend to cause the tool 10 to rotate at a steady speed and to more accurately follow the pilot hole and said teeth will lessen the torque on the tool and cause it to cut more rapidly. The cushioning spring 32 insures maintenance of a uniform pressure on the blades 38 and 39 so that an increase in pressure of the circulated fluid above the piston 17 will not produce an increased thrust through the links 34 on the blades. This pressure on the blades may be readily varied by employing springs 32 of different tensions depending upon the character of the formation to be reamed.

Should the blades be bent due to striking an obstruction, the bend thereof will be in a direction so that said blades may still be swung back to retracted positions and will merely be bent away from the fixed blade 13. Thus, closing of the blades will not thereby be prevented as frequently occurs in underreamers the blades of which fit a slotted portion of a tool body. The bit 53 will follow the pilot hole and will clear the same should it fill up in advance of the tool 10.

Various modifications and changes are contemplated and may obviously be resorted to, without departing from the spirit or scope of the invention as hereinafter defined by the appended claims.

I claim as my invention:

1. A reaming tool comprising an elongated body member having an upper end detachably secured to the lower end of a drill pipe, said body member having a bore in the upper portion thereof communicating with the drill pipe for receiving a circulating fluid under pressure therefrom, a piston slidably mounted in the upper portion of said bore, a pair of reamer blades, means swingably connecting said reamer blades adjacent inner ends thereof to the body member below the piston, means including links connecting the blades to the piston for swinging the blades outwardly to radially extended positions when the piston is displaced downwardly, and spring means urging said piston toward the upper end of said bore for drawing said blades inwardly to retracted positions longitudinally of the tool, said body member having transversely spaced slots disposed below the bore thereof and separated from one another by a part of the body member, said slots having upper ends opening into said bore and having other portions opening downwardly from another part of the body member and radially outwardly thereof, said inner ends of the reamer blades and the lower ends of said links being swingably disposed in said slots, and a stationary blade forming the lower end of the body member and having an upper end disposed between the inner ends of said reamer blades and constituting said first mentioned part of the body member, the outer ends of said reamer blades straddling an exposed lower portion of the stationary blade when the reamer blades are in retracted positions.

2. A tool of the character described comprising a barrel having an upper end detachably connected to a drill pipe and provided with a longitudinal bore communicating with the drill pipe to receive a circulating fluid under pressure therefrom, a piston slidably mounted in the upper portion of said bore and urged downwardly by the pressure of the circulating fluid, a pair of reamer blades having inner ends disposed in the lower end of said barrel, a partition having an upper end secured to the barrel and disposed in the lower end of said bore and defining slots in which the inner ends of the reamer blades are swingably disposed, said slots opening downwardly and radially outward of said barrel, a pivot pin pivotally mounting the inner ends of the reamer blades in the barrel, a spring urging the piston upwardly in said barrel, said piston having a bore extending therethrough, a sleeve fixed to and depending from the piston and communicating with the bore thereof through which the circulating fluid passes from above to below the piston, a block slidably disposed in and closing

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the lower portion of said sleeve, said sleeve having a slot disposed between the piston and said block for escape of the circulating fluid from the sleeve into the bore of said barrel, means retaining said block slidably in the sleeve, a pair of links having complementary ends pivotally connected to the block and opposite ends pivotally connected to the reamer blades at points spaced from the pivot pin, and a cushioning spring disposed in the sleeve and bearing against and urging said block away from the piston whereby the blades are swung inwardly towards positions axially of the barrel when the piston is displaced upwardly by said spring and yieldably urged outwardly to extended positions substantially radially of the barrel when the piston is displaced downwardly, said block being slidably movable in the sleeve toward the piston for compressing the cushioning spring and for restricting the slot of said sleeve for increasing the pressure exerted on the links for urging the blades to extended positions.

3. A tool as in claim 2, a stationary blade forming a depending extension of the partition, the outer ends of said reamer blades straddling said stationary blade when the reamer blades are in retracted positions.

4. A tool of the character described comprising a barrel having an upper end detachably connected to a drill pipe and provided with a longitudinal bore communicating with the drill pipe to receive a circulating fluid under pressure therefrom, a piston slidably mounted in the upper portion of said bore and urged downwardly by the pressure of the circulating fluid, said barrel having a recessed portion disposed beneath and communicating with said bore, a pair of reamer blades having inner ends disposed in said recessed portion of the barrel, a pivot pin pivotally mounting the inner ends of the reamer blades in the recessed portion of the barrel and in which the inner ends of the reamer blades are swingably disposed, a spring urging the piston upwardly in said barrel, said piston

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having a bore extending therethrough, a sleeve fixed to and depending from the piston and communicating with the bore thereof through which the circulating fluid passes from above to below the piston, a block slidably disposed in and closing the lower portion of said sleeve, said sleeve having a slot disposed between the piston and said block for escape of the circulating fluid from the sleeve into the bore of said barrel, means retaining said block slidably in the sleeve, a pair of links having complementary ends pivotally connected to the block and opposite ends pivotally connected to the reamer blades at points spaced from the pivot pin, and a cushioning spring disposed in the sleeve and bearing against and urging said block away from the piston whereby the blades are swung inwardly towards positions axially of the barrel when the piston is displaced upwardly by said spring and yieldably urged outwardly to extended positions substantially radially of the barrel when the piston is displaced downwardly, said block being slidably movable in the sleeve toward the piston for compressing the cushioning spring and for restricting the slot of said sleeve for increasing the pressure exerted on the links for urging the blades to extended positions.

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