Nov. 15, 1938. J. NIXON 2,136,518

PIPE CUTTER

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FIG. 1.

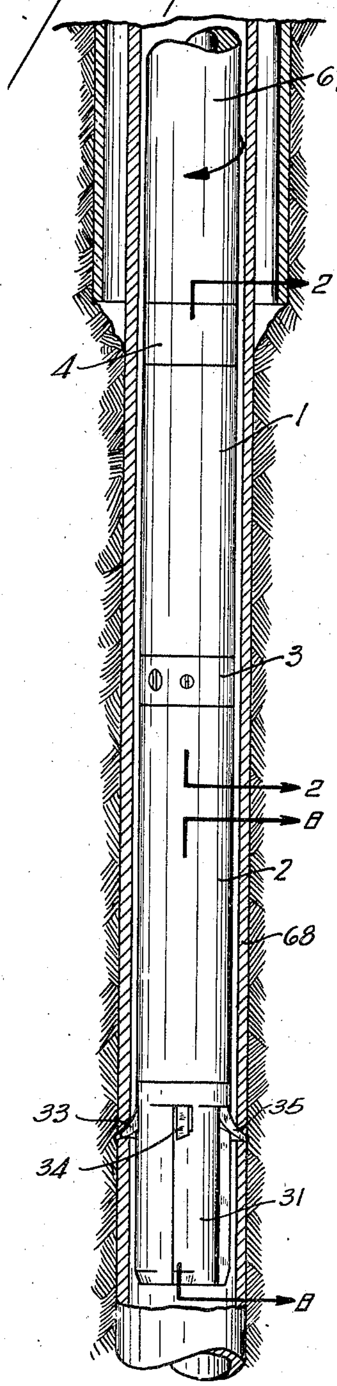

FIG. 13.

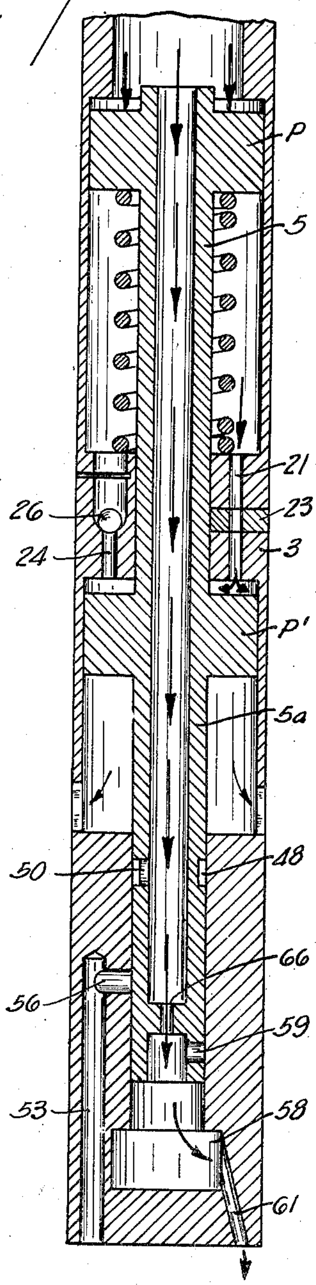

FIG. 14.

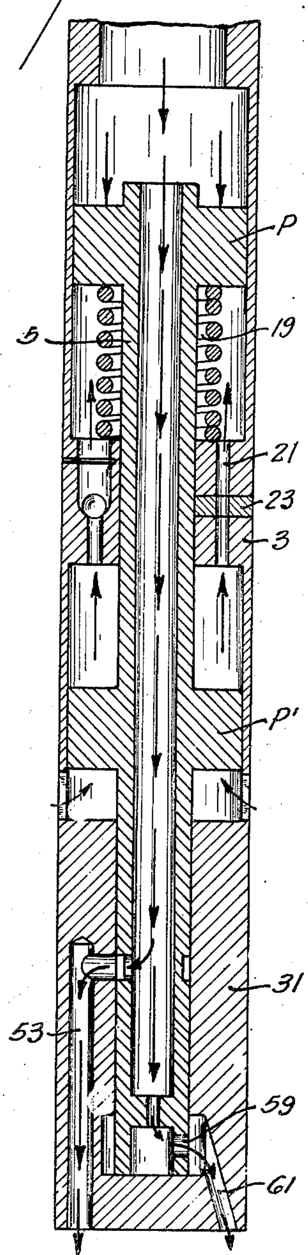

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FIG. 2

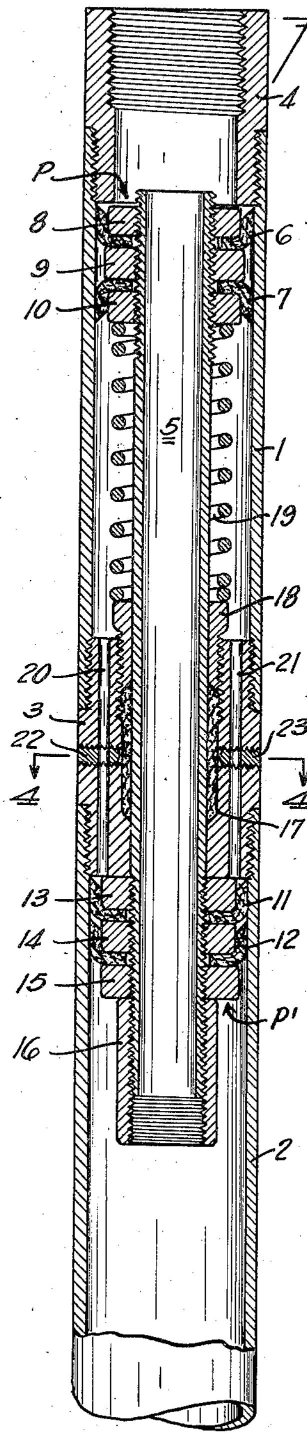

FIG. 4

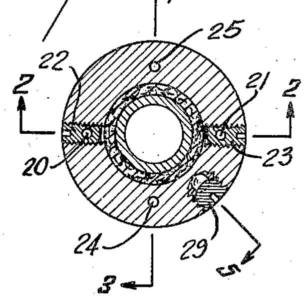

FIG. 5

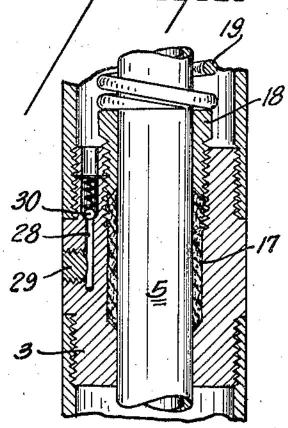

FIG. 3

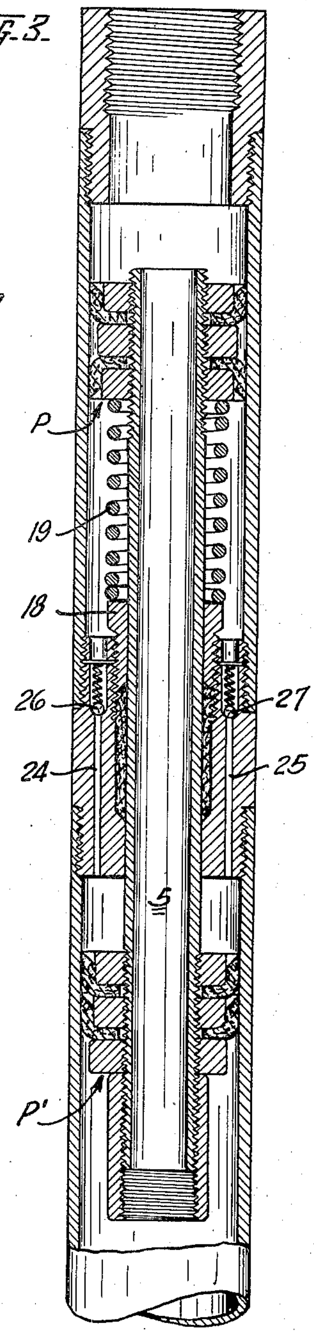

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FIG. 8.

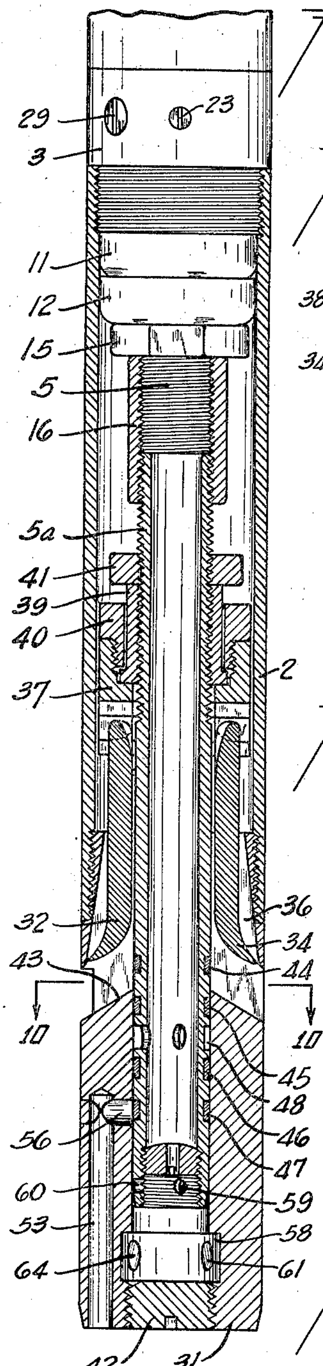


FIG. 9.

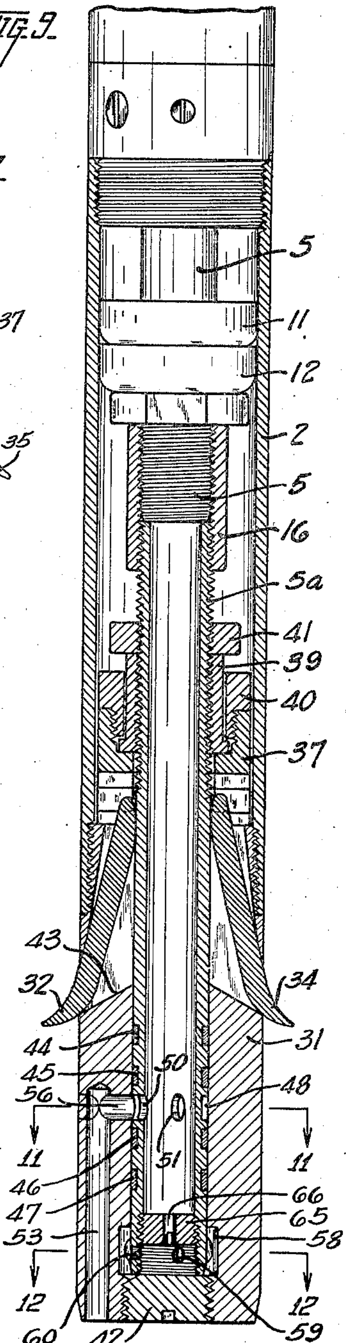


FIG. 6.

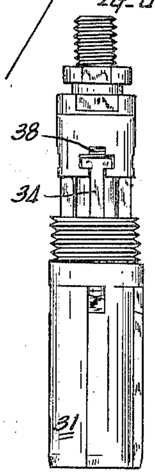


FIG. 7.

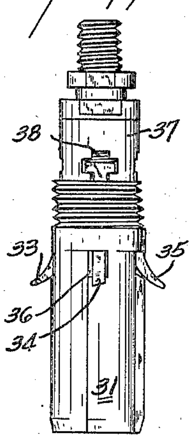


FIG. 10.

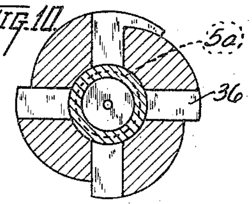


FIG. 11.

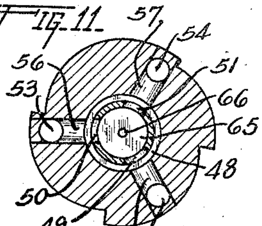
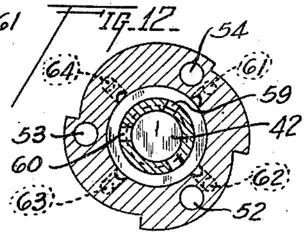


FIG. 12.



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Patented Nov. 15, 1938

2,136,518

UNITED STATES PATENT OFFICE

2,136,518

PIPE CUTTER

Joe Nixon, Oklahoma City, Okla.

Application September 19, 1936, Serial No. 101,545

8 Claims. (Cl. 164—0.7)

My invention relates to pipe cutters.

It has for its general object the provision of a new and improved inside cutter for cutting casing and pipe, and particularly for cutting perforated liners for casing and pipe, inside the bore of a well.

The cutting of liners is probably the most difficult job for which cutters are used. A liner is a string of perforated pipe placed inside a pipe or casing to prevent sand and mud carried by oil rising in the casing from filling it and thus preventing access to the oil strata. Liners sometimes extend from the bottom of the well upward several hundred feet. In some wells the oil carries so much sand that the sand not only fills the liner, but after a period of time fills a portion of the casing above the liner. This necessitates removal of the liner which can only be accomplished after it has been cut into sections. To do this the pipe cutter must first penetrate the sand in the casing above the liner, which is necessarily of smaller diameter than the casing. This penetration of the sand can only be accomplished by mixing of water or drilling fluid with the sand immediately adjacent the cutter. To do this circulation must necessarily be provided through the cutter body. Cutters in present use permit of a slight circulation through the body until the cutter blades reach their maximum cutting positions, at which time all circulation through the cutter is stopped because the lower open end of the hollow actuator seats on a plug in the bottom of the cutter body. It is thus impossible to force the fluid through the cutter to agitate and mix the fluid and sand, and allow the cutter to pass downward to the liner. My cutter is so designed that when the blades assume maximum cutting position, the circulation of fluid is not stopped but is increased greatly by an increase of passage area through the cutter. This permits my cutter to penetrate sand or other obstructions to its cutting position in the liner.

Also, cutters in present use are so designed that when fluid pressure is applied in the drill pipe the cutter blades are immediately forced to their maximum cutting positions, unless a cutting surface is encountered by each blade. Should one blade encounter a perforation, that blade at least partially enters the perforation, and is sheared off when the cutter body is rotated. My cutter is so constructed that the blades move toward their cutting positions uniformly and slowly regardless of the pressure applied to the fluid in the drill pipe; thus no blade can move a greater distance than the other blades, even though it should encounter a perforation, and the shearing off of blades is practically eliminated.

When cutters of present design have completed a cutting operation, the pressure is removed from the fluid in the drill pipe and the cutter withdrawn from the liner into the casing of larger diameter, which diameter affords sufficient space for the blades to move to their maximum cutting position without contacting the sides of the casing. The weight of the fluid in the drill pipe above the cutter is sufficient to force the actuator to the lower limit of its stroke. The passage through the cutter is then closed, as previously mentioned, and the fluid above is trapped in the drill pipe, which must necessarily be pulled from the well while full of the trapped liquid. This is particularly true of wells in very porous formations where the drill pipe pressure forces the fluid into the porous formation rather than forcing it up around the drill pipe to the top of the well. With my cutter, since an increased passage area is provided when the actuator is at the lower end of its stroke, the fluid in the drill pipe simply passes on through the cutter, the drill pipe sections are drained, and contain no fluid when they are disjoined, one by one, at the top of the well.

In wells having heavy mud at or near their bottoms it is necessary to force sufficient fluid downward through the drill pipe to raise the heavy mud outside the drill pipe but inside the casing to the top of the well so that the heavy mud can be introduced inside the drill pipe. If this heavy mud is not raised to the top, its weight on the outside of the drill pipe will more than offset the weight of mud inside the drill pipe, and prevent drainage of the pipe. Since cutters of present design do not allow continued forced circulation of drilling fluid downward through the drill pipe after they have cut through the casing or liner, there is no way of continuing the flow of the lighter drilling fluid downward to raise the heavier mud to the top of the hole. Hence the drill pipe must be removed from the hole full of fluid. By providing increased flow of fluid through my cutter after the blades have cut through the casing or liner, my cutter permits continued circulation of fluid until the heavier mud is raised to the top of the well and is introduced into the drill pipe. The mud inside the pipe is then heavier than the mud outside and therefore the pipe is drained of fluid as it is removed from the casing.

Specific objects of the invention, then, are to provide a cutter all blades of which are moved uniformly at controlled speed toward their maximum cutting positions regardless of whether or not a cutting surface is encountered by one or all of the blades during their movement, and regardless of the motive fluid pressure exerted downward through the drill pipe; one in which the speed at which the blades move toward their maximum cutting positions may be changed according to needs; in which free circulation of pressure fluid is allowed at all times, before, during, and after the cutting operation; in which the circulation of pressure fluid through the cutter is increased very greatly after the blades reach their maximum cutting position; which because of the free circulation of fluid therethrough is capable of penetrating sand and detritus which may be encountered as it is lowered toward its cutting position in the pipe or casing; the cutting blades of which are automatically reset for any number of cutting operations without the necessity of removing the cutter from the casing; which because it permits free circulation of the pressure fluid at all times permits drainage of the pressure fluid in the drill pipe above it as the drill pipe and cutter are withdrawn from the casing; which notifies the operator when the pipe has been cut; which will cut a perforated casing without its blades being forced through any of the perforations and thus being sheared off as the cutter rotates; and, which is efficient in accomplishing all the purposes for which it is intended.

With these and other objects in view as will more fully appear hereinbelow, my invention consists in the construction, novel features, and combination of parts hereinafter more fully described, pointed out in the claims hereto appended, and illustrated in the accompanying three-sheet drawing, of which,

Figure 1 is a side elevation of the complete device in position inside a casing after the casing has been cut;

Figure 2 is a vertical section of the upper portion of the cutter showing the actuator at its upper limit of movement, and is taken along the line 2—2 of Figs. 1 and 4;

Figure 3 is a view similar to Fig. 2 but shows the actuator at the opposite end of its stroke, and is taken along the line 3—3 of Fig. 4;

Figure 4 is a horizontal section taken along the line 4—4 of Fig. 2;

Figure 5 is a fragmentary vertical section taken along the line 5 of Fig. 4 and shows particularly the inlet to the piston chamber above the packer;

Figure 6 is an assembled view of the lower portion of the device with the blades and blade holder at the upper end of their permitted movement;

Figure 7 is a view similar to Fig. 6 but shows the blades extended to maximum cutting position and the blade holder at the lower end of its stroke;

Figure 8 is a vertical section of the lower portion of the cutter with the blades in inactive position;

Figure 9 is a view similar to Fig. 8 but with the blades in active cutting position;

Figure 10 is a horizontal section taken along the line 10—10 of Fig. 8;

Figure 11 is a horizontal section on the line 11—11 of Fig. 9;

Figure 12 is a horizontal section along the line 12—12 of Fig. 9;

Figure 13 is a diagrammatic view of the cutter with the actuator at the upper end of its stroke and particularly traces the flow of pressure fluid as well as speed governing fluid through the device during the downstroke of the actuator; and,

Figure 14 is a diagrammatic view similar to Fig. 13 with the actuator at the lower end of its stroke, showing the manner in which the fluid passage area is increased.

Referring now more particularly to the drawings, wherein like numerals designate like parts in all the figures, numeral 1 (Figs. 2 and 3) designates the upper piston barrel, numeral 2 the lower piston barrel, and numeral 3 the combination stuffing box and coupling which threadedly engages both barrels and holds them together. The upper barrel is internally threaded to engage a suitable coupling 4, male or female, to facilitate attachment of the cutter to the usual string of drill pipe, not shown. A hollow piston rod 5 extends centrally through the upper barrel 1, stuffing box 3, and into the lower barrel. At its upper end the rod 5 carries a piston designated as a whole by the letter P, and which is comprised of two leather cups 6 and 7, each facing away from the other, which are held in position by cup rings 8, 9, and 10 which threadedly engage the rod 5. Near its lower end, within the lower barrel 2, the rod 5 is equipped with a second piston, designated as a whole by the letter P' and which comprises a pair of leather cups 11 and 12, both facing toward the stuffing box, and held in position by cup rings 13, 14 and 15 which threadedly engage the rod 5. A coupling 16 threadedly engages the lower end of the rod 5 facilitating its attachment to the remainder of the actuator, which will be hereinafter described.

The stuffing box 3 carries the usual annular packing 17 held in position by the packing nut 18 which threadedly engages the upper end of the stuffing box 3. A coil spring 19 surrounds the rod 5 within the upper barrel 1. Its lower end bears on the nut 18 and its upper end on the cup ring 10. This spring tends to normally hold the rod 5 at the upper end of its stroke, as in Fig. 2.

It will be seen that fluid forced down through the drill pipe (not shown) and through the coupling 4 would, if the lower end of the rod 5 were substantially closed and if sufficient pressure were applied, immediately force the rod 5 to the opposite end of its stroke, as in Fig. 3, against the tension of the spring 19. To prevent this almost instantaneous movement of the rod I provide a governing means through the stuffing box.

This governing means will now be explained. Longitudinally through the side walls of the stuffing box 3, I provide two (or more) fluid passages 20 and 21, the flow through which may be controlled by screw plug valves 22 and 23, each of which has a cross perforation intermediate its ends adapted to register with the passages 20 and 21 when the plugs are in predetermined positions. These plugs may be adjusted from outside the cutter by a screw driver. Spaced radially from the passages 20 and 21 in the stuffing box are other longitudinal fluid passages 24 and 25 (Fig. 3), which permit only of upward movement of a fluid due to the spring pressed ball check valves 26 and 27 positioned therein.

The wall of the stuffing box is also provided with a short longitudinal fluid passage 28 (Fig. 5) which extends from the upper end of the box 3 to a point intermediate its ends, and which is intersected by a latitudinal passage which affords communication with the outside of the cutter. This latter passage is normally closed by a plug

29, which may be replaced at will by a suitable pressure grease fitting (not shown) for introducing a fluid into the passage 28, upward through the spring pressed ball check valve 30 and into the space between the piston P and the stuffing box 3.

After the annular space just mentioned has been filled with a lubricant or any other suitable fluid, it will be seen that by adjusting the plugs 22 and 23 the volume of the fluid which may pass through the passages 20 and 21 in a given time, and under a given pressure may be controlled. The speed at which the fluid may pass through the passages 20 and 21 into the annular chamber between the stuffing box 3 and the piston P' will directly govern the speed at which the rod 5 moves from the upper end of its stroke (Fig. 2) to the lower end of its stroke (Fig. 3). When the pressure on the motive fluid above the piston P is removed then the spring 19 will return the rod 5, and its pistons, to the upper end of their stroke. On the return stroke the governing fluid which has passed into the chamber below the stuffing box may pass upward not only through the passages 20 and 21, but also through the passages 24 and 25. The desirability of providing speed governing means for the rod will be later explained.

Referring now to the lower portion of the device as illustrated in Figs. 6 to 12, a hollow extension rod $5a$ is coupled to the lower end of the piston rod 5 by the coupling 16, its lower end terminating at a point substantially beyond the lower end of the barrel 2. Tightly enclosing the lower end of the rod $5a$ but permitting its reciprocation therein is a hollow valve body 31, its upper end threadedly attached to the lower end of the barrel 2. Milled into the surface of its inner wall and communicating with its upper end this body 31 has a plurality of radially spaced longitudinal slots, which are alike in dimension and all of which are designated by the numeral 36, the walls of which act as guides for a like plurality of cutting blades 32, 33, 34 and 35. The lower ends of these slots 36 penetrate the wall of the body 31 and thereby afford passage therethrough for the lower cutting edges of the blades, as clearly shown in Figs. 7 and 9. The blades 32, 33, 34 and 35 are T-shaped at their upper ends and are pivotally carried by a collar-like blade holder 37, which is equipped at its lower end with a like plurality of T-shaped slots 38. This blade holder 37 fits slidably around the rod $5a$ and is also slidable within the barrel 2. It is adjustably secured to the rod $5a$ by means of a shouldered internally threaded sleeve 39, and an externally threaded collar 40 which screws into the upper end of the holder, and whose lower end completes an annular recess within the holder, in which the shoulder on the sleeve 39 may rotate. The collar 40, however, prevents relative longitudinal movement of the holder and rod $5a$ unless the sleeve 39 is screwed upward or downward on the rod $5a$, in which case the blade holder 37 is also moved upward or downward. A lock nut 41 is provided for tightly contacting the upper end of the sleeve 39 and thereby locking it in a desired longitudinal position on the rod $5a$.

In Fig. 9 it will be seen that the downward stroke of the entire reciprocatory structure is limited by the contact of the lower end of the rod $5a$ with the plug 42 which is threaded into the lower end of the valve body 31. With the reciprocatory structure in this position the sleeve 39 is screwed downward on the rod $5a$ until the cutting edges of the blades move outward to their limit and are stopped by the edges of the slots. In this position the blades are considered adjusted for their maximum cut.

It will be noticed that due to the sloping lower edge 43 of the slots 36, combined with the outwardly curving lower ends of the blades 32, 33, 34 and 35, the blades are positively forced out through the slots when the blade holder is forced downward within the barrel 2 by fluid pressure exerted on the piston P, as previously explained. It is now also evident that by governing the downward speed of the reciprocatory structure, the speed at which the blades move toward their maximum cutting positions is also positively governed.

The means for increasing the flow of motive fluid through the cutter when the reciprocatory structure has reached the lower end of its stroke and when the cutter blades have simultaneously reached a predetermined cutting position will now be described. Near its lower end the rod $5a$ is equipped with a plurality of piston rings 44, 45, 46, and 47 (Figs. 8 and 9) which prevent the passage of a fluid between the exterior of the rod $5a$ and the interior wall of the body 31. An annular groove 48 is formed in the exterior wall of the rod $5a$ and acts as a fluid passage. Ports 49, 50, and 51 through the wall of the rod $5a$ afford commmunication between the interior of the rod and the groove 48. Extending from its lower end, the body 31 has a plurality of longitudinal fluid passages 52, 53 and 54 which terminate intermediate its ends and which are intersected by a like plurality of latitudinal fluid passages 55, 56 and 57 which afford communication between the passages 52, 53 and 54 and the interior bore of the body 31 at a point in alignment with the groove 48 when the rod $5a$ is at the lower end of its stroke. With this alignment fluid is permitted to pass from the interior of the rod $5a$ into the groove 48, through the passages 55, 56 and 57 and out the lower end of the cutter through the passages 52, 53, and 54, even though the ports 49, 50 and 51 do not exactly register with the passages 55, 56, and 57.

The valve body 31 has an enlarged bore 58 near its lower end which affords an annular fluid passage around the end of the rod $5a$ when it is at the lower end of its stroke. The lower end of the rod $5a$ has a plurality of through ports 59 and 60 immediately adjacent its extreme end. Thus when the rod $5a$ seats on the plug 42, and its lower end is closed, fluid may pass through the ports 59 and 60 into the bore 58. A plurality of longitudinal ports 61, 62, 63 and 64 (Figs. 8 and 12) are also formed in the wall of the body 31 and afford a fluid passage from the bore 58 to the outside. These ports are spaced circumferentially from the passages 52, 53 and 54 as shown in Fig. 12.

The lower end of the rod $5a$ is internally threaded for a distance above the ports 59 and 60 for receiving a threaded plug 65, which has a small central perforation 66. This perforation allows circulation of motive fluid through the cutter at all times, regardless of the position of the lower end of rod $5a$ within the valve body 31, and independent of the passages 49 to 57 inclusive.

The valve body 31 is akin in exterior shape to a reamer, as shown by the sectional views in Figs. 10, 11 and 12, having longitudinal ribs radially spaced about its surface. It is formed in this manner to facilitate disposal of the cuttings made by the blades. This particular feature is not essential to my invention, however, and I do not wish to be limited by this feature.

Operation

From the description thus far the manner of assembling the device and properly adjusting the blades for desired depth of cut will be apparent.

After the blades have been properly adjusted, and the chamber between the piston P and the stuffing box 3 has been filled as previously described with a suitable fluid, the assembled cutter is attached by means of the coupling 5 to the lower end of a section of drill pipe 67 and lowered into the casing or liner 68 to the point at which it is desired to cut the casing or liner. If sand is encountered before the cutter reaches its cutting position in the liner, drilling fluid or water may be forced downward through the drill pipe (Figs. 13 and 14), through the piston rod 5 and extension rod 5*a*, through the perforation 66 in the plug 65, and out the lower end of the body 31 through the passages 59 and 60, where it mixes with the sand forming a solution through which the cutter may pass downward. If high pressure is exerted on the fluid the piston P will move the rod 5 and its extension 5*a* downward to the position shown in Fig. 14, at which time the fluid may pass through the ports 49, 50, and 51, groove 48, and passages 52 to 57 inclusive out the lower end of the cutter. This provides an increased volume of fluid passing through the cutter, if and when needed. After the sand has been penetrated the fluid pressure may be removed from above the piston P at which time the spring 19 will return the pistons and rods to the upper end of their stroke, as shown in Fig. 13.

When the cutting position within the liner or casing is reached, the drill pipe is rotated and fluid pressure is again exerted downward on the piston P, which moves downward only as fast as the control fluid may pass from the chamber above the stuffing box through the valves 22 and 23 into the chamber below the stuffing box 3. On its downward stroke the rod 5 moves the blade holder 37, which in turn forces the blades slowly toward their maximum cutting position. The cuting edges of the blades, of course, contact the interior of the pipe to be cut and as the device is rotated they cut through the pipe. Due to the controlled outward movement of the blades neither irregularities on the interior surface of the pipe nor perforations through the wall of the pipe effect the outwardly projecting blades. Instead of entering the perforation or irregularity each blade maintains its relative position with the other blades, and the usual shearing off of blades is practically eliminated.

When the blades have cut entirely through the pipe, they continue their outward movement until the down stroke of the rods 5 and 5*a* stops, at which time the flow of power fluid through the cutter is increased, which tends to reduce the pressure being applied on the fluid at the upper end of the drill pipe. This reduction of pressure immediately notifies the operator that the pipe has been cut. All pressure on the fluid is then removed by the operator. The cutter may then be moved either upward or downward to a second cutting position and the operation repeated. As many cuts as are desired may be made without removing the cutter from the hole, the blades being reset after each cutting operation by the spring 19.

While I have described and illustrated a specific embodiment of my invention I am aware that numerous alterations and changes may be made therein and I do not wish to be limited except by the prior art and the scope of the appended claims.

I claim:

1. A pipe cutter having a hollow body; cutting blades movably mounted in the body; a blade actuator, normally held in an inactive position in said body, movable into its active position by fluid pressure; and fluid escapement means within the body in advance of said actuator for controlling the speed at which said actuator moves into its active position under the influence of said fluid pressure.

2. A pipe cutter comprising: a barrel having bit apertures through its walls; a spring pressed plunger carrying actuator reciprocably mounted and normally held in an inactive position in said barrel, and adapted to be moved to an active position by fluid pressure exerted on the plunger; a plurality of bits operably connected to said actuator, normally held in an inactive position when said actuator is in an inactive position, and adapted to move through said apertures toward a cutting position outside said barrel as said actuator is moved away from its inactive position; and fluid escapement means in the barrel in advance of said actuator for controlling the traveling speed of said actuator and hence the speed at which said bits approach their maximum cutting position.

3. A pipe cutter comprising: a substantially hollow barrel having bit apertures through its walls intermediate its ends; a tubular actuator reciprocably mounted in the barrel and having a piston mounted near its upper end, a bit holder intermediate its ends, and a perforated plug substantially closing its lower end, said actuator being normally held at the upper end of its movement by a coil spring; a plurality of bits mounted on the holder and normally held thereby within the barrel, their lower ends in alignment with said apertures and adapted to be forced outward into cutting position by contact with the lower edges of said apertures as the holder is moved downward in the barrel by said actuator; and valve means within the barrel for controlling the speed at which said actuator reciprocates, and hence the speed at which said bits approach their maximum cutting position outside said barrel; said actuator adapted to be moved downward in said barrel by fluid forced into the barrel against said piston.

4. A pipe cutter comprising: a substantially hollow barrel having bit apertures through the wall thereof intermediate its ends; a bit holder reciprocably mounted in the body and held against rotation therein; bits swingingly mounted in the holder in alignment with said bit apertures, the cutting ends of said bits adapted to be forced outward through the apertures as the holder moves in one direction; an actuator reciprocable in said body having a plunger mounted near its upper end and normally held inactive by a coil spring, and adapted to be moved downward by fluid pressure exerted on the plunger; longitudinally adjustable operative connections between said bit holder and said actuator; valve means mounted inside the body for controlling the speed at which said actuator reciprocates within the barrel.

5. A pipe cutter comprising: a substantially hollow barrel having bit apertures through its walls intermediate its ends; a tubular actuator

reciprocably mounted in the barrel and having a piston mounted near its upper end, a bit holder intermediate its ends, and a perforated plug substantially closing its lower end; said actuator being normally held at the upper end of its movement by a coil spring; a plurality of bits mounted on the holder and normally held thereby within the barrel, their lower ends in alignment with said apertures and adapted to be forced outward into cutting position by contact with the lower edges of said apertures as the holder is moved downward in the barrel by said actuator; valve means within the barrel for controlling the speed at which said actuator reciprocates, and hence the speed at which said bits approach their maximum cutting position outside said barrel; and a sleeve valve formed in the lower end of said actuator adapted to allow increased circulation of motive fluid through said actuator when said actuator reaches its limit of downward movement; said actuator adapted to be moved downward in said barrel by fluid forced into the barrel above said piston.

6. A pipe cutter comprising: a substantially hollow barrel having bit apertures through the wall thereof intermediate its ends; a bit holder reciprocably mounted in the body and held against rotation therein; bits swingingly mounted in the holder in alignment with said bit apertures, the cutting ends of said bits adapted to be forced outward through the apertures as the holder moves in one direction; an actuator reciprocable in said body having a plunger mounted near its upper end and normally held inactive by a coil spring, and adapted to be moved downward by fluid pressure exerted on the plunger; longitudinally adjustable operative connections between said bit holder and said actuator; valve means mounted inside the body for controlling the speed at which said actuator reciprocates within the barrel; and a sliding valve formed in the lower end of said actuator for allowing escape of pressure fluid when said actuator reaches a predetermined point in its downward movement in the barrel.

7. A pipe cutter having a hollow body; cutting blades movably mounted in the body; a hollow fluid pressure operated blade actuator reciprocably mounted in the body; operative connections between the actuator and the blades; fluid escapement means within the body for controlling the speed at which said actuator moves said blades toward their maximum cutting position; ports in the actuator; and ports in the body; the ports adapted to register when the actuator has moved the blades to a predetermined cutting position and to thereby allow the free circulation of pressure fluid through said actuator.

8. A pipe cutter adapted to cut by rotation within the work to be cut comprising: a hollow barrel plugged at its lower end and having circumferentially spaced bit apertures through its walls intermediate its ends; a stuffing box dividing the barrel into two chambers; a hollow bit actuator extending from one chamber through the stuffing box into the other chamber and reciprocatable in the barrel; pistons carried by the actuator, one in each of said chambers; valve controlled fluid passages in the stuffing box for controlling flow of a fluid from one chamber to the other; and a plurality of bits operably connected to said actuator and aligned with said bit apertures; the cutting edges of said bits adapted to be moved from an inactive position within the barrel toward an active cutting position outside the barrel by said actuator, and at a speed in direct proportion to the speed of movement of said actuator; said actuator adapted to be moved downward in the barrel by fluid pressure exerted on the top of the uppermost one of said pistons; the speed of movement of said actuator adapted to be controlled by the speed at which a fluid may pass from one of said chambers to the other.

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