March 10, 1942. R. O. CHILDERS 2,275,946

DEVICE FOR REMOVING CASING SECTIONS

Filed May 16, 1941

Fig. 1.

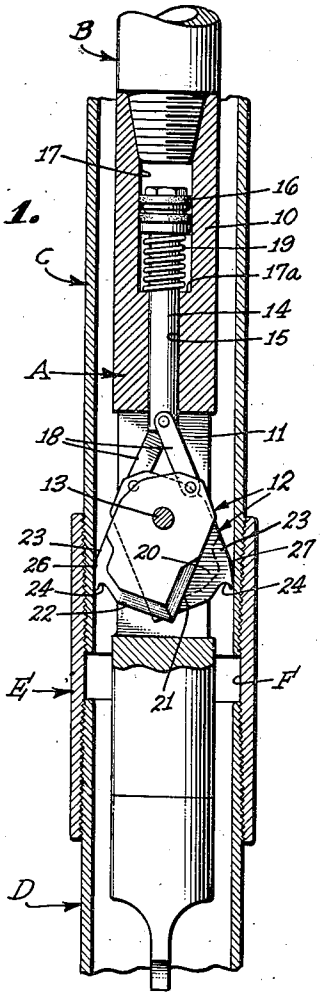


Fig. 2.

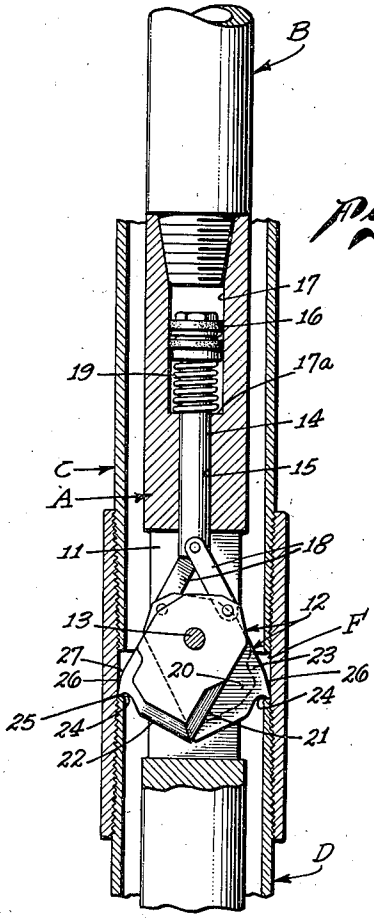


Fig. 4.

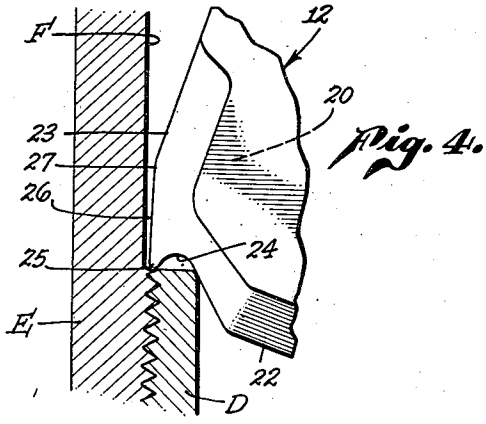
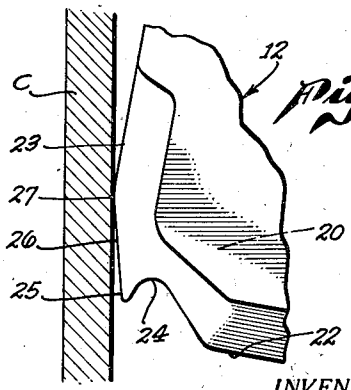


Fig. 3.



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DEVICE FOR REMOVING CASING SECTIONS

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Application May 16, 1941, Serial No. 393,757

14 Claims. (Cl. 164—0.3)

This invention relates to pipe cutting tools, and particularly to tools for drilling up casing or liner sections positioned within well bores.

Casing and liner cutting tools have been employed for cutting out sections of drillable and steel casing at regions in the well bore where it is desired to expose producing formations. One type of tool that has successfully removed such sections is disclosed in United States Patent No. 1,857,616, granted May 10, 1932, for a "Hydraulic underreamer." This tool cuts away the particular casing section upon rotation of the tool in the well bore by causing its cutter blades to act upon the metal of the casing and effect its removal by reducing it to chips or shavings.

It has heretofore been difficult to position the cutter blades with definiteness at the top of the casing or liner section that is to be removed. Accordingly, it is an object of the present invention to provide a casing cutting tool which is not only capable of removing or drilling up a casing or liner section, but which can also positively locate or check the position of the extremities of such sections in the well bore.

This invention has other objects which will become apparent from a consideration of the form in which it is embodied shown in the drawing accompanying and forming part of the present specification. This form will now be described in detail to illustrate the general principles of the invention, but it is to be understood that such detailed description is not to be taken in a limited sense, since the scope of the invention is best defined by the claims appended hereto.

Referring to the drawing:

Figure 1 is a longitudinal section through a well casing disclosing an expansible casing cutting and removing tool with its cutter blades positioned above the section to be removed;

Figure 2 is a view similar to Figure 1, disclosing the positive location of the top of the section to be removed by the casing cutting tool;

Figure 3 is an enlarged sectional view, showing the contact of one of the blades with the inner wall of the casing, as in Figure 1; and

Figure 4 is an enlarged sectional view, showing the blade contact with the casing, as in Figure 2.

In its general aspects, the invention contemplates a casing cutting and removing tool which is run into a casing or liner on the end of a drilling string. The cutter blades are initially retracted while the tool is being run in the casing, but upon reaching the region of the casing section to be removed, they are expanded outwardly to contact the wall of the casing. The blades are so formed that when expanded against the casing, further lowering of the drilling string and cutting tool enables the blades to positively engage and locate the top of the next lower casing or liner section, which prevents further downward movement of the tool within the casing. When this condition occurs, the operator is apprised of the fact that the cutting elements of the tool are located at the top of the section to be removed, whereupon the cutting tool is rotated at the proper cutting speed and the outward expansive force exerted on the cutter blades continued to begin the cutting and removal of the casing section from its top downwardly.

As specifically disclosed in the drawing, the cutting tool A is run in the casing on the end of a tubular string B. This casing is made up of sections C, D joined together by casing or coupling collars E which leave a small longitudinal space F between the adjacent ends of the casing sections of larger internal diameter than the inside diameter of the sections themselves. If the lower casing section D is to be cut away, it is desired to begin this removal at its top end or at the point in which it is joined to the casing collar E.

The cutting tool A includes a main barrel or body 10 formed with a transverse opening or slot 11 in which cutting blades 12 are pivotally mounted on a pin 13 extending across the opening. These blades 12 are normally retained inwardly of the slot within the confines of the tool body 10, being movable outwardly hydraulically by a mechanism including a plunger 14 slidable within a central longitudinal bore 15 in the tool body, and having a piston 16 at its upper end reciprocable within a cylinder bore 17 in the body. A link 18 connects the plunger with each of the cutter blades, the point of pivoting between the lower ends of the links and the cutter blades 12 being on the other side of the cutter pivot pin 13 from which its cutting edges are located, so that downward movement of the piston 16 and plunger 14 swings the cutter blades about their pivot pin in opposite directions in an upward and outward direction.

A helical spring 19 is disposed around the plunger 14 between the lower end of the piston 16 and the bottom 17a of the cylinder bore 17. It is apparent that the action of fluid under pressure against the piston 16 moves it downwardly against the force exerted by the spring 19 whenever the cutter blades 12 are swung outwardly, and that release of this hydraulic pressure al-

lows the spring to move the piston upwardly to its initial position, and in so doing elevates the plunger 14 to retract the blades once more in the transverse slot 11 and within the confines of the tool body 10. Further details of the operating mechanism of the particular tool in question are unnecessary to a proper understanding of the present invention, specially since such details, together with the fluid circulating system for washing away cuttings, may be found in the patent above referred to, to which attention is invited.

Each cutter blade 12 has its leading face 20 hard-faced along the bottom edge 21, along the outer edge 22, and along the top edge 23, in order that the blades might effectively remove the casing even when they are only partially expanded outwardly, a position which they occupy when the removal of the casing section is begun. When the cutting tool has been lowered to the region of the casing section which is to be removed, the pumps are started at the surface of the well bore to force fluid through the tubular string B for action upon the piston 16 for the purpose of swinging the cutter blades 12 outwardly into contact with the casing section. While this fluid force is being exerted, the tool A is rotated at the proper cutting speed to allow the top and side cutting edges 23, 22 of the blades to cut upon the inside of the casing section. As this cutting action through the casing proceeds, the hydraulic force on the piston gradually swings the blades outwardly to a further extent until the casing section has been completely severed and a sufficient length removed to enable the cutting blades to be disposed outwardly to their maximum extent, or in a horizontal position in which the bottom edges 21 of the cutting blades act upon the upper end of the severed casing section.

Continued rotation of the drilling string and cutting tool and their gradual lowering enables the bottom edges 21 to remove the casing over the desired distance along the formation, the chips or shavings being flushed away by the drilling fluid. After sufficient of the casing section has been removed, the fluid pressure is released to enable the spring 19 to retract the blades 12 within the confines of the tool body and allow its withdrawal to the surface of the well bore.

For the purpose of enabling the operator to know definitely when the top of the removable casing section has been reached, a notch 24 is formed in the side of each blade to form a corner 25 at its top region adapted to seat upon the upper end of a casing section. The outer portion of the top cutting edge 23 is bevelled inwardly from this corner 25 to provide an inclined casing engaging surface 26. The notch 24 of the blade and this inclined surface 26 are so related as to prevent the corner 25 of the notch from engaging the casing when the blades have been partly expanded to an extent limited by their engagement with the wall of the casing. When in this position, the inclined or tapered surface 26, or the heel portion 27 at which this surface merges into the remainder of the top cutting edge, contacts the wall of the casing to prevent the corner 25 of the notch from digging into the wall. This condition obtains since the inclined face 26 or the heel 27 is then disposed radially outwardly to a further extent than any other parts of the cutter blades. However, with the blades positioned adjacent the enlarged space F between the adjoining casing sections C, D, the fluid pressure acting on the piston 16 will swing the blades 12 outwardly to a further extent, as permitted by the enlarged space F, in which position the corners 25 of the blades are disposed outwardly to the greatest extent.

The tool A is lowered in the casing until the cutter blades are positioned in the casing section C immediately above the one D that is to be removed. The pumps at the surface of the well bore are then started to exert a hydraulic force on the piston 16 and expand the blades 12 outwardly against the wall of the casing section. As indicated above, the inclined surfaces 26 or heels 27 of the blades will ride upon the casing section C, preventing the blades from digging into the casing and allowing the tool to be lowered therewithin. As this lowering proceeds, the blades will come adjacent the space F between the adjoining casing sections C, D, allowing the corners 25 to snap into this enlarged space and occupy the outermost position referred to above. Continued lowering of the drilling string and tool thereafter causes the corners to seat upon the top end of the removable casing section D, thus preventing further downward movement of the tool. As a result, the operator is apprised of the fact that the cutting blades are positioned at the top of the section which is to be removed, whereupon rotation of the tool will be undertaken to effect severing of the section D from its collar, horizontal extension of the blades 12, and the progressive drilling up of the casing or liner section D.

From the foregoing description, it is apparent that a device has been provided which is capable of positively locating the ends of casing sections and liners, thereby eliminating guesswork as to the depths of such terminals in the well bore, and the position of the cutter blades of the drilling tool with respect thereto.

I claim:

1. A pipe cutting tool, including a body adapted to be connected to a drilling string, cutter means carried by said body, means for moving said cutter means laterally of said body for cutting operation upon a pipe positioned in a well bore, and means on said cutter means removed from a pipe cutting portion thereof for positively locating an end of said pipe within said well bore.

2. A pipe cutting tool, including a body adapted to be connected to a drilling string, cutter means carried by said body, means for moving said cutter means laterally of said body for cutting operation upon a pipe positioned in a well bore, and means on said cutter means removed from a pipe cutting portion thereof cooperable with an end of said pipe for positively arresting downward movement of said tool within said well bore.

3. A pipe cutting tool, including a rotatable body adapted to be connected to a drilling string, cutter means normally carried by said body in retracted position, means for moving said cutter means outwardly of said body for cutting operation upon a pipe within which said tool is adapted to be positioned, means on said cutter means cooperable with an end of said pipe upon outward expansion of said cutter means for positively arresting downward movement of said tool within said pipe, and means for returning said cutter means to its retracted position and for holding it in such retracted position.

4. A pipe cutting tool, including a rotatable body adapted to be connected to a drilling string,

cutter means normally carried by said body in retracted position, means for moving said cutter means outwardly of said body for cutting operation upon a pipe within which said tool is adapted to be positioned, and means on said cutter means spaced from the bottom cutting edge thereof and cooperable with an end of said pipe upon outward expansion of said cutter means for positively stopping downward movement of said tool within said pipe.

5. A pipe cutting tool, including a rotatable body adapted to be connected to a rotatable drilling string, cutter means normally carried by said body in retracted position, means for moving said cutter means outwardly of said body for cutting operation upon a pipe within which said tool is adapted to be positioned, and a corner on said cutter means spaced from the bottom cutting edge thereof and cooperable with an end of said pipe upon outward expansion of said cutter means for positively stopping downward movement of said tool within said pipe.

6. A pipe cutting tool, including a rotatable body adapted to be connected to a rotatable drilling string, a cutter blade normally carried by said body in retracted position, means for moving said blade outwardly of said body for cutting operation upon a pipe within which said tool is adapted to be positioned, said blade having a corner spaced from its bottom cutting edge which is engageable with an end of said pipe upon outward expansion of said blade for positively stopping downward movement of said tool within said pipe, and said blade having means thereon engageable with said pipe for preventing contact between said corner and the inner wall of said pipe.

7. A pipe cutting tool, including a rotatable body adapted to be connected to a rotatable drilling string, a cutter blade pivotally mounted on said body in retracted position, means for swinging said blade outwardly of said body for cutting operation upon a pipe within which said tool is adapted to be positioned, said blade having a corner spaced from its bottom cutting edge which is engageable with an end of said pipe upon outward expansion of said blade for positively stopping downward movement of said tool within said pipe, said blade having a tapered surface engageable with said pipe for preventing contact between said corner and the inner wall of said pipe.

8. A pipe cutting tool, including a rotatable body adapted to be connected to a rotatable drilling string, a cutter blade pivotally mounted on said body in retracted position, means for swinging said blade outwardly of said body for cutting operation upon a pipe within which said tool is adapted to be positioned, said blade having a notch in one of its cutting edges providing a corner engageable with an end of said pipe upon outward expansion of said blade for positively stopping downward movement of said tool within said pipe, said blade having a tapered surface extending between said corner and an upper blade cutting edge which is engageable with said pipe for preventing contact between said corner and the inner wall of said pipe.

9. A pipe cutting tool, including a rotatable body adapted to be connected to a rotatable drilling string, a pair of cutter blades pivotally mounted on said body in retracted position for swinging movement about a common axis, means for simultaneously swinging said blades outwardly of said body in opposite directions for cutting operations upon a pipe within which said tool is adapted to be positioned, each of said blades having a corner spaced from its bottom cutting edge engageable with an end of said pipe upon outward expansion of said blade for positively stopping downward movement of said tool within said pipe, each of said blades having a tapered surface extending between its top and side cutting edges which is engageable with said pipe for holding said corner inwardly of the wall of said pipe.

10. A pipe cutting tool, including a rotatable body adapted to be connected to a rotatable drilling string, a pair of cutter blades pivotally mounted on said body in retracted position for swinging movement about a common axis, hydraulically actuated means for simultaneously swinging said blades outwardly of said body in opposite directions for cutting operations upon a pipe within which said tool is adapted to be positioned, each of said blades having a notch in one of its cutting edges providing a corner engageable with an end of said pipe upon outward expansion of said blade for positively stopping downward movement of said tool within said pipe, each of said blades having a tapered surface extending between said corner and its upper cutting edge which is engageable with said pipe for holding said corner inwardly of the wall of said pipe.

11. A pipe cutting tool, including a body adapted to be connected to a drilling string, cutter means carried by said body, hydraulically operated means comprising cylinder and piston instrumentalities for moving said cutter means laterally of said body for cutting operation upon a pipe positioned in a well bore, and means on said cutter means for positively locating an end of said pipe within said well bore.

12. A pipe cutting tool, including a body adapted to be connected to a drilling string, cutter blades carried by said body, means for moving said cutter blades in different directions laterally of said body for cutting operation upon a pipe positioned in a well bore and for centering said body in said pipe, and means on at least one of said cutter blades for positively locating an end of said pipe within said well bore.

13. A pipe cutting tool, including a body adapted to be connected to a drilling string, a cutter blade carried by said body in retracted position with its cutting portion extending generally vertically of said body, means for moving said cutter blade laterally of said body to place said cutting portion in a generally horizontal position for cutting operation upon a pipe within a well bore, and means on said cutter blade removed from its cutting portion for positively locating an end of said pipe within said well bore.

14. A pipe cutting tool, including a body adapted to be connected to a drilling string, cutter means carried on said body in retracted position, means for moving said cutter means laterally of said body for cutting operation upon a pipe within a well bore, means on said cutter means for positively locating an end of said pipe within said well bore, and means for returning said cutter means to its retracted position and for holding it in such retracted position.

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