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OUTSIDE PIPE CUTTER

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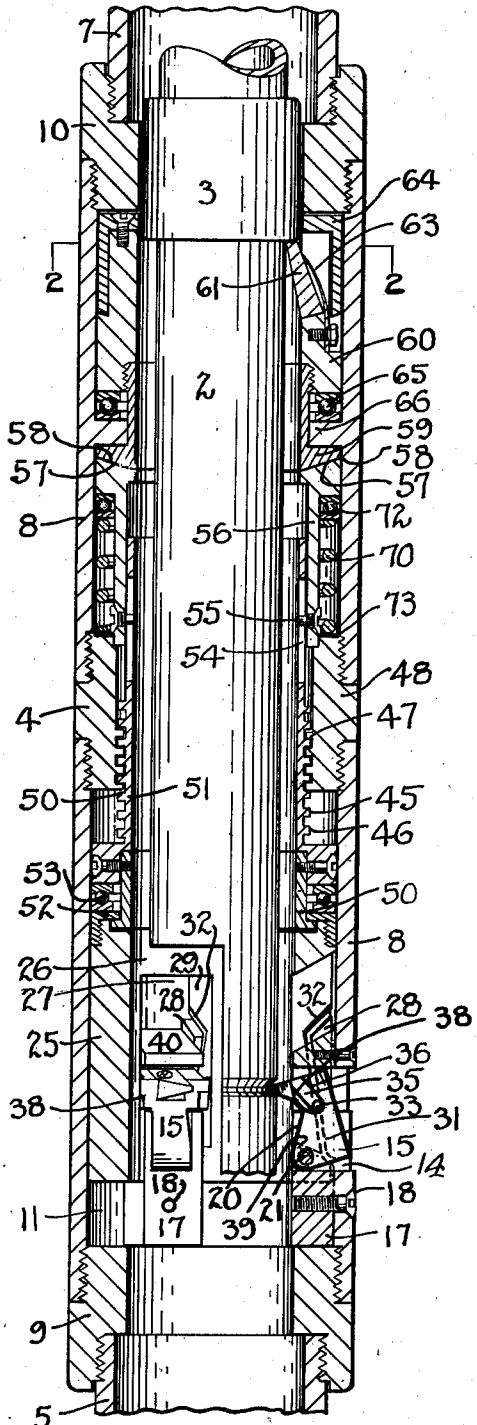


Fig. 1.

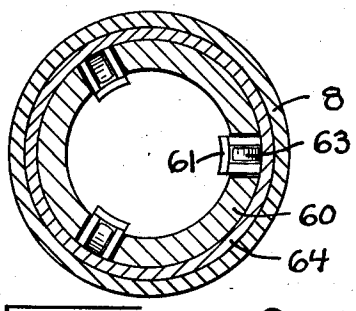


Fig. 2.

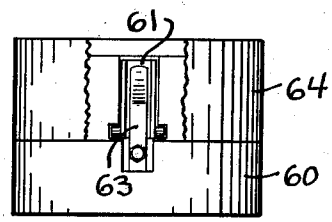


Fig. 3.

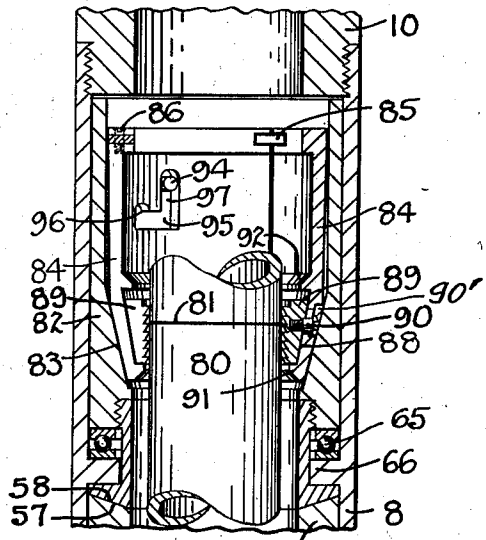


Fig. 4.

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OUTSIDE PIPE CUTTER

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16 Claims. (Cl. 164—0.6)

The invention relates to an outside pipe cutter of the type which is to be lowered into a well bore to telescope over a piece of pipe which is to be cut and removed from the well.

With the present type of outside pipe cutter it will be understood that the well bore is usually full of mud, sand, and other foreign materials so that the cutting operation usually has to be performed in a body of liquid and in many instances the tool and the pipe being cut are not in a vertical position and the pipe may not be centered in the tool so that it is the exception rather than the rule to have the parts in correct alignment and in perfect running order so that all of the cutters will uniformly engage the pipe being cut.

It is not unusual to have the cutter blades gouge or dig into the pipe because of the position of the tool relative to the pipe or because of the nature or condition of the pipe being cut and as a result of other unavoidable circumstances. It is therefore one of the objects of the invention to provide a pipe cutter wherein the cutters will be forced to perform the cutting operation by a differential pressure which is determined by the resistance which is encountered by the cutters.

Another object of the invention is to provide a pipe cutter wherein a drive unit to advance the cutters is advanced in direct proportion to the amount of rotation so long as the resistance to the advancement of the cutter does not exceed a predetermined amount, and to provide an arrangement wherein no further advancement of the cutters will be accomplished until the resistance to advancement decreases below the predetermined value.

Another object of the invention is to provide two friction drives to effect advancement of the cutters which are so arranged that only the differential pressure between the two is available to cause the advancement of the cutters.

Another object of the invention is to provide a rotatable set of cutters whose advancement is effected by the relative rotation of a driving unit.

Still another object of the invention is to provide a driving unit for pipe cutters wherein a slip joint connection is provided so that only a predetermined driving pressure can be applied to the cutters.

It is also an object of the invention to provide a gripping device for a flush joint pipe in order to actuate an outside pipe cutter.

Other and further objects of the invention will be readily apparent when the following description is considered in connection with the accompanying drawing wherein:

Fig. 1 is a central, vertical, sectional view of a pipe cutter embodying the invention and illustrating the arrangement of the parts when a cut has been partially completed.

Fig. 2 is a sectional view taken on the line 2—2 of Fig. 1 and looking downwardly.

Fig. 3 is a side elevation with certain parts broken away in order to illustrate the arrangement of the pipe engaging dogs by which the tool is anchored with respect to the pipe being cut.

Fig. 4 is a sectional, vertical, central view of a modified form of pipe engaging apparatus to be employed when a flush joint pipe is being cut.

The fish or pipe being cut is illustrated generally in Fig. 1 as the pipe 2, and the usual form of such pipe is provided with couplings 3. This pipe for some reason or other may be junked or stuck in a well bore and is to be severed so that it may be removed.

The cutting tool is illustrated generally at 4 and may have any desired type of milling tool or cutter attached to the lower end 5 thereof. The upper end of the tool will be connected to a string of pipe 7 which is known as the operating string and is used to impart rotation to the tool and particularly to the tool housing 8. This housing is preferably located between the couplings 9 and 10 so that an enlarged chamber 11 is formed by the housing. The lower part of this chamber is provided with a lateral opening 14 in which the cutter 15 is positioned. The cutter, however, is pivoted on a supporting rib 17. This rib may be fastened to the housing 8 by screws 18. This rib 17 is slotted at 20 to provide a cutter recess and the transverse pin 21 passes through the sides of the rib and supports the cutter 15 in the position seen in Fig. 1 so that it may oscillate toward and away from the pipe 2.

In the form of the invention shown in Fig. 1 there are three cutters 15 and, of course, three corresponding ribs 17. Intermediate these ribs 17 are the drive wedges or fingers 25 which are arranged for longitudinal movement relative to the housing 8 as will be later described. These fingers 25 are preferably formed integral with a supporting ring 26. The top of the space between the fingers 25 is indicated at 27.

The edges or sides of these fingers 25 are peculiarly formed with a longitudinal outstanding shoulder 28 which constitutes a wedge for causing advancement of the cutters. This shoulder

extends out from the normal face 29 of the edge of the finger 25 but is gradually tapered so that it becomes thinner and terminates in a rather sharp lower edge 31.

Formed in the face 29 directly in front of the wedge 28 is a control slot 32 which is arranged to receive a lug 33 which is formed on the side of the cutter 15 on the outermost portion of the ear 35. This ear 35 has a beveled upper face 36 which is arranged to be abutted by the wedge 28 to force the cutter to pivot inwardly. The lug 33 travels in the slot 32, however, and prevents the cutter from advancing further than it is driven inwardly by the wedge 28. This prevents the cutter going into the pipe more than a predetermined amount so that the cutters will not take too large a bite into the metal and become broken. The particular configuration of the slot 32 should be noted because when it reaches the top of the wedge 28 it is deflected outwardly again so as to cause the cutters to move back into the recess 14 so as to withdraw the cutters from engagement with the pipe. Both edges of each finger 25 are formed with the wedge 28 and slot 32 so that the cutter is confined in its proper position and supported at each side.

The under face 38 of the cutter is arranged to abut the beveled face 39 which is also formed on the edge 29 of the fingers 25. This engagement prevents the cutter from dropping inwardly while the tool is being lowered into position and only permits it to be advanced inwardly after the face 39 has moved downwardly away from the face 38 upon downward movement of the fingers 25.

A protective shoulder 40 is carried by the housing 8 and positioned directly above the recess 14 so that the cutter cannot be injured as it is being lowered into or raised from the well bore. It will be understood that this shoulder 40 is positioned directly between the fingers 25 so that they can slide longitudinally on each side of this lug and the cutters 15.

In order to effect longitudinal movement of the wedge 28 to cause advancement of the cutter the fingers 25 and the head 26 are caused to move longitudinally of the housing 8 by means of the threaded friction drive 45. It will be noted that the threads 46 are of the acme square shoulder type so that considerable force can be exerted thereby. These threads 46 are arranged to engage corresponding threads 47 which are carried by the coupling 48 which is part of the housing 8. The friction drive 45 is a part of the entire drive unit 50 which is made up of the fingers 25 and the head 26 which are connected to a sleeve 51 by means of the interlocking ring 52. This arrangement forms a shoulder to receive the anti-friction bearing 53 so that the head 26 and fingers 25 may rotate with respect to the sleeve 51.

The sleeve 51 continues above the threads 46 and is provided with a plurality of slots 54 which receive the pins 55 carried by the slip joint head 56. In this manner the sleeve 51 may have relative longitudinal movement with respect to the slip joint head 56 but may not rotate relative thereto.

The slip joint head 56 is arranged with a friction surface 57 which is adapted to engage a similar and corresponding friction surface 58 which is carried by the ring 59. This ring 59 is fastened to a bushing 60 which carries a plurality of dogs 61 which are arranged to engage under the coupling 3. The springs 63 are positioned in the bushing 60 behind the dogs 61 to cause them to extend forwardly and click underneath the coupling 3 so that they will always be pressed into position. A cap 64 may be positioned over the dogs in order to protect them against injury.

An antifriction bearing 65 is positioned beneath the bushing 60 and directly above the shoulder 66 which is formed on the inside of the housing 8. A compression spring 70 is arranged between the slip joint head 56 and the coupling 58 in order to apply the desired upward pressure to the slip joint head 56. An antifriction bearing 72 may be provided between the spring and the slip joint head.

When a cut is to be made the parts are assembled as shown and lowered into the well until the dogs 61 click beneath a coupling such as 3 which is most closely adjacent the elevation where the cut is to be performed. In many instances the cutting tool is rotated by the string of pipe 7 as it is lowered into the well and telescopes over as much pipe which is to be recovered as possible. Different sized pipe and the conditions encountered in the well determine the maximum amount of pipe which can be cut and removed satisfactorily.

When the dogs 61 have clicked under the coupling 3 the entire tool is raised until the dogs are engaged firmly underneath the lower end of the coupling as seen in Fig. 1. The desired strain or pull is then exerted on the pipe 7 so as to insure the desired frictional contact between the dogs 61 and the collar 3, and to also insure that the entire tool will remain at the desired elevation so that an accurate cut may be made.

The next operation is to begin rotation of the string of pipe 7 and consequently the rotation of the housing 8 and the cutters 15. It will be understood, however, that the bushing 60 remains stationary because of the engagement of the dogs 61 with the coupling 3. The thrust due to the strain on the operating pipe 7 is transferred to the bushing 60 through the antifriction bearing 65 which is resting on the shoulder 66. In this manner the ring 59 is, of course, fixed to the bushing 60 and remains stationary therewith.

The spring 70 exerts an upward pressure on the bearing 72 so that the slip joint head 56 is pressed upwardly against the ring 59 so that there is a frictional contact or drive between the faces 57 and 58 which constitutes the slip joint connection. Due to this friction between the faces 57 and 58 the slip joint head 56 will have a tendency to remain stationary with the dogs 61. The pins 55 compel the sleeve 51 to remain stationary. The fingers 25 while connected to the sleeve 51 insofar as longitudinal movement is concerned, are free to rotate with the housing 8 and the cutters 15 because of the fact that they are straddling the ribs 17.

With the housing 8 caused to rotate by the string of pipe 7 and the sleeve 51 caused to remain stationary because of the dogs 61, it seems obvious that there will be relative rotation between the threads 46 and 47 so that the sleeve 51 will be caused to move downwardly with the slot 54 sliding on the pins 55 and fingers 25 moving downwardly with respect to the ribs 17 and the cutter 15. This downward movement of the fingers 25 causes the wedge 28 to move downwardly relative to the ears 36 so that the thicker portion of the wedge gradually moves in behind

the ear and causes the cutter to move forward on the pin. The initial downward movement of the fingers 25 moves the face 39 away from the face 38 so that the cutters are unlocked. The lugs 33 travel in the slot 32 and prevent the cutter from dropping downwardly or traveling faster than they are forced forwardly by the wedge 28.

It seems obvious that so long as the cutters 15 do not encounter any unexpected resistance that the dogs 61 will remain stationary and the friction faces 57 and 58 will be held together with a sufficient pressure because of the spring 70 to hold the sleeve 51 against rotation. Thus the threads 46 will be caused to travel downwardly relative to the threads 47 and the housing 8 and the cutters will be advanced forwardly in direct proportion to the amount of rotation of the housing 8 which rate of advancement depends upon the pitch of the threads 46 and 47.

The particular novelty of the present invention resides in the arrangement of the slip joint connection between the faces 57 and 58 when considered in combination with the threads 46 and 47. As previously pointed out a great many cutters in tools of this type have been broken because of the fact that the tool is compelled to operate in a body of slush and grit with its particular position unknown to the operator. If the cutter gouged into the pipe the operator was not aware of the fact and the cutter would be broken which necessitated the removal of the tool and replacement of the cutter. Where the hole is very deep this operation might require half a day or more, with the possibility of losing the fish. These two frictional surfaces, which for the purpose of description may be described as the slip joint drive between the faces 57 and 58, and frictional connection between the threads 46 and 47, will be opposed to each other in compelling advancement of the cutters.

The provision of these two friction surfaces is designated as a differential drive for the cutters because so long as the cutters are taking a normal bite into the pipe they will be caused to advance in direct proportion to the amount of rotation of the housing 8. If, however, difficult cutting is encountered or the tool is off-center so that some one cutter is compelled to carry more than its share of the load, it is then desirable to retard the advancement of the cutters, while continuing their rotation, until the area causing the difficulty has been negotiated.

It seems obvious that the slip joint friction drive is the controlling factor of the advancement of the cutters, whereas the friction drive connection controls the amount of advancement.

When the cutters are pressed against the pipe there will be, of course, a resistance to downward movement by the wedge 28. This resistance is transmitted to the sleeve 51 in the form of a resistance against downward movement; that is, relative rotation between the housing 8 and the sleeve 51. The friction necessary to compel this downward movement is transmitted from the threads 47 to the threads 46 and constitutes a friction connection. The reaction of this connection, however, is transmitted from the sleeve 51 to the pins 55 and directly to the slip joint friction drive between the faces 57 and 58. The friction itself exerted on these faces is a direct force which results from the amount of resistance to advancement encountered by the cutters.

The spring 70 may be adjusted by using any desired strength of spring, or shims 72 may be positioned under the lower end of the spring where it abuts against the coupling 48 in any desired amount. The pressure which the spring will exert on the slip joint head 56, and accordingly the thrust which can be transmitted by the slip joint friction connection, can in this manner be controlled or varied as desired. Various sized tools will have various strength springs and the desired adjustment may in this manner be obtained.

It seems obvious that two friction differential surfaces are provided to withstand the resistance to advancement encountered by the cutters. The direct thrust will be from the cutters to the slip joint connection. So long as the friction between the faces 57 and 58 is greater than the resistance encountered by the cutters the slip joint head 56 will remain stationary so that the threaded connection will cause advancement of the sleeve 51 and the cutting will proceed in a uniform manner. If one of the cutters should gouge the pipe, a pit or pocket be encountered, or for any other reason a shock is imparted to one of the cutters so that it cannot rotate, the force of this shock is transmitted to the friction faces 57 and 58, and if the shock is greater than the amount which can be resisted because of the setting of the spring 70, then the slip joint head 56 will rotate relative to the ring 59 and this joint will slip.

As soon as the head 56 begins to rotate the sleeve 51 will, of course, rotate with it and there will be a corresponding reduction in the rate of advancement of the wedge 28 and the cutters 15. If the resistance to advancement encountered by the cutters is great enough so that it overcomes the friction between the faces 57 and 58, then the entire drive unit assembly with the exception of the dogs 61 and the ring 59 will rotate with the housing and there will be no advancement of the cutters whatever.

During this action the threads 46 and 47 rotate together without relative movement. This spinning action may continue until the resistance encountered by the cutters has been overcome. Thus, if a hard portion of pipe is encountered the operator may continue his rotation until this hard portion of pipe has been cut away because the slip joint connection is constantly urging the cutters to advancement by a pressure which is determined by the set of spring 70, and whether or not there is an advancement depends upon the amount of friction which can be transmitted by the threads 46 and 47, so that the advancement is controlled by the resistance encountered and there is, therefore, a differential pressure always tending to advance the cutters and in many instances conditions will be encountered wherein the rate of advancement of the cutters will be very slow as compared with the rate of rotation. A very fine adjustment can be accomplished with this type of structure and the advancement of the cutters may be either uniform in direct proportion to the rotation or uniform as a function of the resistance encountered, or they may be subjected to no advancement whatever, entirely dependent upon the conditions under which the cut is being effected.

It has been found in actual practice that cutters driven in this manner are exceptionally satisfactory and breakage of the cutters has been practically eliminated. On the other hand a satisfactory cut can be negotiated because it is only accomplished by virtue of a differential pres-

sure which is resiliently applied so that it will yield to pressure and avoid undue stresses being applied to the cutters.

In some instances the fish 2 or pipe being cut is not provided with couplings 3 under which the dogs 61 may be anchored and Fig. 4 of the drawing shows a somewhat modified form of pipe engaging portion of the tool which can be employed when this flush joint pipe is being cut.

The pipe to be cut is illustrated at 80 and the flush joint at 81. The housing 8, slip joint head 56, the shoulder 66, and the antifriction bearing 65 are all identically the same as shown in Fig. 1. The bushing 60, however has been modified somewhat and is shown at 82 as having a tapered seat 83 thereon. This seat is arranged to receive three segments 84 which are loosely formed together by a toggle plate 85. This plate is held in position by small screws 86 so that the three sections 84 have limited relative vertical and lateral movement with respect to each other so that they can accommodate themselves to the tapered seat 83. Each of these segments is formed with an inside beveled face 88 which is arranged to carry a jaw 89. This jaw is held in position for limited sliding movement by means of the pin 90 which is movable in a slot 90' in the segment. The lower ends of the jaws are protected by an outstanding shoulder 91 and the upper ends are protected by a similar shoulder 92.

The housing 8 carries one or more inwardly projecting pins 94 which are received in a J-slot 95. The short leg 96 of this slot ordinarily receives the pin 94 when the device is being lowered into the hole because this holds the pipe engaging assembly upwardly so that the segments are not forced toward the center by the beveled face 83. When the elevation where the pipe is to be engaged has been reached the operating string of pipe 7 is rotated sharply a portion of a revolution so that the pin 94 is jerked out of the leg 96 of the J-slot and will move over to the long leg 97 so that the slip assembly will drop downwardly relative to the housing 8. In this manner the segments are forced inwardly by the beveled slip 83 and slight upward pull on the entire tool causes the jaws 89 to grip the pipe. So long as the strain is maintained on the operating string the tool is anchored in position.

This jaw assembly serves the same purpose as the anchoring dogs 61 in order to provide a resistance to rotation for the slip joint friction drive.

What is claimed as new is:

1. An outside pipe cutting tool comprising a housing, cutter blades therein, means to advance said cutters, a drive thread connection between said housing and said means to effect longitudinal movement upon relative rotation, pipe engaging members tending to restrain said means against rotation, and a slip joint drive between said members and said means whereby the resistance encountered by said cutters if less than the friction drive of said slip joint will effect advancement of the cutter and if greater than such friction will cause slipping of said joint.

2. A differential drive outside pipe cutter including a rotatable set of cutters, a stationary drive unit therefor adapted to engage the outside periphery of the pipe to be cut, a friction drive in said unit, and a friction drive connection between said unit and said cutters, said two friction drives being arranged so that when a predetermined resistance to rotation is encountered by said cutters said first mentioned friction drive will slip and cause said friction connection to be ineffective.

3. In an outside pipe cutting tool, means to engage the pipe being cut to anchor said tool, a slip joint friction drive abutting said anchor, a threaded connection between said drive and said tool, cutter members movable with said tool, and wedge means connected to said drive to advance said cutter members, said threaded connection being controlled to advance said wedge only when the resistance to advancement is less than the friction of said slip joint drive.

4. In an outside pipe cutting tool, means to engage the pipe being cut to anchor said tool, a slip joint friction drive abutting said anchor, a threaded connection between said drive and said tool, cutter members movable with said tool, and wedge means connected to said drive to advance said cutter members, said threaded connection being controlled to advance said wedge only when the resistance to advancement is less than the friction of said slip joint drive, and additional means to vary the friction of said slip joint drive.

5. In an outside pipe cutting tool having an anchor and cutters, a pair of friction driving connections located outside of the pipe to be cut and adapted to advance the cutters to working position, and means to transmit the thrust of said cutters to said connections so that the cutters are advanced only when the resistance to advancement is less than the friction of one of said connections.

6. In a pipe cutting tool having an anchor and cutters, a drive unit to advance the cutters, a slip joint connecting said unit to said anchor, means to vary the frictional drive of said joint, a threaded connection between said unit and said tool to move said unit to advance said cutters, said threaded connection being operative to advance said cutters only when said slip joint exerts a friction in excess of that imparted to the cutters by said threaded connection.

7. In a pipe cutting tool having an anchor and cutters, a rotatable housing, a drive unit threaded thereto to advance the cutters by screwing of said threads, and a friction connection between said anchor and unit to control the screwing of said threads, as a function of the resistance encountered by said cutters.

8. In a pipe cutting tool having an anchor and cutters, a rotatable housing, a drive unit threaded thereto to advance the cutters by screwing of said threads, and a friction connection between said anchor and unit to control the screwing of said threads by the differential pressure between said friction connection and the resistance encountered by the cutters.

9. In a pipe cutting tool having an anchor and cutters, a drive unit having a friction connection normally held stationary by said anchor, and a friction connection having a threaded portion, a threaded member cooperating with said threaded connection to advance said cutters, the threads of said threaded members cooperating to provide a friction connection between said cutters and unit to advance the cutters as a function of the differential pressure between said first friction connection and the resistance against said threaded means by said cutters.

10. In a pipe cutting tool having an anchor and cutters, a drive unit having a friction connection normally held stationary by said anchor, and a friction connection having a threaded portion, a threaded member cooperating with said threaded connection to advance said cutters, the threads

of said threaded members cooperating to provide a friction connection between said cutters and unit to advance the cutters as a function of the differential pressure between said first friction connection and the resistance against said threaded means by said cutters whereby shocks or excessive loads may be transferred from said cutters to said first friction connection.

11. In a pipe cutting tool having an anchor and cutters, a body, a bushing mounted thereon, said anchor including pipe engaging slips mounted on said bushing, a ring having a friction surface secured to said bushing, and means operatively connected to said cutters and frictionally engaging said surface to provide a friction connection between the anchor and cutters.

12. In a pipe cutting tool having an anchor and cutters, a body, a bushing rotatably mounted thereon, said anchor including pipe engaging slips mounted on said bushing, a ring having a friction surface secured to said bushing, and means operatively connected to said cutters and frictionally engaging said surface to provide a friction connection between the anchor and cutters.

13. In a pipe cutting tool, a body, cutter members mounted in said body, a bearing surface on said body, a bushing mounted thereon, pipe engaging slips mounted on said bushing, and a ring having a friction surface mounted on said bushing, and means operatively connected to said cutters and frictionally engaging said surface to provide a friction connection between the anchor and cutters.

14. In a pipe cutting tool having an anchor and cutters, a body, a bushing rotatably mounted thereon, said anchor including pipe engaging slips mounted on said bushing, a drive sleeve threaded to said body to advance the cutters by relative rotation of the sleeve and body, and a friction connection between said sleeve and said bushing.

15. In an outside pipe cutting tool, a body, cutters in said body, a bushing having a tapered seat rotatably mounted in said body above said cutters, jaw carrying means slidably mounted within said bushing and adapted to move inwardly upon said tapered seat, and means for releasably holding said jaw carrying means from inward movement.

16. In an outside pipe cutting tool, a body, cutters movably mounted in said body, a bushing having a tapered seat rotatably mounted on the body, jaw carrying means slidably mounted within said bushing and adapted to move inwardly upon said tapered seat and means on said body for engaging said bushing to hold said jaw means from anchoring position and releasable by rotation of said body to allow anchoring of the tool by said jaw means.

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