

Oct. 20, 1942.

R. E. CONNER

2,299,528

CASING MILL

Filed Sept. 22, 1941

2 Sheets-Sheet 1

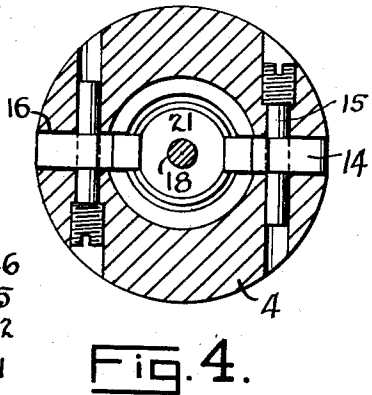
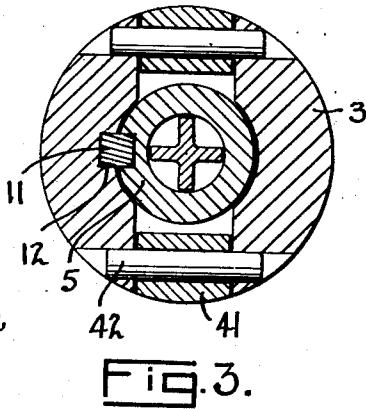
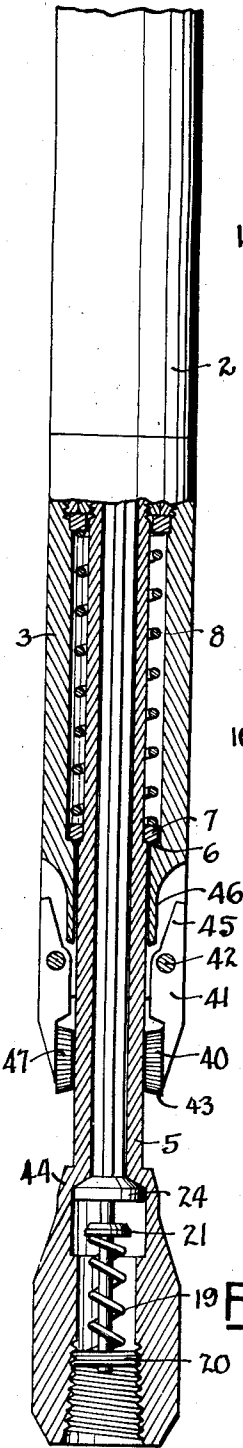
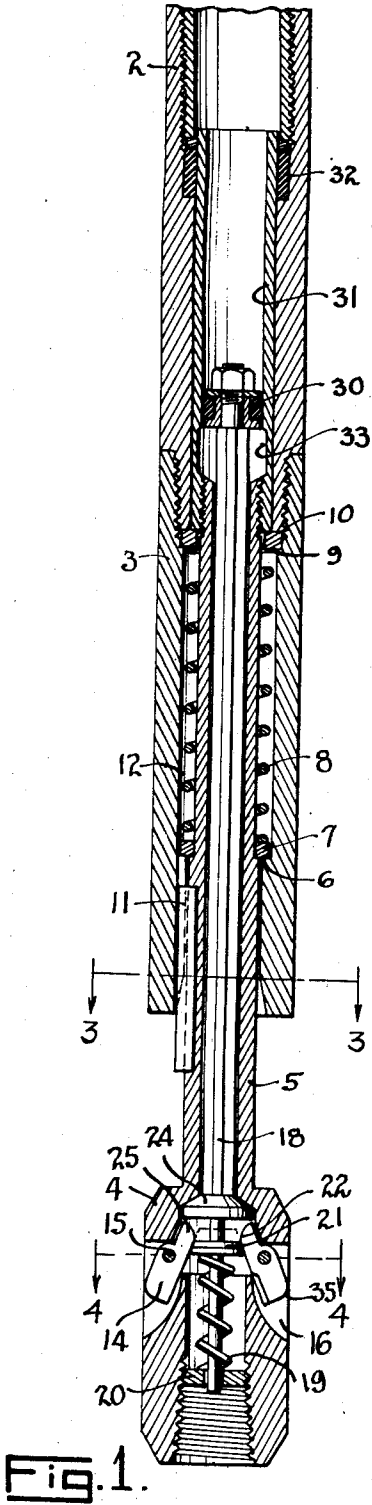


Fig. 2.

RAY E. CONNER
INVENTOR.

Lester B. Clark.
ATTORNEY.

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2 Sheets-Sheet 2

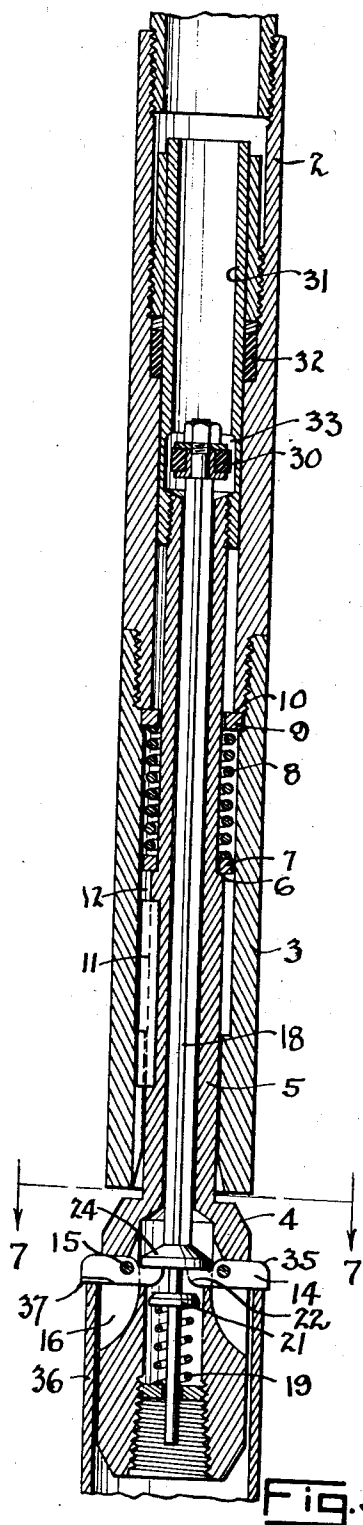


Fig. 5.

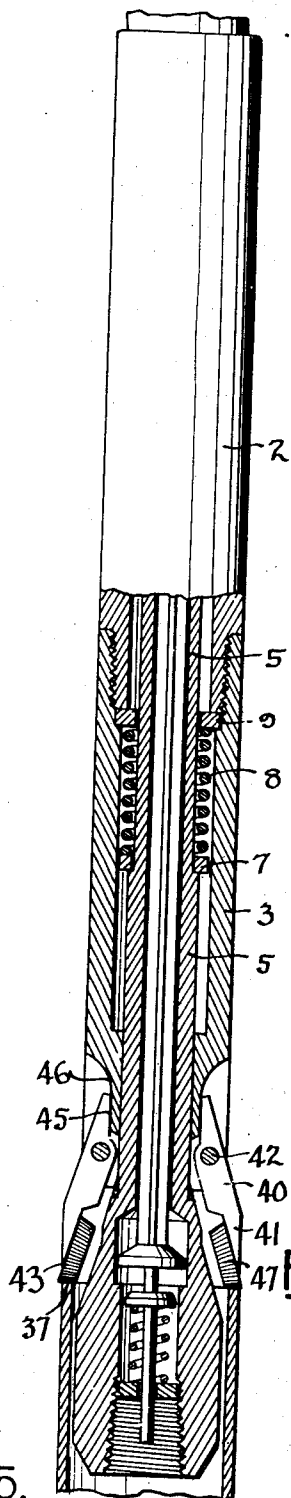


Fig. 6.

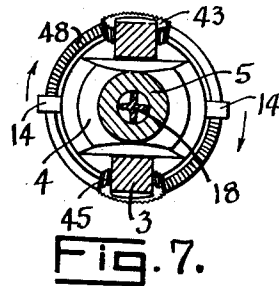


Fig. 7.

RAY E. CONNER.
INVENTOR.

Lester B. Clark

ATTORNEY.

UNITED STATES PATENT OFFICE

2,299,528

CASING MILL

Ray E. Conner, Houston, Tex.

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10 Claims. (Cl. 164—0.7)

The invention relates to a casing mill, and particularly to a mill to be used in a well bore for milling pipe or casing.

In many instances in well drilling and producing operations it is desirable to cut a string of pipe either by severing it into two pieces so that one portion may be removed, or in other instances it is desirable to entirely remove a section of the pipe for carrying on desirable operations at that elevation in the well where the pipe has been removed.

In operating milling tools in a well bore considerable difficulty has been encountered in applying a predetermined or proper amount of weight or force upon the cutting members to accomplish the cutting action. It will be appreciated that a long string of pipe suspended in a well bore is subject to considerable stretch and it is difficult to know at the surface exactly how much weight is being applied to the cutters. The string of operating pipe has considerable weight and it is only necessary to apply a small portion of this weight to the cutters. If an excess of weight or force is applied, the cutters may be broken or damaged or be caused to cut into the pipe being severed by cutting too great an amount.

It is also one of the objects of the present invention to provide a milling cutter wherein only a predetermined force is applied to the cutters and wherein any excess is then taken by additional roller or supporting members carried by the operating pipe. In this manner only a predetermined force is applied to the cutters and damage or injury is avoided.

Another object of the invention is to provide a casing mill with a retractible head so that a predetermined force can be provided which will tend to force the cutters against the work.

Another object of the invention is to provide a casing mill with a housing and sliding cutter head so that the housing may contact the cutting facing and absorb all but a predetermined portion of the load applied through the operating pipe.

Still another object of the invention is to provide alternate cutters and rollers in a casing mill so as to roughen the working face to permit the cutters to obtain a greater bite.

Still another object of the invention is to provide an actuating mechanism for the cutters of a casing mill so that a signal will be given to the surface by a variation in hydraulic pressure to indicate when the cutters are extended.

Another object of the invention is to provide a

casing mill with extensible cutters and supporting rollers.

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

Fig. 1 is a vertical sectional view through the tool ready to be lowered into the well bore with the section taken on the line of the cutters.

Fig. 2 is a view similar to Fig. 1, but with the section taken at right angles to the section of Fig. 1.

Figs. 3 and 4 are sections taken on the lines 3—3 and 4—4 respectively of Fig. 1.

Figs. 5 and 6 are sectional views corresponding to Figs. 1 and 2, respectively, but illustrating the tool as being extended and in operating position.

Fig. 7 is a section taken on the line 7—7 of Fig. 5.

The tool of the present invention is to be lowered into the well bore by means of an operating string of pipe 2 which may be of any length in order to lower the tool to the desired elevation in the well bore. This pipe carries a housing 3, which is hollow and arranged to telescopically receive a cutter head 4.

The cutter head 4 has a stem 5 thereon which extends into the housing 3. This stem has a shoulder 6 carrying a thrust ring 7 which is engaged by the lower end of a coil spring 8. The upper end of this spring engages a thrust ring 9 on the shoulder 10 inside of the housing so that the spring normally tends to thrust the cutter head 4 to the extended position shown in Fig. 1. A key or spline 11 moving in the groove 12 in the housing tends to hold the cutter head 4 non-rotatably in the housing.

This cutter head has a set of cutter members 14 pivoted on the shafts 15 in the lower end thereof. These cutters work in the recesses 16 so that they are extensible in the position shown in Fig. 5.

In order to actuate the cutters 14, a plunger 18 is slidably arranged inside of the head and stem and is normally urged upwardly by a spring 19 engaging against a plate 20 in the head. This plunger carries a flange 21 which engages the heel portion 22 of each of the cutters to urge the cutters to retracted position, as seen in Fig. 1. An upper flange 24 is also carried by the plunger 18 and is arranged to engage the upper surface 25 of the heels 22 so as to move the cutters to extended positions when the plunger moves downwardly, as seen in Fig. 5.

In order to actuate this plunger a piston 30 is

attached to the upper end thereof and is arranged to move in a working barrel 31, which is attached to the upper end of the stem 5. A suitable packing 32 prevents leakage of fluid past the working barrel.

It seems obvious that when hydraulic pressure is applied through the operating pipe 2, that such pressure will engage the piston 30 and cause it to move downwardly to the position shown in Fig. 5, where such plunger has moved into an enlarged portion 33 in the working barrel so as to permit the by-passing of some of the fluid.

When the piston moves to the position of Fig. 5 there will be a reduction in the resistance to the flow of fluid so that there will be a drop in pressure at the surface and the operator will thus receive an indication that his cutters have been extended.

The toe portion 35 of each of the cutters constitutes a cutting edge so that as they are pivoted outwardly from the position of Fig. 1 to the position of Fig. 5, they will contact the inside surface of the pipe 36 which is to be cut. In this way the hydraulic pressure can be used to force the cutters outwardly to penetrate the pipe and make the initial cut. During this initial cutting operation the operating pipe 2 will be rotated to rotate the cutter head, but the pipe will be held at a constant elevation until such time as the piston 30 moves into the opening 33 to signal the operator that his cutters are fully extended.

Where it is desired to cut away any considerable length of the pipe 36 so as to leave an open portion in the well bore, or for any other reason, it is desirable to more than just sever the pipe it is necessary to apply considerable weight to the cutters in order to accomplish the cutting action. Overloading of the cutters however may break the cutters, and with this in mind a special construction has been arranged upon the housing 3.

It seems obvious that the spring 8 may be of a desired strength such as to apply the desired pressure to the cutters and the cutter head upon the face 37 which is being cut on the upper end of the pipe 36, as seen in Fig. 5. Thus, when the cutters 14 have been extended, the operating pipe 2 will be lowered somewhat so as to compress the spring 8, and in this manner apply a load to the cutters. The exact elevation of the cutting tool in the well is not known at the surface because of the stretch of the string of pipe hanging in the well, and therefore the exact amount of lowering which will apply the desired load upon the cutters can hardly be estimated from the surface. The torque applied to a string of pipe may also change its length as the long operating pipe winds up several turns or revolutions when a pipe is being cut.

With a view, therefore, of arranging a construction so that the operator can predetermine the amount of load to be applied to the cutters and to avoid overloading the cutters, the lower end of the housing 3 has been equipped with a set of rollers or supports 40. These supports are in the form of arms 41 pivoted at 42 and carrying the roller members 43, as best seen in Fig. 2. These supporting arms are normally retracted, as seen in Fig. 2, so that the tool may be lowered into position. After the cutters have been extended, as seen in Fig. 5, then the operating pipe is lowered to compress the spring 8, and as this pipe moves downwardly, the supporting rollers will engage the inclined face 44 on the cutter head so that these supporting arms will be pivoted outwardly to the position shown in Fig. 6. In this

position the shank portions 45 of the support arms engage the face 46 on the housing to limit the outward movement of the support arms. As will be seen in Fig. 6, the rollers 43 now rest upon the face 37 being cut by the cutters 14.

The only force applied to the cutter head and the cutters is therefore the force of the spring 8 which is now compressed. Any additional weight or force due to the lowering of the operating pipe 2, will be taken by the rollers riding on the face 37. In this manner only a predetermined load can be applied to the cutters and any injury or damage to the cutters will be avoided.

It will be noted that the rollers 43 are toothed or roughened at 47 so that they will bite into the surface 37 and roughen the surface, as seen at 48 in Fig. 7, just ahead of the cutters 14. This will permit the cutters to take a greater bite and speed up the cutting action.

When sufficient cutting has been accomplished, it is only necessary to lift up on the operating pipe 2 and to cut off the flow of hydraulic pressure, whereby the cutters will be retracted by the plate 21 and returned to the position of Fig. 1, and the supporting arms will return to the position of Fig. 2.

Broadly, the invention contemplates a casing mill wherein a predetermined load is arranged to the cutters, and wherein a signal is rendered to the operator to indicate that his cutters are extended.

What is claimed is:

1. A casing milling tool to penetrate and cut away a section of pipe or casing in a well bore comprising a housing, a set of roller mills thereon, a cutter head carried by said housing, cutter members on said head, a plunger carried by said head and operable by hydraulic pressure to extend said cutters, said roller mills being adapted to support said tool by engaging a surface formed by said cutters and a telescoping connection between said housing and head with means therebetween so that only a predetermined force is applied to said cutters.

2. A casing milling tool to penetrate and cut away a section of pipe or casing in a well bore comprising a housing, a set of roller mills thereon, a cutter head carried by said housing, cutter members on said head, a plunger carried by said head and operable by hydraulic pressure to extend said cutters, said roller mills being adapted to support said tool by engaging a surface formed by said cutters and a telescoping connection between said housing and head with means therebetween so that only a predetermined force is applied to said cutters and any excess of force is carried by said rolling mills.

3. A casing mill including a set of cutters, a set of rollers to contact the surface being cut, an operating pipe connected to said rollers so that the load of the pipe is carried by said rollers, and resilient means to transmit a predetermined force to said cutters.

4. A casing mill including an operating pipe, a set of cutters carried thereby, spring means to transmit a predetermined force from the pipe to the cutters, and roller members to also contact the surface being cut to absorb any additional force so as to protect said cutters.

5. A casing mill including an operating pipe, a set of cutters carried thereby, spring means to transmit a predetermined force from the pipe to the cutters, and roller members to also contact the surface being cut to absorb any additional force so as to protect said cutters, said rollers

being toothed so as to roughen the surface being cut to permit a greater bite by the cutters.

6. A mill for pipe in wells including a housing, a cutter head normally extended therefrom, cutters on said head, a plunger movable in said head by hydraulic pressure to actuate said cutters, and roller supports on said mill to roll on the portion of the pipe being cut to support the load of the tool.

7. A mill for pipe in wells including a housing, a cutter head normally extended therefrom, cutters on said head, a plunger movable in said head by hydraulic pressure to actuate said cutters including means to vary the hydraulic pressure when said cutters are extended, and roller supports on said mill to roll on the portion of the pipe being cut to support the load of the tool.

8. A mill for pipe in wells including a housing, a cutter head normally extended therefrom, cutters on said head, a plunger movable in said head by hydraulic pressure to actuate said cutters including means to vary the hydraulic pressure when said cutters are extended, and roller

means on said housing to roll on the pipe being cut to prevent more than a predetermined load on said cutters.

9. A mill for pipe in wells including a housing, a cutter head normally extended therefrom, cutters on said head, a plunger movable in said head by hydraulic pressure to actuate said cutters including means to vary the hydraulic pressure when said cutters are extended, and means on said housing to prevent more than a predetermined load on said cutters including resilient means and roller members to contact the face being cut.

10. A mill for pipe in wells including a housing, a cutter head normally extended therefrom, cutters on said head, a plunger movable in said head by hydraulic pressure to actuate said cutters to first penetrate the pipe and to retract the cutters upon reduction of the hydraulic pressure, means to support the mill on the pipe being cut, and additional means to resiliently advance said cutters against the pipe.

RAY E. CONNER.