

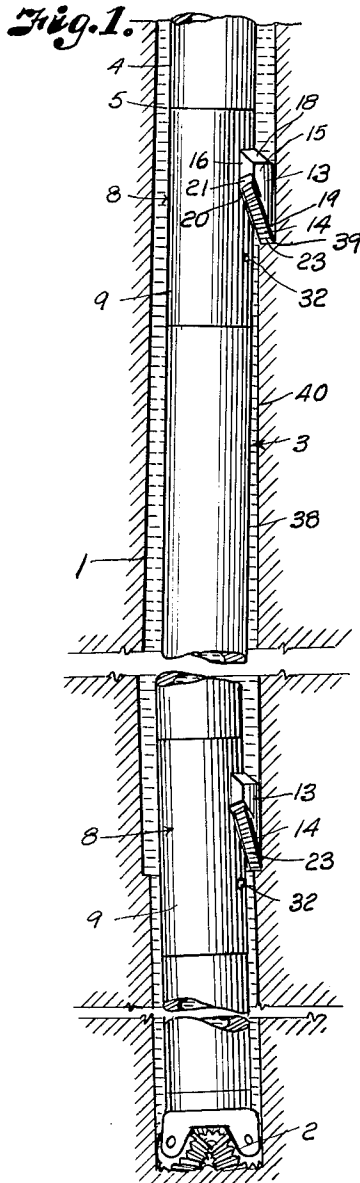
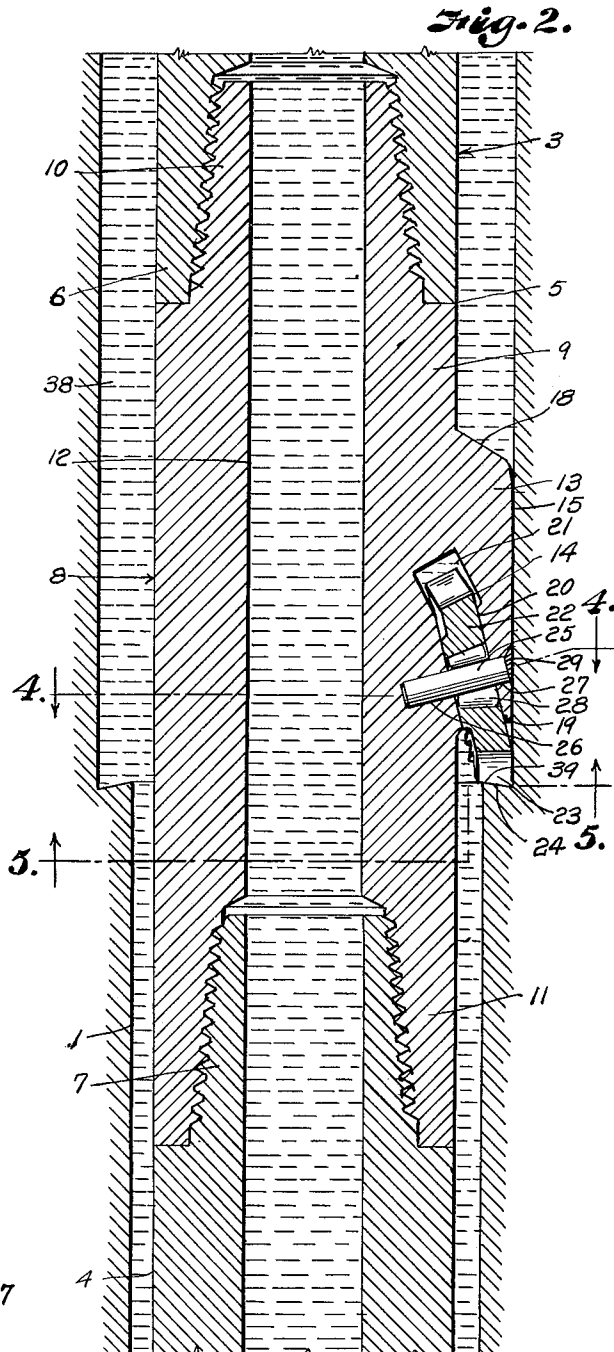
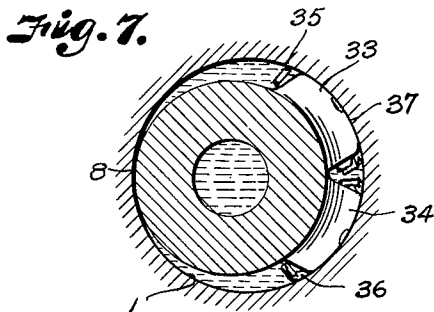
Jan. 25, 1966

E. B. WILLIAMS, JR
REAMER WITH A ROLLING CUTTER FOR ENLARGING AND
STRAIGHTENING BORE HOLES

3,231,033

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2 Sheets-Sheet 1



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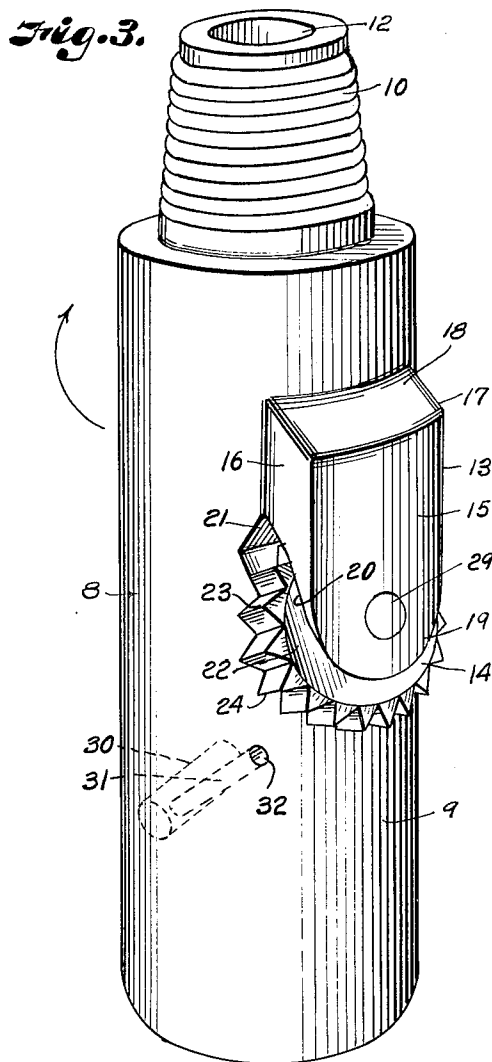
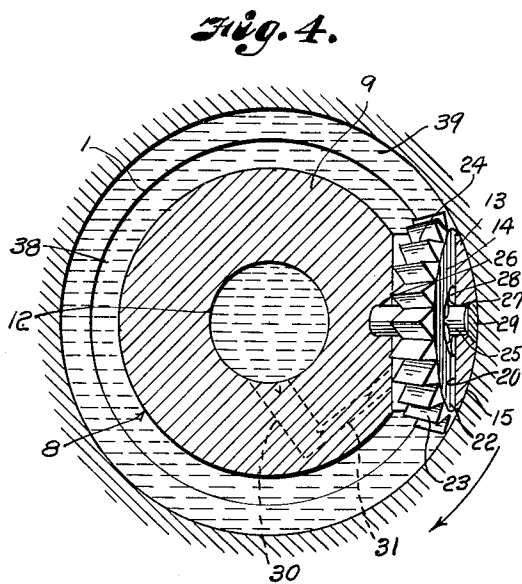
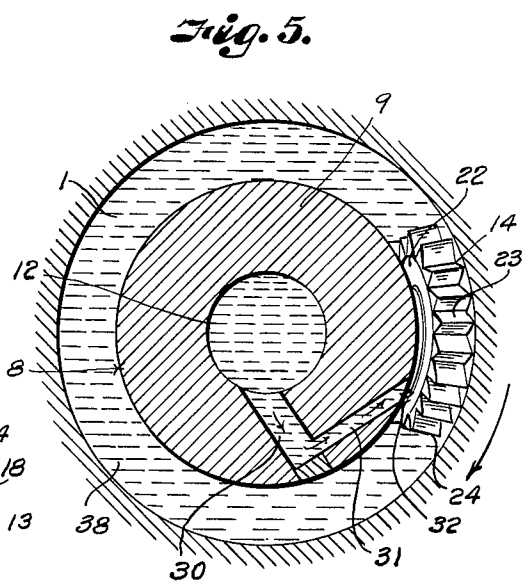
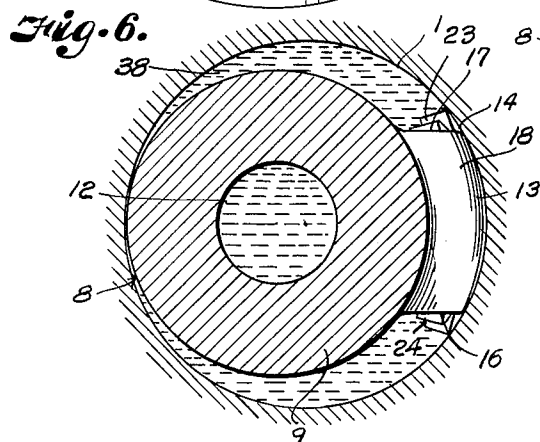
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2 Sheets-Sheet 2



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3,231,033

REAMER WITH A ROLLING CUTTER FOR ENLARGING AND STRAIGHTENING BORE HOLES

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4 Claims. (Cl. 175-334)

This invention relates to a reamer for use in a string of drill pipe employed in the rotary drilling of bore holes into earth formations.

For example, it often becomes necessary to enlarge the diameter of a bore hole being drilled, in order to run a casing which has an inner diameter at least conforming to the diameter of the bore hole being drilled. Also, in drilling bore holes through earth formations, it is difficult to maintain a straight hole, consequently, it is desirable to ream out and straighten portions of a bore hole at different depths while the drilling continues, to prevent binding and excessive wear of the drill pipe caused by rubbing thereof on the wall of the bore hole.

It is obvious that for economy and speed of drilling, the reamer must be capable of passage through diameters corresponding to the diameter of the hole being drilled, and at the same time be capable of reaming to larger diameters at places where reaming is required.

It is, therefore, an object of the present invention to provide a reamer having rotatable cutting means that may be connected into the drilling string anywhere along the length thereof, and which may be run with the drill pipe to depths in the bore hole where the reaming operation is to start, and which is capable of being withdrawn through the diameters of the bore hole corresponding with the diameter of the drill bit being used.

In accomplishing this object, a reamer is provided having a rotatable cutter or cutters projecting from one side only of the drill pipe, so that the largest transverse width thereof is such that it may pass through circumferences corresponding with the diameter of the bore hole produced by the drill bit that is attached to the lower end of the drilling string.

Further objects of the invention are to provide a reamer having a rotatable cutter large enough and mounted in a manner to withstand thrusts of the drill pipe thereon; to provide an adequate fluid supply for cooling the cutter and removing the cuttings therefrom; and to provide a reamer which permits the drill pipe to yield for relieving lateral thrusts in case the resistance to rotation becomes so excessive as to be destructive to the drilling string.

In accomplishing these and other objects of the invention, I have provided improved structure, the preferred forms of which are illustrated in the accompanying drawings, wherein:

FIG. 1 is a vertical section through a bore hole, and showing a drilling string therein having a drill bit on the lower end thereof and provided along its length with one or more reamers constructed in accordance with the present invention.

FIG. 2 is an enlarged longitudinal section through a reamer and the portions of the drilling string that connect therewith.

FIG. 3 is a perspective view of one of the reamers, particularly illustrating the rolling cutter thereof.

FIG. 4 is a partial cross section on the line 4-4 of FIG. 2, since the rolling cutter is illustrated in plan, and showing the fluid channels in dotted lines, and through which is discharged drilling fluid to keep the path of the rolling cutter free of cuttings.

FIG. 5 is a similar section, taken on the line 5-5 of FIG. 2, showing the channels which discharge the drilling fluid in full lines, and viewing the rolling cutter from below.

FIG. 6 is a cross section through the bore hole produced by the bit, and showing the reamer passing therethrough to a reaming position.

FIG. 7 is a cross section through a reamer having a plurality of cutters and showing passage thereof through a bore hole to be reamed.

Referring more in detail to the drawings:

1 designates a bore hole being drilled through earth formations by a drill bit 2 attached to the end of a string of drill pipe 3. The string of drill pipe is made up of stands of pipe sections 4 that are connected together by tool joints 5. The tool joints 5 include an internally threaded box 6 (FIG. 2) on one section that usually connects with an externally threaded pin 7 on the next lower section of drill pipe.

In drilling the bore hole 1, it may be necessary to case off certain of the formations. This is accomplished by running a reamer into the bore hole to enlarge the diameter thereof to accommodate a casing (not shown) having an inner diameter near that of the bore hole. In many instances it is desirable to follow the reamer with the casing, in which case the reamer must be capable of being withdrawn through the casing.

Also, in drilling bore holes it is difficult to drill a straight hole, because the drill bit, due to the character of the formations, tends to lead off in various directions (FIG. 1), consequently, the drill pipe 3 rotates in a crooked hole and is subject to wear where the tool joints rub on the walls of the bore hole in attempting to follow the curvature of the crooked hole. For example, the bore hole shown in FIG. 1 curves toward the right, so that the drill pipe rubs with greater pressure on that side of the hole. This places the drill pipe under greater stress and results in failures of the drill pipe, caving of the wall, and wedging of the drill pipe in the bore hole. Therefore, it is desirable to ream the bore hole at such places, to straighten the hole and ease bending conditions of the drill pipe.

To accomplish a reaming operation for running in a casing, the drill pipe is provided with a reamer 8 constructed in accordance with the present invention, to ream out and straighten the inner side of the longitudinal curvature of the bore hole substantially independently of the original axis and permit a larger casing to follow the reamer into the bore hole. In straightening a bore hole, one or more of the reamers 8 may be connected into the drilling string and lowered through the bore hole to the place that the reaming operation is to be started.

The reamer 8 includes a generally cylindrical body 9, having a diameter substantially conforming to the outer diameter of the drill pipe sections 4 in which it is to be connected. The upper end of the cylindrical body 9 has an externally threaded pin 10, conforming to the pins 7 of the drill pipe sections, to couple the reamer into the box 6 of an upper stand of drill pipe. The lower end of the body has an internally threaded box 11, conforming to the boxes 6 of the stands of drill pipe sections, to connect with the pin 7 of a lower drill pipe section, as shown in FIG. 2. The cylindrical body 9 has an axial bore 12 extending therethrough and through the pin 10 to the box 11, to provide a continuation for flow of drilling fluid through the string of drill pipe.

Extending from only one side of the cylindrical body is a lateral projection 13, carrying a rolling cutter 14. The projection 13 has an outer arcuate face 15 and radial side faces 16 and 17. The upper face 16 of the projection 13 slopes inwardly and upwardly toward the cylindrical body to join therewith.

In order that the reamer may be passed through the bore hole 1 that is made by the drill bit 2, the overall distance between the outer face 15 of the projection 13 and the opposite side of the cylindrical body is slightly less than the diameter of the bore hole 1 (FIG. 7).

The lower end 19 of the projection is preferably semi-circular. Extending upwardly and inwardly from the lower end 19 of the projection 13 is a recess or slot 20 that continues into the body 9 in a slight enlargement 21. The slot 20 extends completely through the projection in the rotary direction to accommodate the rolling cutter 14 therein. The rolling cutter 14 has a disk portion 22 having a conical periphery in the form of teeth 23 provided with chisel shaped edges 24. The teeth 23 have a width along the edges 24 corresponding to the amount that the bore hole 1 is to be reamed.

The rolling cutter 14 is carried on a shaft 25 having its ends carried in a recess 26 in the body member 9 and an opening 27 in the lateral projection 13. The rolling cutter 14 is preferably journaled on antifriction bearings 28.

In assembling the parts, the rolling cutter 14 is moved into the slot 20 with the antifriction bearings 28 therein and the axial center of the bearings is registered with the recess 26 and the opening 27. The inner end of the shaft 25 is then inserted in the opening 27, slid through the bearings and seated in the recess 26, after which the outer end of the shaft is welded to the projection 13, as indicated at 29, FIG. 2. It is thus obvious that the lower end 19 of the lug overlaps the outer face of the cutter to take the radial thrusts of the drill pipe against the wall of the bore hole so that the cutter rolls freely upon the shaft 25.

In order to supply drilling fluid to the teeth of the rolling cutter for cooling the edges 24 and for discharging the cuttings therefrom, the body member 9 of the reamer has a channel 30 extending from the axial bore 12 to connect with a smaller channel 31 extending upwardly and discharging through a port 32 in the periphery of the tubular body at an angle (FIG. 3) in front of the rolling cutter. The channel 30 acts as a choke to restrict the drilling fluid in the amount desired, and to maintain pressure within the drill pipe so as to supply the drilling fluid to similar reamers located at lower positions in the string of drill pipe and to the drill bit 2.

The modified form of the invention shown in FIG. 7 conforms to the structure just described, with the exception that there are two lateral projections 33 and 34, each mounting a rolling cutter 35 and 36, respectively. The outer faces 37 of the projections are formed on the radii of the bore hole made by the drill bit 2, so that the reamer can be lowered therethrough to the place where the reaming operation is to start. The axes of the cutters 35 and 36 and the cutters themselves are also set at an angle, so that the cutters will not interfere with lowering of the reamer into the bore hole 1, as shown in FIG. 7.

In using the reamer constructed as described for enlarging a bore hole to accommodate a casing (not shown) having an inside diameter conforming to the original diameter of the bore hole, a reamer 8 is connected above the drill bit 2 between any two adjoining stands 4 of the drill pipe, and started into the bore hole 1. The drill pipe is rotated in the usual manner, while drilling fluid is circulated downwardly through the drill pipe for discharge through the drill bit to wash cuttings made by the bit to the top of the bore hole by way of the upflow passageway 38. Rotation of the drill pipe gyrates the rolling cutter 14 in a circular path about the axis of rotation. The cutting action is started by the chisel edges 24 of the teeth to chip away the formation and form an annular shoulder 39 that deepens as the reaming progresses.

A portion of the drilling fluid is discharged through the channel 30 and choke channel 31 and port 32 to discharge in a jet against the rolling cutter.

In using the reamers for straightening a crooked hole, as shown in FIG. 1, one or more of the reamers may be

inserted in the drill pipe at places where the drill pipe tends to rub on the wall of the bore hole, as, for example, on the inside line of curvature, as indicated at 40 (FIG. 1). The drill pipe, with one or more reamers thereon, is readily lowered through the bore hole of the diameter made by the drill bit 2, since the total diametrical width of the reamer from the lower portion of the rolling cutters to the opposite side of the cylindrical body 9 is such that it may be lowered through the bore hole, as shown in FIG. 7, to the place where the reaming is to be started. Since the drill pipe tends to depend in a straight line, it will crowd the side of the bore hole to be straightened, and the tension in the drill pipe causes the rolling cutters to start the reaming action when the drill pipe is rotated. The reamers may be inserted in the drill pipe so that they act in successive order in removing the side of the bore hole sufficiently to straighten the bore hole and relieve bending of the drill pipe, as shown in FIG. 1.

It is obvious that with the mounting of the rolling cutter as above described, the cutter is splayed outwardly and downwardly, so that the teeth which are effective in reaming, cut a path of substantially greater diameter than the diameter of the bore hole produced by the drill bit 2.

What I claim and desire to secure by Letters Patent is:

1. In combination with a string of rotary drill pipe having a drill bit axially connected on the lower end for drilling a bore hole upon rotation of the string of drill pipe,

a reamer for straightening the bore hole having a cylindrical body substantially the same diameter as the diameter of the drill pipe,

connections on respective ends of the cylindrical body for connecting said body of the reamer coaxially into the string of drill pipe at a point spaced above the drill bit,

a rolling cutter having a disk portion provided with peripheral teeth having inwardly extending cutting edges, and

means for journaling the cutter on one side of said body for rotation on an axis substantially transversely of the axis of the drill pipe to cause the cutting edges of the reamer to roll along a path circumferentially of the axis of the bore hole made by the drill bit but on a center independently of said axis.

2. In combination with a string of rotary drill pipe having a drill bit axially connected on the lower end for drilling a bore hole upon rotation of the string of drill pipe,

a reamer for straightening the bore hole having a cylindrical body substantially the same diameter as the diameter of the drill pipe,

connections on respective ends of the cylindrical body for connecting said body of the reamer coaxially into the string of drill pipe at a point spaced above the drill bit,

said cylindrical body having a projection extending from only one side thereof and having an arcuate outer face concentric with the rotational axis of the drill pipe for contact with the wall of the bore hole drilled by the bit and said cylindrical body having a width between said arcuate face and the opposite side of said body substantially equal to the diameter of the drill bit, whereby the drill pipe with the reamer connected therein can be lowered into the bore hole previously made by the bit,

said projection having a slot extending upwardly and inwardly from the under face thereof,

a rolling cutter having a disk portion rotatable in the slot and having peripheral teeth with outer faces located in the plane of the arcuate face of the projection and having inwardly extending cutting edges, and

means for journaling the cutter in said slot for rotation on an axis substantially transversely of the axis of the drill pipe to cause cutting edges of the teeth

5

of the reamer to roll along a circular path circumferentially of the axis of the bore hole made by the drill bit but on a center independently of said axis of the bore hole made by the drill bit.

3. In combination with a string of rotary drill pipe 5
having a drill bit axially connected on the lower end for drilling a bore hole in an earth formation upon rotation of the string of drill pipe,

a reamer for straightening the bore hole having a cylindrical body substantially the same diameter as the 10
diameter of the drill pipe,

connections on respective ends of the cylindrical body for connecting said body of the reamer axially into the string of drill pipe at a point spaced above the 15
drill bit,

said cylindrical body having a projection extending from one side only thereof and provided with an arcuate outer face concentric with the rotational axis of the drill pipe for contact with the wall of the bore hole drilled by the bit and said cylindrical body having a width between said arcuate face of the projection and the opposite side of said body substantially 20
equal to the diameter of the drill bit, whereby the drill pipe with the reamer connected therein can be lowered into the bore hole previously made by the bit,

said projection having a slot extending upwardly and inwardly from the under face thereof,

a rolling cutter having a disk portion rotatable in the slot and having peripheral teeth with outer faces 30
located in the plane of the arcuate face of the projection and having inwardly extending cutting edges, and

6

a shaft journaling the cutter thereon and having ends carried in aligning openings in the projection and in said body at the respective sides of the disk portion and on which the cutter turns with the cutting edges of the teeth rolling along a circular path having a center substantially independent of the axis of the bore hole made by the drill bit while the thrust of the drill pipe against the wall of the bore hole is taken by said arcuate face, leaving the cutter free to rotate on said shaft and cut away the formation on the inner side of the longitudinal curvature of the bore hole.

4. A combination as described in claim 3,
in which the cylindrical body of the reamer has an axial bore forming a continuation of flow passageways for drilling fluid in the drill pipe sections and a channel connected therewith and discharging below the rolling cutter to wash cuttings made by the teeth thereof.

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