

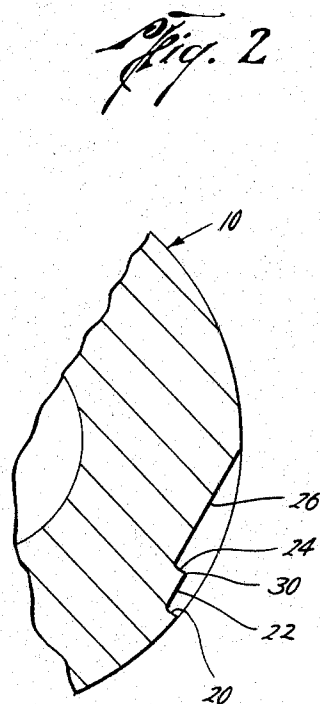
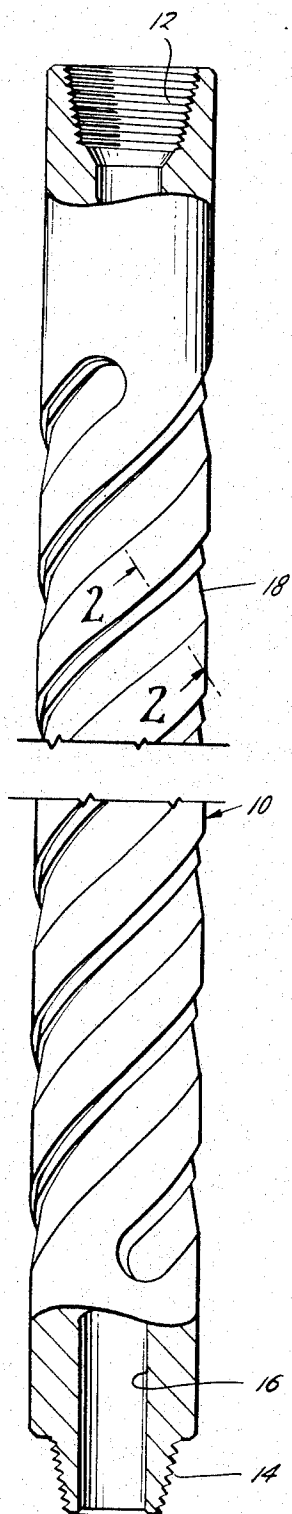
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HELICAL GROOVED TUBULAR DRILL STRING

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HELICAL GROOVED TUBULAR DRILL STRING
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3 Claims. (Cl. 64-1)

The present invention relates to a helical grooved tubular drill string, and more particularly, to an improved helical groove in a tubular drill string such as a drill collar for use in drilling wells.

In the past, helical or spiral groove drill collars have been used in drilling wells for minimizing sticking in the bore holes due to differential pressure between the formation pressure and hydrostatic pressure, such a disclosed in Patents Numbers 2,999,552 and 3,194,331. The present invention is generally directed to various improvements in a spirally grooved tubular drill string to break up and decrease mud buildup in the groove, provide increased fluid passage through the groove, to provide a rotative force to impart torque to the groove drill string to lessen the possibility of wall sticking, and to assist in unsticking the string in the event that it becomes stuck.

It is the general object of the present invention to provide a spiral or helically grooved tubular drill string in which the groove includes two or more connected steps to provide increased fluid passage, cut up drill particles, and provide a surface to impart a rotational force on the string.

A further object of the present invention is the provision of a helically or spirally grooved drill collar having a deeper multi-step type of groove for lessening wall sticking of the string in the well bore, providing increased fluid passage through the groove, cutting up the mud particles to decrease mud cake buildup in the groove, and providing a torque or turbine effect to reduce the tendency of the string to stick or to assist to unstick the string if it becomes stuck, all without unduly decreasing the weight of the drill string.

A still further object of the present invention is the provision of an improvement in a helically grooved tubular member wherein the groove is provided in a section transverse to the groove with a series of connected steps starting inwardly at the leading edge of the groove in the direction of drill string rotation, each of the steps extending inwardly to provide a cutting shoulder for breaking up mud particles and to provide a surface substantially perpendicular to the direction of rotation to act against the flowing drill mud to effect a torque or turbine effect tending to rotate the drill string.

Yet a further object of the present invention is the provision of an improved helical groove in the outer peripheral surface of a tubular drill string member in which the groove in a section transverse to the groove is a two step shape starting at the leading edge of the groove in the direction of string rotation and directed inwardly in which each step includes first and second legs, the second legs being substantially perpendicular to the first legs, the first legs of the second step being inwardly directed in a substantially radial direction and the first leg of the first step being substantially parallel to the first leg of the second step and in which the connection between the first and second steps forms a sharp corner for cutting up mud particles flowing through the groove, and the second leg of the second step ends in a smooth continuous surface at the periphery of the drill string.

Other and further objects, features and advantages will be apparent from the following description of a presently preferred embodiment of the invention, taken in conjunction with the accompanying drawing, where like

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character references designate like parts throughout the several views, and where

FIGURE 1 is a longitudinal view, partly in section, of a preferred embodiment of the present invention, and FIGURE 2 is a cross-sectional view taken along line 2-2 of FIGURE 1.

As is conventional in rotary well drilling operations, a string of pipe sections, generally about 30 feet in length, extend through the well bore and are driven in a clockwise direction at the surface to rotate a drilling bit on the bottom, with drilling fluid or mud being pumped to the bit through the interior of the string and returning upwardly to the surface through the annulus between the string and the well bore. Generally, the lower sections of the drill string consist of drill collars of greater weight and thickness. Spiral or helical grooves have been provided on the exterior of the peripheral surface of the drill collars to lessen the likelihood of the collar sticking to the wall of the well bore because of the decreased area contact between the string and the wall of the well bore. Therefore, the present invention provides a deep spiral groove to provide an increased fluid passage through the groove to clearly reduce the bearing surface of the string against the well bore, but to avoid unduly decreasing the weight of the drill collars. The present invention is directed to providing a multi-step type of helical groove which will provide increased fluid passage through the groove, provide a cutting shoulder in the groove to break up the mud particles, and to provide surfaces in the groove on which the upward flow of drilling fluid in the annulus between the string and the well bore may act to impart a rotative effect on the string.

Referring now to FIGURE 1, a section of drill string pipe such as a drill collar 10 is provided consisting of an elongate tubular member adapted to be connected in a drill string such as by a conventional screw threaded box 12 at one end and a screw threaded pin connection 14 at the second end and a central passageway 16 there-through for the passage of drill fluid or mud internally of the collar 10 to the drill bit (not shown). At least one, and preferably three helical grooves 18 are provided in the outer periphery of the collar 10, for example only at an angle of $21\frac{1}{2}^\circ$ to the axis of the collar 10, for reducing the peripheral bearing surface or the collar in contact with the wall of the well bore.

Referring now to FIGURE 2, the helical groove 18 includes two or more steps, here shown as two for convenience, with the first step including sides 20 and 22 and the second step including sides 24 and 26. The steps extend inwardly from the leading edge of the groove 18 in the direction of the drill string rotation. Thus, leg 20 of the first step is positioned at the leading edge of the groove and extends inwardly with the leg 22 of the first step being perpendicular to the leg 20. Similarly, the second step includes the leg 24 which is preferably directed radially inward and is connected perpendicularly to the leg 22 of the first step and with leg 26 of the second step being perpendicular to leg 24 of the second step. The leg 26 then provides a continuous line to the peripheral trailing surface of the groove 18 at the surface of the collar 10. Preferably, the inward extending leg 20 of the first step is parallel to the inwardly extending step 24 of the second step and both are generally perpendicular to the direction of rotation of the collar 10.

It is to be noted that the multi-step type of spiral groove as shown provides a deep fluid passage through the periphery of the drill collar 10 that lessens the periphery contact with the well bore, and yet the connected step type of groove does not unduly reduce the desired weight of the drill collar 10.

For example only, in a six inch outside diameter drill collar, the depth of the second leg 22 from the outer pe-

riphery of the drill collar may be .214 inch, and depth of the second leg 26 of the second step from the outer periphery of the drill collar may be .339 inch with the cross-section groove width of the entire groove being $1\frac{15}{16}$ inches.

In addition, it is noted that a cutting shoulder 30 is provided at the intersection of the adjoining steps which will act to break up the mud particles flowing upwardly through the groove 16 and reduce the tendency of mud cake build up in the spiral groove, and thereby acts to maintain a full flow fluid passageway to insure the maintenance of reduced area of the collar 10 in contact with the wall of the well bore.

Another feature of the multi-step type groove is the fact that the legs 20 and 24 are positioned in planes parallel to the axis of the groove 18 and thus are acted upon by the action of the drilling mud flowing upwardly in the groove 18. The action of the drilling fluid will produce a torque or turbine effect to tend to rotate the drill bit in the direction of rotation thereby tending to prevent sticking of the collar 10 in the well bore. In addition, in the event that the drill collar does become stuck the action of the drill fluid flowing upwardly in the groove 18 will produce a force or turbine effect so that it would be possible with high mud pump pressure to impart a rotational force adjacent the point of sticking which would tend to spin the drill collar 10 out of its stuck position. For instance, assuming a drill collar having a $4\frac{3}{4}$ inch OD and a $2\frac{1}{4}$ ID position in a $6\frac{3}{4}$ ID well bore through which drill mud weighing 10 pounds per gallon is pumped at 400 gallons per minute through the bore 16 a torque of 198 foot pounds is exerted on a single drill collar under these conditions. Thus, in a drill string having 30 collars a torque of 5940 foot pounds would be exerted by the action of the drilling mud on the sides 20 and 24 of the multi-step helical grooves 18. Therefore, a tremendous torque force or turbine effect is provided adjacent the drill string at the position where sticking is most likely to occur thereby decreasing the likelihood of sticking, or in the event of sticking, provides a torque below the stuck point which can be increased by increasing the pumping speed of the drilling mud to assist the torque that is applied at the rotary table in rotating and freeing the drill string.

In operation, the drill collars 10 are connected in a drill string by the box 12 and pin 14 threaded connections generally in position above the drill bit, and the drilling string is rotated in a clockwise direction. Drilling fluid or mud is pumped downwardly through the drilling string and through the central bore 16 to the drill bit and then upwardly through the annulus between the drill string and the well bore and the spiral grooves 18 will tend to lessen the possibility of the collars 10 sticking in the well bore. The deep multi-step type of groove 18 will provide more fluid passage through the grooves, decrease mud cake buildup in the grooves, the sharp cutting shoulder 30 will break up the mud cuttings flowing up the groove and the action of the flowing fluid acting on the legs 20 and 24 provide a force tending to rotate the drill collar in the direction of rotation thereby lessening the tendency to stick, and providing a force to spin the collar out of a stuck position in the event that it becomes stuck.

The present invention, therefore is well adapted to carry out the objects and attain the ends and advantages

mentioned as well as others inherent therein. While a presently preferred embodiment of the invention is given for the purpose of disclosure, numerous changes in the details of construction and arrangement of parts can be made which will readily suggest themselves to those skilled in the art and which are encompassed within the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. In an elongate tubular member adapted to be connected in a drill string and having at least one helical groove in the outer peripheral surface of the member, the improvement in said groove comprising, said groove in section transversely of the groove being a series of connected steps starting inwardly at the leading edge of the groove in the direction of drill string rotation, each step having two legs, the first leg of each step extending inwardly and the second leg being substantially perpendicular to the first leg.
2. In an elongate tubular member adapted to be connected in a drill string and having at least one helical groove in the outer peripheral surface of the member, the improvement in said groove comprising, said groove in section transversely to the groove being a series of connected steps, each step having two legs, the first leg of the first step extending inwardly from the leading edge of the groove in the direction of drill string rotation, the second leg being substantially perpendicular to the first leg and the first legs being directed substantially perpendicular to the direction of rotation to provide shoulders on which fluid flow may act to rotate the member.
3. In an elongate tubular member adapted to be connected in a drill string and having at least one helical groove in its outer peripheral surface, the improvement in said groove comprising, said groove in section transversely to the groove being a two step shape starting at the leading edge of the groove in the direction of drill string rotation and directed inwardly, each step including first and second legs, the second legs being substantially perpendicular to the first legs, the first leg of the second step being inwardly directed in a substantially radial direction, and the first leg of the first step being substantially parallel to the first leg of the second step, the first legs forming shoulders against which the fluid flow in the groove acts to rotate said member, the connection between the first and second steps forming a sharp shoulder for cutting up mud particles flowing through said groove, and the second leg of the second step ending at the trailing edge of the groove.

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