This invention relates to improvements in tubular members, such as drill collars and drill pipe, which form parts of a drill string for use in the rotary drilling of wells. More particularly, it relates to a tubular drill string member which, as disclosed in my Patent No. 2,999,552, is so formed as to reduce the area of its periphery engageable with the well bore, and thereby lessen the likelihood of its becoming stuck due to differential pressure thereacross.

In the preferred form of the invention described in this patent, the periphery of the tubular member is grooved along one or more continuous spiral paths by means of a boring tool extending through a machine. However, these spiral grooves are necessarily cut upon a relatively long pitch which is beyond the range of the ordinary turning machine, so that it has been necessary to in some way modify such machines. This, of course, entails considerable expense, and it is an object of this invention to provide a tubular drill string member of this general type wherein the periphery thereof may be grooved for the desired purposes without the necessity of a turning machine, or at least without the necessity of a turning machine especially adapted for cutting spiral grooves to a relatively long pitch.

This as well as other objects are accomplished, in accordance with the illustrated embodiments of the present invention, by means of a tubular drill string member having a plurality of longitudinally displaced grooves extending generally axially along its outer periphery and with longitudinally successive grooves being circumferentially offset with respect to one another so as to form, in effect, areas of grooves along one or more spiral paths about the member. This construction permits a conventional tubular drill string member to be converted to one having the advantages mentioned in my earlier patent merely upon movement of a cutter over its periphery without concurrent rotation of one with respect to the other. Furthermore, even when such a conventional tubular member is mounted upon a turning machine, it is not necessary to especially adapt the latter for cutting grooves of a long pitch since no turning is required. Thus, the cutter on the turning machine may merely be moved longitudinally of the tubular member to cut intermittent grooves thereupon, and the tubular member and cutter rotated with respect to one another to a position for forming longitudinally successive grooves as mentioned.

In the drawings, wherein like reference characters are used throughout to designate like parts:
FIG. 1 is a longitudinal view of part of a conventional drill string extending through a well bore and having a portion thereof engaged against a side of the bore;
FIG. 2 is a cross-sectional view of the drill collar and bore, taken substantially along broken line 2—2 of Fig. 1;
FIG. 3 is a longitudinal view, partly in section, of a drill collar constructed in accordance with one embodiment of the present invention, and with an intermediate portion thereof broken away;
FIG. 4 is a cross-sectional view of the drill collar of FIG. 3, as seen along broken line 4—4 of FIG. 3;
FIG. 5 is a cross-sectional view of a modified form of the embodiment of drill collar shown in FIGS. 3 and 4;
FIG. 6 is a longitudinal view, partly in section, of a drill collar constructed in accordance with another embodiment of the present invention; and
FIGS. 7A and 7B are longitudinal views, also partly in section and broken away, of a joint of drill pipe constructed in accordance with one embodiment of the present invention.

Turning now to a detailed description of the above-described drawings, FIGS. 1 and 2 illustrate the problem with which tubular drill string members of the type contemplated by the present invention are concerned. More particularly, these figures show a conventional type of drill collar 11 having a portion 12 of its cylindrical periphery engaged with a side of a well bore 13. In the drilling of an oil or gas well, the space within the bore and about the drill collar is filled with a drilling mud which has a high specific gravity so that it will normally be at a hydrostatic pressure greater than the pressure of the formation adjacent thereto.

As is apparent from FIGS. 1 and 2, the differential in pressure between the drilling mud and that of the formation is effective over an area determined not only by the length of the portion 12 of the collar, but also by the peripheral arcuate portion of such portion transcribed by the angle theta. If this area is large, as it well may be, and the pressure differential is of considerable magnitude, it is quite possible that there would not be sufficient power available at the wellhead or tensile strength in the upper unstack portions of the string to produce an axial lifting force sufficient to overcome this radial force such that the collar will remain stuck. An example of the force which may be encountered is set forth in my earlier patent. Although the problem has been described herein particularly in connection with a drill collar, it obviously also pertains to the drill pipe connected in the drill string above the collars.

As shown in FIGS. 3 and 4, in accordance with one embodiment of the present invention, a drill collar 14 comprises an elongate, thick-walled tubular member 15 connected in a drill string at its upper and lower ends. More particularly, the upper end of this tubular member has a threaded box 16 for connection with a threaded pin 17 on the lower end of a drill pipe 18, and the lower end is provided with a threaded pin 19 for connection with the threaded box 20 of another such collar or, as shown, a bit-sub 21 which connects the collar with any suitable rotary type bit 22. Generally, there will be more than one drill collar connected between the drill pipe and bit, although for purposes of illustration, it is sufficient to illustrate and describe the single collar 14.

As is apparent from the drawings, the diameter of the ungrooved periphery of the tubular member 15 is uniform from one end to the other, although this invention contemplates that the ends of such member above and below the grooved area thereof may be slightly larger or smaller than the ungrooved area intermediate such ends. In any case, the maximum diameter of the collar is less than that of the bit 22 so that an annulus is formed between the well bore and collar during the drilling operation.

There are a number of axially extending grooves 23 formed in the periphery of the tubular member 15 intermediate lands on opposite sides of the groove, each such groove being shallow so as to provide a maximum of area adapted to be held out of engagement with the well bore with only a minimum loss of weight and strength. More particularly, and as shown in FIG. 4, each such groove has a base which forms, in a section transversely of the tubular member, a line which is flat between its intersection with opposite ends with the periphery of the tubular member. However, I contemplate that, as described in my earlier patent, the base of the groove may form, in the aforementioned cross section, a line which departs somewhat from flat in that it may be slightly concave or, on the other hand, convex, as illustrated by the
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The joint of drill pipe 28 illustrated in FIGS. 7A and 7B also comprises a tubular member 29, although such member has much thinner walls than the tubular member forming the above-described drill collars. A tool joint is welded or otherwise secured to each opposite end of the tubular member 29, in this case a box 30 being welded to the upper end of such member and a pin 31 being welded to the lower end thereof. As in the case of the drill collars, the joint of drill pipe 28 has an ungrooved peripheral area intermediate its opposite ends which is of uniform diameter and equal to or either slightly smaller or slightly greater than the diameter at such opposite ends.

Similarly to the drill collars illustrated in FIGS. 3 to 5, the drill pipe 28 has a plurality of groups of shallow, circumferentially spaced and axially extending grooves 32 cut in the outer periphery thereof, with the groups being longitudinally displaced along such member, and with the grooves of each group being substantially parallel to and circumferentially offset with respect to the grooves of a longitudinally successive group. Obviously, then, the outer circumference of such pipe would appear, in cross section, as does the outer circumference of the drill collars shown in either FIGS. 4 or 5, depending on the particular group of the grooves 32.

That is, as can be seen from FIGS. 4, 4 and 5, the radial distance from the axis of each tubular member to its outer surface at its ends is greater than the minimum radial distance from said axis to the base of each of the grooves in the tubular member. More particularly, in the illustrated embodiments, the maximum outer diameter of the opposite ends of the tubular members is at least as large as the maximum outer diameter of the lands between the grooves.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects heretofore set forth, together with other advantages which are obvious and which are inherent to the apparatus.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. An integral, elongate tubular member having means at its opposite ends for connection above the drill bit in an oil or gas well drill string and a plurality of longitudinally displaced, generally axially extending grooves formed in its outer periphery intermediate lands on opposite sides thereof, longitudinally successive grooves being circumferentially offset with respect to one another, the radial distance from the axis of said member to its outer surface at its ends being greater than the minimum radial distance from said axis to the base of each of said grooves, and the outer diameter of the lands on said tubular member being uniform.

2. A tubular member of the character defined in claim 1, wherein longitudinally successive axial grooves are substantially equally spaced circumferentially about said member.

3. A tubular member of the character defined in claim 1, wherein additional grooves connect the ends of each axial groove within longitudinally successive axial groove.

4. A tubular member of the character defined in claim 1, wherein lands extend continuously along opposite sides of each of said grooves.

5. A tubular member of the character defined in claim 4, wherein said lands are of uniform outer diameter and extend continuously along opposite sides of the grooves.
6. An integral, elongate tubular member having means at its opposite ends for connection above the drill bit in an oil or gas well drill string and a plurality of longitudinally displaced, generally axially extending grooves formed in its outer periphery intermediate lands on opposite sides thereof, longitudinally successive grooves being circumferentially offset with respect to one another, and the maximum outer diameter of the opposite ends of said tubular member being at least as large as the maximum outer diameter of said lands.

7. An integral, elongate tubular member having means at its opposite ends for connection above the drill bit in an oil or gas well drill string and a plurality of longitudinally displaced, generally axially extending grooves in its outer periphery intermediate lands on opposite sides thereof, longitudinally successive grooves being circumferentially offset with respect to one another, and each said groove having a base forming, in a section perpendicular to the axis of said member, a line which is at least substantially flat and intersects at its opposite ends with the peripheral surface of said member, and the lands being of a uniform outer diameter and extending continuously along opposite sides of each groove.

8. An integral, elongate tubular member having means at its opposite ends for connection above the drill bit in an oil or gas well drill string and a plurality of longitudinally displaced, generally axially extending grooves in its outer periphery, longitudinally successive grooves being circumferentially offset with respect to one another, an additional groove connecting the end of each axially extending groove with only the end of a longitudinally successive axially extending groove, and the outer periphery of said tubular member intermediate its ends being of a uniform diameter and including lands extending continuously along opposite sides of each axial groove.

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