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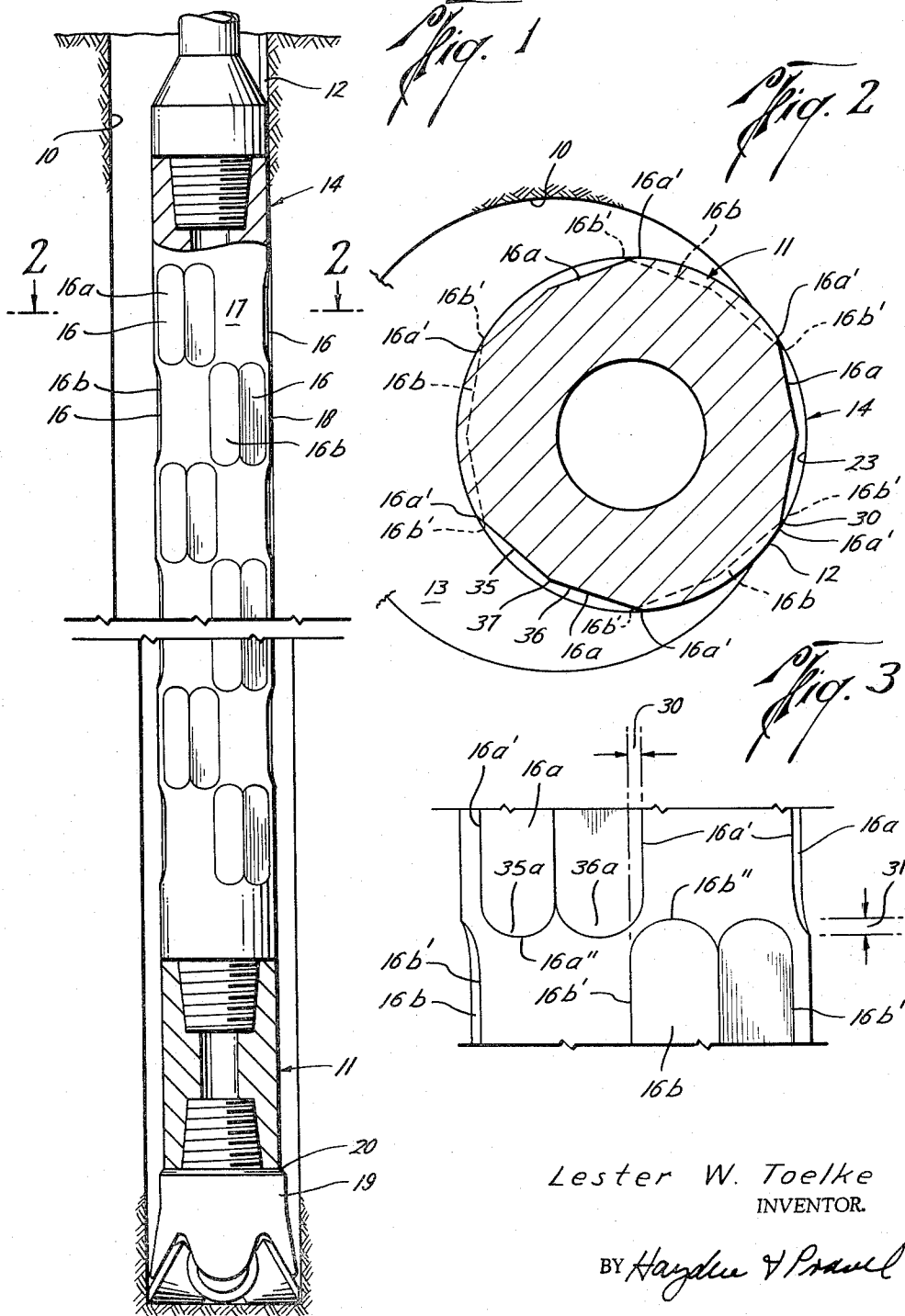
L. W. TOELKE

3,175,374

TUBULAR MEMBER FOR USE IN WELL DRILLING OPERATIONS

Filed June 22, 1962

2 Sheets-Sheet 1



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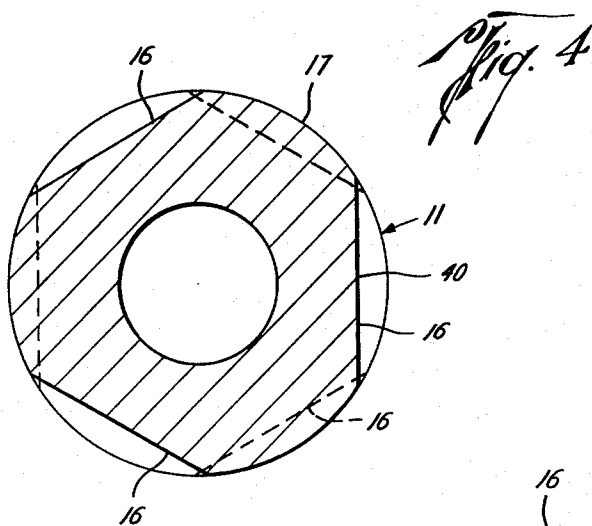
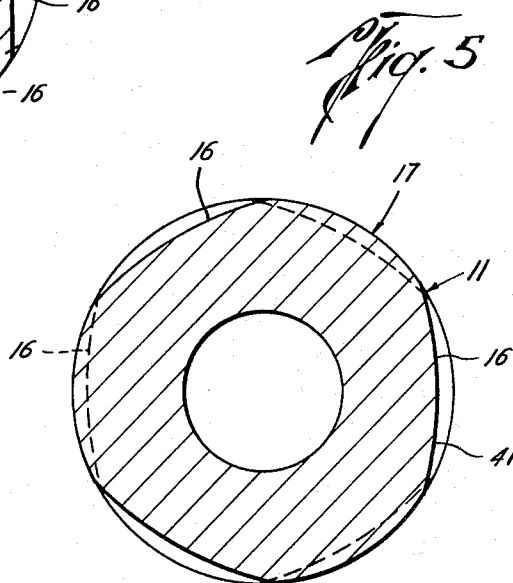
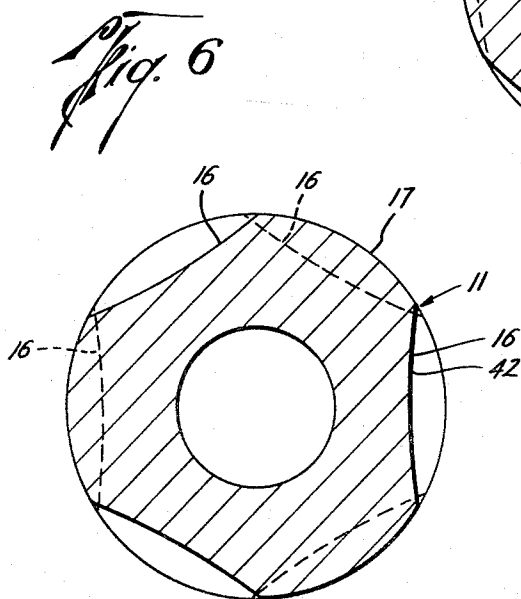
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TUBULAR MEMBER FOR USE IN WELL DRILLING OPERATIONS

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8 Claims. (Cl. 64—1)

The present invention relates to a tubular member for use in well drilling operations, and more particularly, to the surface arrangement of a drill string tubular member used in the drilling of wells.

In the rotary drilling of wells, a drilling bit is normally supported on the lower end of a drill string, the drill string extending upwardly to the earth's surface where rotation is imparted thereto to effect drilling or penetration of the earth's surface. The drill string, as generally contemplated at the present time, is composed of a plurality of tubular sections which are adapted to be threadedly engaged at each end, the drill string also including one or more heavy tubular members called "drill collars" for concentrating a desired weight immediately above the bit to apply weight on the bit in a manner to increase the rate of penetration of the drill bit and to attempt to drill the well in the desired direction or relationship relative to the earth's surface.

In some instances, a substantial number of drill collars are positioned in the drill string in an endeavor to apply a substantial weight on the drilling bit; however, the drill string, including the drill collars and the other tubular sections forming the drill string, is of a smaller outer diameter than the size of the bit secured at the lower end thereof, and during drilling operations, a drilling fluid is circulated downwardly through the drill string and discharged through the drill bit and then returned to the earth's surface in the annulus surrounding the drill string in the well bore. In most instances, the drill string will engage or rub against the side of the well bore during drilling operations. This causes severe, but in most instances, very smooth wear or lapping on one side of the well bore thus effecting a channel or seat which partially envelops the tubular member sometimes developing a seal between the surface of the channel in the formation in the well bore and the abutting drill string surface which prevents fluid communication between these abutting surfaces. If this occurs opposite a formation with a lower pressure than the hydrostatic head of the drilling fluid and if the drilling string is static for a matter of a few seconds, the differential pressure may hold the drilling string against the wall with such force that it cannot be then loosened by normal methods. When the drill string becomes stuck from this cause it is known as being "wall stuck," therefore it is desirable to prevent a fluid seal from developing even though the drill string is against the wall of the well.

The present invention is directed to a drill string incorporating a means which overcomes the above and other problems encountered in connection with the sticking of a drill string in a well bore.

An object of the present invention is to provide a tubular drill string member having a plurality of recesses on its outer peripheral surface to thereby accommodate fluid flow around the tubular drill string member at all times during drilling operations and even though the drill string may engage the well bore wall on one side and thereby inhibit sticking thereof in the well bore.

Yet a further object of the present invention is to provide on a tubular drill string for use in well drilling operations a plurality of circumferentially and longitudinally extending spaced recesses in the outer surface of the tubular member to provide fluid passages of substantial extent even when it is engaged against the side of the well bore so that drilling fluid access to that surface area of the

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well bore wall contacting the drilling member is effected to thereby inhibit sticking of the drilling member in the well bore.

Various means and methods have been proposed with a view of endeavoring to center the drill string in the well bore to inhibit sticking, and various means of grooving of the drill string have been proposed; however, such procedures generally increase the cost of drilling operations in that they require special equipment. Also, it is desirable to provide a maximum size flow path for drilling fluid access circumferentially of the drill string to inhibit clogging or restriction of the fluid flow paths formed on the drill string, and it is desirable to accomplish this with a minimum of forming or grooving on the drill string to thereby reduce the initial cost of preparing the drill string and to inhibit the presence of weak spots or stress areas in the drill string.

The present invention has for one of its further objects the provision of a plurality of recessed areas which extend circumferentially and longitudinally of the drill string to provide a maximum unrestricted area for fluid flow around the drill string when it is in the well bore.

Still a further object of the present invention is to provide a means for continuous fluid circulation circumferentially of a drill string tubular member even though it may be engaged with one side of the well bore wall.

A further object is to interrupt the normal outer surface of a drill string at a plurality of circumferentially and longitudinally spaced intervals to provide fluid access circumferentially of the drill string.

Still a further object is to provide a plurality of smooth recesses on the surface of a drill string member which recesses are of less longitudinal extent than the drill string member, and which recesses extend circumferentially and longitudinally to interrupt the normal surface at a plurality of spaced longitudinal and circumferential intervals.

Yet a further object of the present invention is to provide a means for accomplishing fluid circulation circumferentially of a drill string tubular member even though it may be engaged with one side of the well bore, which means can be provided at a minimum of expense and with a minimum of deleterious effect upon the tubular drill string member.

Still another object of the present invention is to provide a tubular member with an external surface configuration which reduces the normal outer circumferential area but without substantially decreasing its strength and to provide for fluid access circumferentially of the tubular drill string member even when it is engaged against the side of the well bore wall.

Yet a further object of the present invention is to provide a means for forming a tubular drill string to inhibit "wall sticking" thereof in the well bore.

Other objects and advantages of the present invention will become more apparent from a consideration of the following description and drawings wherein:

FIG. 1 is a vertical sectional view of a lower portion of a well bore illustrating partly in elevation a portion of the tubular drill string of the present invention and showing a drill bit secured to the lower end thereof;

FIG. 2 is a sectional view on the line 2—2 of FIG. 1 to further illustrate the means of the present invention for accommodating fluid flow circumferentially of the tubular drill string even when it is engaged against one side of the well bore wall;

FIG. 3 is an enlarged view of a portion of the tubular member of FIG. 1 illustrating one form of arranging the recesses on the tubular drill string member in accordance with the present invention;

FIG. 4 is a transverse sectional view of a tubular drill string illustrating another form of the present invention;

FIG. 5 is a transverse sectional view of the tubular drill

string illustrating another form of the present invention; and

FIG. 6 is a transverse sectional view illustrating still another form of drill string of the present invention.

Attention is first directed to FIG. 2 of the drawings wherein a portion of a well bore 10 is illustrated in sectional view with the drill string represented generally at 11 therein. It will be noted that the drill string 11 is shown as having been moved to one side of the well bore 10, and more particularly, seated in the longitudinally channel 12 formed in the well bore 10. It can be appreciated from the illustration of FIG. 2 of the drawings that where the pressure existing in an adjacent formation 14 of the earth's surface withdraws drilling fluid from the well bore, the drilling fluid hydrostatic head in the annulus 13 causes the drill string 11 to be held laterally against the well bore. As the drill string 11 is rotated, and gradually lowered, it sometimes forms the channel 12 therein on the side of the well bore against which it rubs. The channel 12 in some instances may extend for a substantial vertical distance along the well bore 10, and may partially envelope the tubular drill string, as illustrated in FIG. 2 of the drawings. The rubbing of the drill string against the portion which partially envelopes it may create a seal between the drill string surface and the formation surface, and it has been found in practice that under this condition, if rotation of the drill string 11 is stopped even for a short period of time, the drill string may become stuck due to the differential pressures, above noted, thereby preventing further rotation or longitudinal movement of the drill string 11 within the well bore 10.

In order to inhibit sticking of the drill string 11 in the well bore 10, the present invention provides a plurality of longitudinally and circumferentially extending recesses designated generally at 16, which recesses are formed in the outer peripheral surface or skin 17 of the tubular drill string 11. The outer peripheral surface 17 is normally in the form of substantially a circle on a plane transverse of the longitudinal axis of the tubular member, and the recesses 16 reduce the surface area of the normal outer peripheral surface or skin 17, but actually increase the total outer surface area of the drill string in which they are formed. As illustrated in the drawings, the recesses 16 are shown as being formed in the drill collar 18 portion of the drill string 11, which drill collars are positioned in the drill string 11 in close proximity to the drilling bit 19 secured on the lower end 20 of the drill string 11.

It is to be further noted that as illustrated in FIG. 1 of the drawings, the recesses 16 are circumferentially spaced and also longitudinally spaced of the drill string 11 and are of suitable longitudinal and circumferential extent so that fluid communication circumferentially of a substantial longitudinal extent of the drill collar 18 is effected. The arrangement and extent of the recesses on the outer surface 17 provides a plurality of fluid flow paths each of which is of substantial longitudinal extent so that circumferential fluid communication, or fluid access is effected even between the drill collar 18 and the surface 23 of the channel 12 formed in the well bore 10 when the drill string is in contact with the side of the well bore.

As more clearly illustrated in FIGS. 2 and 3 of drawings, in the form of the invention shown, the recesses represented at numeral 16a which are spaced circumferentially in a row around the drill collar 18 overlap the spaced recesses represented by the numeral 16b in the next adjacent row. For example, the termination, or intersection of each of the recesses 16a in one row with the outer peripheral surface 17 of the drill collar 18 is represented by the numeral 16a', and the termination, or intersection of each of the recesses 16b in the next adjacent row with the outer peripheral surface 17 is represented by the numeral 16b', and it can be seen in FIG. 3 of the

drawings that the termination, or intersection of the recesses 16a and 16b, namely 16a' and 16b', overlap each other circumferentially by the amount represented at 30 although this overlap is offset longitudinally as seen in the drawings.

It is to be further noted that the recesses 16a and 16b overlap each other longitudinally, also as more clearly illustrated in FIG. 3. For example, the longitudinal termination, or intersection of each of the recesses 16a with the outer peripheral surface 17 may be represented by the numeral 16a'', and the longitudinal termination, or intersection of each of the recesses 16b with the surface 17 may be represented by the numeral 16b'', and it can be seen that each of the recesses 16a overlaps the next adjacent recesses 16b by the amount represented at 31 even though the overlap is offset circumferentially.

Therefore, since each recess 16a is overlapped circumferentially and longitudinally by the next adjacent recess 16b which is offset therefrom circumferentially and longitudinally, fluid access or fluid communication around the collar 18 is established throughout the longitudinal extent of the drill collar 18 which is provided with the recesses, and the communication in the recessed areas is maintained even between the surface 23 of the channel 12 in the well bore 10 and the recesses 16 in the outer surface 17 of drill collar 18. It can be appreciated that the overlapping relationship of the recesses provides a substantial circumferential outer area of the drill collar 18 which is in fluid communication with the annulus 13 even though the drill collar is seated in the channel 12. Thus, a substantial portion of the hydrostatic differential pressure acting to hold the drill collar 18 in channel 12 at the side of the well bore 10 is relieved.

The arrangement of the recesses 16 on the drill collar 18 as illustrated in FIGS. 1, 2, and 3 of the drawings provides a substantial size flow path for fluid to be circulated to the channel 12 formed in the well bore 10 thereby inhibiting sticking of the drill collar 18 in the channel. Also, the recesses 16 may be of any suitable longitudinal and circumferential extent, thereby providing a fluid opening which is of substantial extent and less likely to become clogged by materials or cuttings which may be carried in the drilling fluid 13.

In the particular form of the recesses 16 illustrated in FIGS. 1, 2, and 3 of the drawings, it can be seen that each recess 16 is formed by milling or cutting flat surfaces 35 and 36 in the outer peripheral surface 17 of the drill collar 18 with the flat surfaces 35 and 36 in the outer peripheral surface 17 of the drill collar 18 with the flat surfaces 35 and 36 joining along their adjacent edge 37. The surface of the end portions 35a and 36a of each of the flat surfaces 35 and 36 gradually slope up toward the outer peripheral surface 17 as seen in the drawings. Also, the side termination of the recesses intersect the outer surface 17 in a manner so as not to form upstanding shoulders. This eliminates sharp, upstanding shoulders which might effect an undesirable scraping action in the well bore when the well string is pulled upwardly. Also, such construction eliminates "pockets" in which cuttings or sediment from the well bore may collect.

Thus, as fluid is circulated downwardly through the drill string 11 and discharged through the bit 19 on the lower end thereof, it is circulated upwardly through the well bore 10 in the annulus 13 surrounding the drill string 11. The arrangement of the recesses on the drill collar 18 enables the fluid to communicate substantially completely or circumferentially around the drill string throughout the extent of the portion of the drill string which has the recesses 16 provided thereon. Since the fluid may be communicated circumferentially of the recessed portion of the drill string 11 at all times, wall sticking of the drill string is substantially reduced.

It should be noted that the form of the recesses on the drill string 11 may be varied without departing from the scope of the present invention. For example,

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in FIG. 4, a drill string 11 is illustrated wherein a plurality of recesses are illustrated on the outer peripheral surface 17 of the drill string 11. It can be seen that the recesses 16 are again staggered circumferentially and longitudinally of the outer peripheral surface 17 and as illustrated in the drawings overlap at their adjacent side and end portions as previously described herein. In the form of the recesses shown in FIG. 4, their bottom surfaces 40 define chords on a transverse plane laterally of the longitudinal axis of the drill string 11.

In FIG. 5, the recesses 16 are again illustrated on the outer peripheral surface 17 of the drill string 11 and again are illustrated as being circumferentially and longitudinally extending and circumferentially and longitudinally staggered on the drill string 11 as described with regard to the other forms of the invention shown herein. However, the bottom surface 41 of each of the recesses 16 illustrated in FIG. 5 is convex in configuration on a plane transverse or laterally of the longitudinal axis of the drill string 11.

In FIG. 6, a plurality of surfaces 16 are again illustrated in the outer periphery 17 of the drill string 11, and in this instance, the base surface 42 of each of the recesses is illustrated as being concave. These recesses are again shown as being staggered circumferentially and longitudinally and also overlapping the next adjacent spaced recess.

It can be appreciated from the foregoing description that the exact contour of the base surface of the recesses may vary without departing from the scope of the present invention. Also, the recesses may be arranged on the drill string 11 or any portion thereof in any manner as desired. As illustrated in the drawings, the preferred form of the invention illustrates recesses 16 which extend longitudinally and laterally of the drill string; however, in some instances, it may be desirable to arrange the recesses at an angle relative to the longitudinal axis of the drill string 11.

An advantage of the present invention resides in the fact that the recesses 16 may be formed in the drill string 11 or in any portion thereof relatively quickly and without any substantial weight loss to the portion of the drill string which is recessed and with causing any undue stresses or stress areas to be set up in the portion of the drill string 11 which is to be recessed. Additionally, the recesses 16 by reason of their longitudinal and circumferential extent provide a substantial fluid passage for communication of fluid in the annulus 13 circumferentially of the drill string 11 at all times. These features are extremely important in that they enable the present invention to accomplish its function without setting up or causing any deleterious effects or weak spots in any portion of the drill string. Also, the present invention reduces the chances of any cuttings or sediment in the mud laden drilling fluid in the annulus 13 from clogging or inhibiting fluid flow or communication circumferentially of the drill string which cuttings or sediment might cause or aid in causing the drill string to become stuck in the well bore.

Also, the present invention is particularly advantageous in that it enables not only a portion of the drill string, such as the drill collars, to be provided with a means for establishing and maintaining fluid communication circumferentially of the drill collars at all times within the well bore 10, but the present invention provides an economic and unique method of providing recessed areas throughout the longitudinal extent of the drill string. The recesses 16 may be provided in each tubular section of a drill string, or in those instances where it may be desired to drill a well bore by means of a drill string which is formed of material other than metal and which is composed of either one long tubular member or several substantially long tubular members joined together (longer than those normally employed in drilling at the present time) the recessed areas can be provided or molded in

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such drill strings with a minimum of effort and at substantial savings.

Also, in some instances the recesses may be arranged on the drill string so that longitudinally spaced recesses overlap only circumferentially, and in some instances it may be desirable to only overlap circumferentially spaced recesses longitudinally. In other situations, the recesses may be spaced over the outer surface of the drill string so that they do not overlap either circumferentially or longitudinally. The present invention provides a means for interrupting the normal outer peripheral surface of a tubular drill string to accommodate fluid access circumferentially of the drill string, even when it is held against the side of the well bore. Also, the interruption of the normal outer surface of the drill string by said recesses occurs at a plurality of longitudinally and circumferentially spaced intervals on the drill string, as shown in the drawings.

The configuration of the recesses shown herein tend to inhibit the collection of dirt and debris, particularly the configuration of FIGS. 1 through 5 inclusive.

Broadly, the present invention relates to a drill string construction and means for establishing and maintaining fluid communications circumferentially of the drill string at all times during well drilling operations.

What is claimed is:

1. A tubular member for use in well bore drilling operations comprising:

- (a) an outer peripheral surface on the tubular member,
- (b) a plurality of recesses spaced circumferentially in a row in said outer peripheral surface,
- (c) there being a plurality of rows of recesses in said outer peripheral surface,
- (d) said recesses having end portions and side portions,
- (e) said end portions of said recesses in each row overlapping said end portions of said recesses in the next adjacent row, and
- (f) said side portions of said recesses in each row overlapping said side portions of said recesses in the next adjacent row.

2. The invention of claim 1 wherein said outer peripheral surface forms a circle on a section laterally of the longitudinal axis of the tubular member, said recesses forming surfaces on the tubular member, said surfaces of said recesses forming in a section laterally of the longitudinal axis of the tubular member a chord in relation to the circle formed by said outer peripheral surface.

3. The invention of claim 1 wherein said outer peripheral surface forms a circle on a section laterally of the longitudinal axis of the tubular member, said recesses forming in a section laterally of the longitudinal axis of the tubular member concave surfaces on the tubular member.

4. The invention of claim 1 wherein said outer peripheral surface forms a circle on a section laterally of the longitudinal axis of the tubular member, said recesses forming in a section laterally of the longitudinal axis of the tubular member convex surfaces on the tubular member.

5. A tubular member adapted to be connected in a drill string for use in well drilling operations having an outer peripheral surface, a plurality of recesses in said surface, said recesses being longitudinally and circumferentially staggered in said outer surface, said recesses terminating in end portions, said end portions of successive, adjacent recesses overlapping longitudinally, said recesses terminating in side portions, said side portions of successive, adjacent recesses overlapping circumferentially, and said outer peripheral surface extending uninterrupted between said recesses.

6. A tubular member for use in well bore drilling operations comprising:

- (a) an outer peripheral surface on the tubular member,

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- (b) a plurality of recesses interrupting said outer peripheral surface at circumferentially and longitudinally spaced intervals substantially throughout the longitudinal extent of the tubular member.
- (c) said outer peripheral surface extending uninterrupted between said recesses, 5
- (d) said recesses terminating in end portions,
- (e) said end portions of successive, adjacent recesses overlapping longitudinally,
- (f) said recesses terminating in side portions, and 10
- (g) said side portions of successive, adjacent recesses overlapping circumferentially.
7. A tubular member for use in well bore drilling operations comprising:
- (a) an outer peripheral surface on the tubular member, 15
- (b) a plurality of recesses spaced circumferentially in a row in said outer peripheral surface,
- (c) there being a plurality of rows of recesses in said outer peripheral surface, 20
- (d) said outer peripheral surface extending between said recesses in each row and between each row of recesses,
- (e) said recesses having end portions and side portions,
- (f) said end portions of said recesses in each row overlapping said end portions of said recesses in the next adjacent row, and 25
- (g) said side portions of said recesses in each row overlapping said side portions of said recesses in the next adjacent row.

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8. A tubular member for use in well bore drilling operations comprising:

- (a) an outer peripheral surface on the tubular member,
- (b) a plurality of recesses interrupting said outer peripheral surface at circumferentially and longitudinally spaced intervals substantially throughout the longitudinal extent of the tubular member.
- (c) successive, adjacent recesses overlapping longitudinally in said surface,
- (d) successive, adjacent recesses overlapping circumferentially in said surface, and
- (e) said outer peripheral surface extending uninterrupted between said recesses.

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