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DRILL STRING STABILIZER

Clarence H. Leathers, 3010 Johnson Ave.,
Redondo Beach, Calif.

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3 Claims. (Cl. 308-4)

This invention relates generally to drill pipe stabilizers which are adapted to be attached onto rotary drill strings and particularly onto drill collars for engagement with the wall of a well in lateral stabilizing relationship with the string, and more particularly with an improved stabilizer having a combination of metallic and elastomeric wear surfaces.

In a drilling operation wherein one or more stabilizers are used on the drill string, and particularly on the drill collars, at a location in the well, it is frequently necessary to wash over the string and past the stabilizers, as for example, when it is desired to clean out loose material in the bottom of the hole. Although the stabilizers are fluted for by-passage of the drilling mud during the drilling operation, the flutes are not ordinarily large enough to pass the loose material or larger pieces which have fallen into the hole or have in some manner become dislodged in the hole beneath the stabilizer. To remove such material it is necessary to either remove the stabilizers from the drill string or cut them away in place, the latter operation being preferred since the former necessitates pulling the pipe from the well. In cutting away the stabilizer body, which is formed of drillable material strong enough to resist lateral deflection of the string within the hole, an overshot having a cutting tool at the lower end thereof is normally lowered down the well over the string and brought into engagement with the stabilizer, following which rotation of the overshot cuts away the stabilizer body. This operation is made difficult by the tendency of the stabilizer to rotate with the cutting tool so that the slipping stabilizer blocks such further lowering of the overshot as is necessary to cut away lower stabilizers mounted on the drill collars.

In the prior state of the art stabilizers have been developed which overcome these two difficulties by forming the main body of the stabilizer of a soft elastomeric material which can be easily cut away by a washover tool and by providing within the elastomeric body at a lesser diameter than the outside diameter of the tool, a metal sleeve which has engaging lugs at the bottom end thereof. The lugs are mateable with similar upwardly extending teeth or lugs on the mandrel or collar to which the stabilizer is affixed. Thus, if the downward force is exerted by the washover tool on the stabilizer it is pressed into non-rotatable engagement with the drill string and the washover tool is allowed to mill away the elastomeric stabilizer body with little difficulty.

It has been found, however, that such stabilizers are not completely satisfactory, due primarily to the fact that the elastomeric body is necessarily soft in both wearing qualities and longitudinal stiffness. That is, the elastomeric material, most generally rubber, is capable of being deformed sufficiently that some binding effects are sometimes encountered in a tight hole, and in addition the surface of the stabilizer which forms the wear surface is not sufficiently resistant to abrasive wear for some stabilizer applications. Another stabilizer of the prior art which attempts to circumvent the above described problems does so by forming the entire stabilizer body out of a relatively soft metal such as aluminum. This metal can, of course, be milled over more easily than a harder steel but such all-metal stabilizers have some disadvantages which are not present in the elastomeric stabilizer. Primarily, such stabilizers have very little cushioning effects since the entire body is formed

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of rigid metal. This cushioning effect has been found to be very desirable in such stabilizers.

Accordingly, it is a primary object of the present invention to provide an improved drill string stabilizer which has an outer contact surface which is resistant to abrasive wear.

It is another object of the present invention to provide an improved drill string stabilizer which utilizes deformable elastomeric material for the cushioning effect inherent in such material.

It is still another object of the present invention to provide an improved drill string stabilizer which is essentially an elastomeric stabilizer body but which is stiffened and strengthened to an extent not heretofore possible in connection with elastomeric stabilizers.

It is a further object of the present invention to provide such a drill string stabilizer which has wear resistant contact surfaces but which is nevertheless easily milled or washed over when necessary in a drilling operation.

It is a still further object of the present invention to provide such a drill string stabilizer which is efficient in use and economical to manufacture.

In its presently preferred form the drill string stabilizer in accordance with the present invention comprises an elongate cylindrical elastomeric body having an outside diameter defining the contact surfaces of the stabilizer. Longitudinally extending flutes are provided extending radially inwardly from the outside diameter to define a plurality of circumferentially spaced longitudinally extending passages separated by longitudinal ribs. Positioned within each of the radially extending longitudinal ribs of the stabilizer there is a relatively soft metal insert having the outer surface of the metal substantially coincident with the outside diameter of the stabilizer such that it provides the contact surface of the stabilizer. The inside diameter of the metal inserts is substantially greater than the inside diameter of the stabilizer such that a rubber or elastomeric cylinder is provided between the metal inserts and the inside diameter of the stabilizer. Within the rubber cylinder there is provided a metallic sleeve which is cylindrical in configuration and has engaging lugs at one end thereof.

The novel features which are believed to be characteristic of the present invention both as to its organization and method of operation, together with further objects and advantages thereof, will be better understood from the following description considered in connection with the accompanying drawing in which a presently preferred embodiment of the invention is illustrated by way of example. It is to be expressly understood, however, that the drawing is for the purpose of illustration and description only and is not intended as a definition of the limits of the invention.

In the drawing:

FIGURE 1 is a vertical section taken through an illustrative well and showing an exemplary drill string with a stabilizer in accordance with the present invention mounted thereon;

FIGURE 2 is an enlarged elevational view of the stabilizer in accordance with this invention shown partly in section;

FIGURE 3 is a sectional view taken along line 3-3 of FIGURE 2; and

FIGURE 4 is a view in perspective showing one of the metallic inserts which is positioned in the elastomeric stabilizer body.

Referring now to the drawings, there is shown in FIGURE 1 a stabilizer 20 in accordance with the present invention mounted upon a sub 11 which is connected into the drill string 12 extending within a vertical well hole 14. The stabilizer is substantially cylindrical in configu-

ration with an inside diameter approximately equal to the outside diameter of a tubular mandrel 15 which is connected to an upper extension 16 by a threaded joint 17, the extension and the mandrel together forming the complete sub. The stabilizer is slidably and rotatably mounted with respect to the mandrel and is movable between an upper shoulder 13 formed by the lowermost surface of the extension 16 and a lower shoulder formed by an irregular bearing surface 31 on the mandrel 15. The sub is adapted for connection into the drill string by threaded joints 18 formed at the lower end of the mandrel 15 and at the upper end of the extension 16. It is understood that the sub may be connected into any portion of the drill string, particularly between the drill collars, for stabilizing purposes. A central passage 19 extends longitudinally through the mandrel and the extension 16 to communicate with similar passages formed in the string for flowing drilling mud therethrough.

Referring now particularly to FIGURES 2, 3 and 4, an improved drill string stabilizer in accordance with the present invention is designated generally as 20 in the figures, and is shown in partial section in FIGURE 2. The stabilizer comprises in general a rigid sleeve 21 with a length substantially equal to, but slightly less than, the overall length of the stabilizer, and which has an inside diameter substantially greater than the inside diameter of the stabilizer and the outside diameter of the section of the mandrel upon which the stabilizer is mounted. The sleeve is preferably formed with a plurality of perforations extending radially therethrough such that it can be molded integrally with the rubber body portion of the stabilizer as described hereinafter.

The stabilizer includes an elastomeric body portion 22 which is secured to the sleeve 21 through the perforations therein. The elastomeric body is sized for downward reception within the well without substantial interference with the wall thereof, with the maximum outside diameter being large enough to effectively stabilize the drill string against lateral deflection by engagement with the formation wall following slight lateral stabilizer displacement. Thus, the elastomeric body 22 is cylindrical in configuration with an inside diameter substantially less than the inside diameter of the sleeve 21 and approximately equal to the outside diameter of the mandrel. A series of longitudinally extending grooves 23 are provided in the inner surface of the body 22 to allow the movement of fluid between the stabilizer and the mandrel sufficient to form a lubricating film therebetween. The elastomeric body 22 extends outwardly beyond the outer diameter of the sleeve 21 to the outside diameter of the stabilizer at 25 in FIGURE 3. The body is formed with a series of longitudinally extending radial flutes 26 which are circumferentially spaced about the stabilizer in the outer surface thereof. The flutes 26 therefore divide the stabilizer body into a series of circumferentially spaced protrusions, or ribs, 27 which are sufficient in width at the outer diameter 25 thereof to provide the necessary bearing surfaces of the stabilizer. Thus, the stabilizer body includes longitudinally extending alternate ribs 27 and flutes 26. The purpose of the flutes is to permit upward passage of drilling fluid in the well without materially interfering with such flow. The relative circumferentially measured width of the ribs and flutes can be readily determined by one skilled in the art.

At the lower end of the sleeve 21 there are provided a series of circumferentially spaced engaging means such as the engaging lugs 30. The lugs are formed with at least one vertical bearing surface thereon which is mateable with the irregular bearing 31 on the sub. The bearing surface on the sub will be oppositely directed to that on the sleeve. Thus, as is well known in the art, if the stabilizer is forced downward into engagement with the sub it is locked in non-rotatable orientation with respect to the sub. As discussed hereinbefore, this is necessary

when a washover operation is to be performed in the well. In such a washover operation it is necessary that the overshot tool mill or cut away the ribs 27 of the stabilizer beyond the diameter of the sleeve 21. That is, the flutes themselves are not sufficient in size to allow the removal of large bodies and the outer diameter of the ribs completely fills the diameter of the well hole. Thus, if it is necessary to cut away a tool beneath the stabilizer it is essential that the tool can pass over the stabilizer, which is done by milling or cutting away that part of the stabilizer body extending beyond the sleeve 21.

In accordance with the present invention there is provided in each of the plurality of ribs 27 a stiffening wear member 40 formed of a substantially rigid and abrasive resistant material such as aluminum. The material from which the wear members 40 are formed must be sufficiently soft so that it can be milled or cut away by an overshot or similar washover tool. As shown particularly in FIGURES 2 and 4, each of the wear members 40 comprises longitudinally extending parallel sections 41 and 41a which are spaced apart and are arcuate in configuration. The sections 41 and 41a have exterior surfaces 42 and 42a, respectively, that coincide in curvature with the outside diameter 25 of the stabilizer. The two vertically extending sections 41 and 41a are spaced apart and connected by bridge members 44. Hence, the wear members 40 have openings 46 extending radially therethrough in order that the rubber from which the stabilizer body is formed can pass through the openings 46 to retain the members 40 in position. The circumferential width of the sections 41 and 41a is less than half the circumferential width of each rib 27 such that the member 40 when in position in the rib presents two surfaces 42 and 42a which are substantially parallel but which are spaced apart. The portion of the body located between the two parallel sections 41 and 41a and radially outward from the bridges 44 is filled with rubber such that the outside surface of each rib 27 is a composite of rubber and metal. Thus, each rib contains an intermediate surface of rubber 50 separating surfaces 42 and 42a of metal which is more resistant to abrasive wear than the rubber. The radially inner surface 51 of the wear members is formed with a radius of curvature substantially symmetrical about the center line of the stabilizer. The thickness of the members 40 is such that the inside surface 51 of each member is radially spaced away from the outside diameter of the sleeve 21 by a substantial distance.

Thus, as shown particularly in FIGURES 2 and 3, each of the members 40 is imbedded in a corresponding one of the ribs 27 by molding the elastomeric body about the members. The rubber will flow through the openings 46 and retain the member in position by filling the entire length of the space existing between the spaced-apart sections 41 and 41a of the rib 40. Thus, each of the ribs is, in effect, floating in the elastomeric body and is spaced away from the rigid sleeve. Accordingly, a rubber cushion is provided by the rubber existing between the wear member 40 and the sleeve 21 and between the sleeve 21 and the mandrel.

Accordingly, it can be seen that when it is necessary to mill or cut away the outer portion of the stabilizer in accordance with this invention, such milling can be easily accomplished due to the configuration of the wear members 40 and the material from which they are formed. The fact that a bridge of relatively less thickness than the spaced-apart sections 41a and 41 is used to join the sections makes it possible that an overshot tool will both mill away and fracture the members 40, causing them to fall as relatively small disengaged parts downward into the well hole. It can also be seen from the description that a stabilizer in accordance with this invention presents a bearing surface which is more resistant to abrasion than rubber alone. The bearing surface is comprised mostly of a series of spaced-apart metal

surfaces with some rubber surface existing between the metal. Since the metal in contact with the wall of the well is isolated from the metallic or rigid parts of the drill string, a cushion is provided against shock being transmitted from the wall of the well to the drill string. In addition, the longitudinally extending wear members 40 stiffen the rubber body sufficiently that it is not deformable into a binding condition.

Thus, in normal operation the drill string may be rotated relative to the stabilizer in the well hole without interference therewith, the stabilizer acting to center the string within the hole. If it becomes necessary to lower a tool, such as a washover tool, within the well beyond the stabilizer, the tool is lowered in the well to cut away the outer portion of the stabilizer, when the tool comes to rest against the stabilizer, the stabilizer is forced down into non-rotatable position on the mandrel and the further rotation of the overshot causes the outer portion of the stabilizer to be milled away without slippage.

What is claimed is:

1. A drill string stabilizer adapted to be rotatably mounted upon a longitudinally extending cylindrical sub in a drill string and adapted to be inserted into a well bore comprising: an elongate cylindrical elastomeric body, said body having an outside diameter substantially equal to the diameter of said well bore and an inside diameter substantially equal to the outside diameter of said sub; alternately circumferentially spaced longitudinally extending flutes and rib sections defined by the exterior surface of said body; a longitudinally extending rigid sleeve positioned within said body, said sleeve having an inside diameter greater than the inside diameter of said body and an outside diameter substantially less than the innermost diameter of said flutes; and a longitudinally extending rigid wear member of drillable metal positioned within and affixed to each of said rib sections respectively, each of said members including first and second longitudinally extending circumferentially spaced apart portions defining first and second arcuate surfaces coincident with the exterior surface of said rib, each of said first and second portions being of equal length substantially equal to the length of said rib sections, each of said wear members including bridge members connecting said first and second portions, each of said members having a radial thickness defining an interior surface of said member spaced radially outward from the outside diameter of said sleeve.

2. A drill string stabilizer adapted to be rotatably mounted upon a longitudinally extending cylindrical sub in a drill string and adapted to be inserted into a well bore comprising: an elongate cylindrical elastomeric

body, said body having an outside diameter substantially equal to the diameter of said well bore and an inside diameter substantially equal to the outside diameter of said sub; alternately circumferentially spaced longitudinally extending flutes and rib sections defined by the exterior surface of said body; a longitudinally extended perforated sleeve positioned within said body, said sleeve having an inside diameter greater than the inside diameter of said body and an outside diameter substantially less than the innermost diameter of said flutes, portions of said elastomeric body extending through said perforations in said sleeve; and a longitudinally extending rigid wear member of drillable material positioned within and affixed to each of said rib sections respectively, each of said members including first and second longitudinally extending circumferentially spaced apart portions defining first and second arcuate surfaces coincident with the exterior surface of the corresponding rib section, each of said first and second portions being of equal length substantially equal to the length of said rib sections, each of said wear members including bridge members connecting said first and second portions, each of said members having a radial thickness defining an interior surface of said member spaced radially outward from the outside diameter of said sleeve.

3. A drill string stabilizer adapted to be rotatably mounted upon a generally vertically oriented drill string comprising: an elongate cylindrical elastomeric body having an outside diameter defining the outside diameter of the stabilizer and an inside diameter substantially equal to the portion of the drill string upon which the stabilizer is adapted to be mounted; circumferentially spaced longitudinally extending flutes and rib sections defined by the exterior surface of said body; and a longitudinally extending rigid wear member of drillable material positioned within and affixed to each of said ribs respectively, each of said members including first and second longitudinally extending circumferentially spaced apart portions defining first and second arcuate surfaces coincident with the exterior surface of the corresponding rib section, each of said first and second portions being of equal length substantially equal to the length of said rib sections, each of said wear members including bridge members connecting said first and second portions.

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