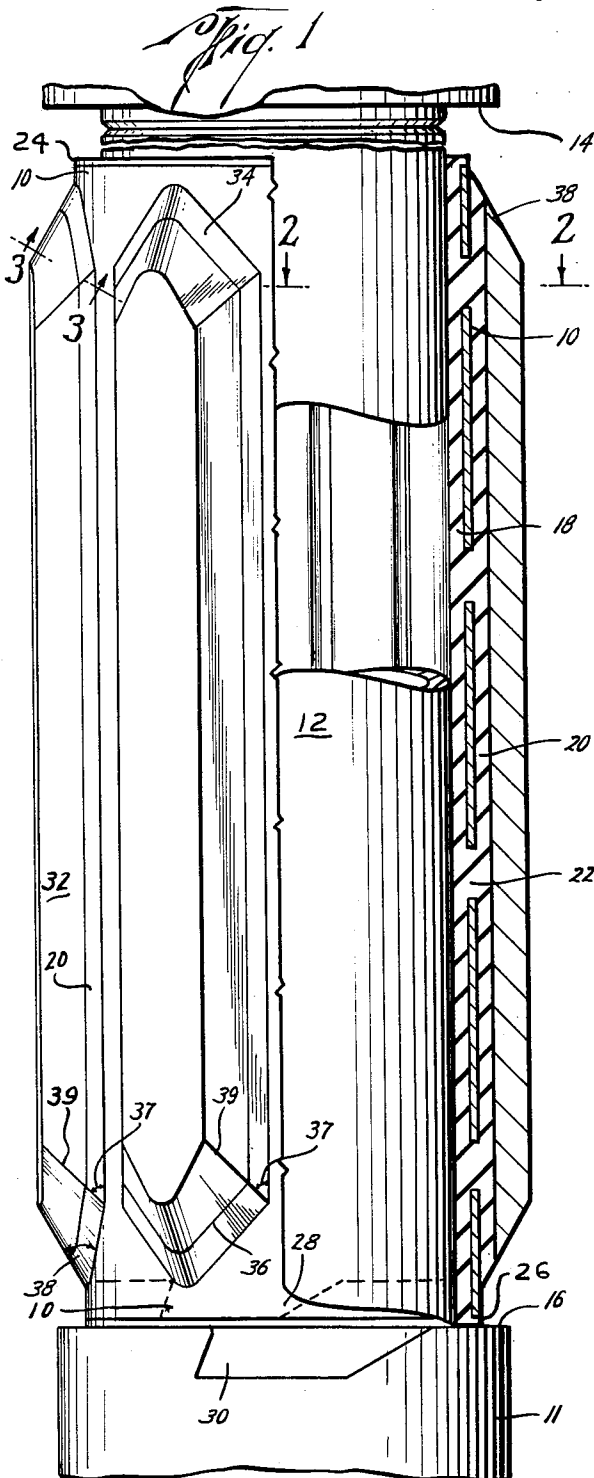
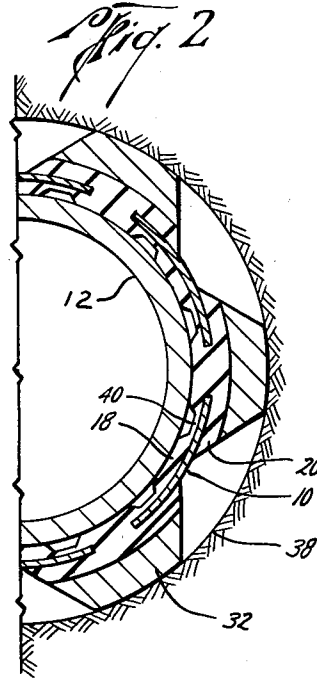
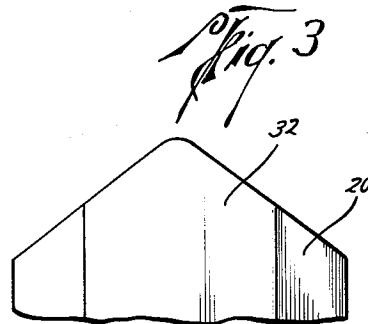


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DRILL COLLAR STABILIZER

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DRILL COLLAR STABILIZER

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This invention pertains to the drilling of oil and gas wells. More particularly, the invention pertains to stabilizers used for the guidance, support and stabilization of rotary drill strings and especially of drill collars, or that portion of the drill string immediately above the drill bit.

The use of stabilizers is desirable in order to obtain the greatest possible benefit from the pendulum effect of the heavy drill collars above the bit for the purpose of drilling the straightest possible hole, and their use is additionally desirable for the purposes of preventing pressure differential sticking and protecting the drill collars and drill string components from bending and scuffing against the hole wall.

There are many problems encountered in drilling holes of great depth which are concerned with the operation of the lower portion of the drill string, that portion which usually comprises a series of drill collars and the bit.

One of such problems is the physical damage suffered by the drill collars through chafing and scuffing contact with the wall of the hole, even though the string comprises heavy, thick-walled drill collars which are used near the bottom of the drill string to obtain a pendulum effect which will be discussed later. Such bending and scuffing reduces the weight and efficiency of the drill collars and eventually renders them useless through the failure of the threaded joints thereof.

The flexibility of the long drill string causes it to strike the hole wall during part of its rotation, especially in those parts near the drill bit. Since the hole itself is almost never exactly vertical, the tendency is for the drill string to lie, or bear heavily, upon the low side of the hole during rotation. This has at least three adverse effects.

First of all, contact with the well wall only a few feet above the drill bit causes uneven downward pressures to be exerted upon the drill bit. As the bit rotates on the bottom of the hole, the effects of uneven pressures on the periphery of the rotating bit are obviously undesirable effects upon the directional stability thereof.

Secondly, such contact adversely affects the two factors of the pendulum effect which tends to keep the hole straight. These two factors are the length of the pendulum, that is, the distance from the point of contact to the bit, and the weight of the collars below such point of contact. Obviously, if the location of the point of contact is not controlled, both the length of the "pendulum" and its weight tend to be minimized, thus losing directional stability. These conditions, along with others, cause deviation of the hole from the vertical to such an extent that the driller is often forced to use a whipstock to bring the deviation of the hole back within acceptable limits.

Also, where soft formations are found, the rotating drill collars tend to burrow laterally into the well wall and simultaneously effect a fluid seal therewith. The pressure of the well fluid on the portion of the rotating drill collars not in contact with the well wall, causes pressure differential sticking of the drill string whereby movement of the string becomes impossible.

In conventional practice, there are in current use several devices, which are used to alleviate the above conditions and which have enjoyed some degree of success.

Conventional devices used for overcoming the above described difficulties, which are generally classified as

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stabilizers, are the cast iron fin, the roller bearing, the rotating blade and the fluted rubber bushing types.

The first and oldest of these devices, because of poor performance, short life, erosion of the well wall and the problems from the heavy iron debris left in the hole after its break up, was abandoned at an early date. Also there was some difficulty in milling off the cast iron fins so that an overshot tool could be used to recover the lower part of the drill string when breaking thereof occurred.

The roller bearing type stabilizer also caused erosion of the well wall due to the moving contact therewith and thereby soon lost its centering and stabilizing influence on the drill string. Also, this tool and the debris left thereby, is subject to the same criticism during "fishing" operations as the cast iron fin stabilizer. Also, the axial beam, or longitudinal rigidity of the metal stabilizer was a large factor in its demise. The irregular directions and surfaces of the holes drilled by rotary bits often caused the long rigid metal stabilizers to stick before they reached the bottom of the hole. Reamers fitted above the bits were necessary to alleviate this situation.

The rotating blade type stabilizer has been successful in soft formation areas but has also caused erosion of the well wall and has demonstrated very poor durability in hard formation areas. Also, difficulties in using an overshot, similar to those met in the use of the iron fin type, are present in the use of this device.

All of the above types of stabilizers are of rigid construction and for that reason, are not able to follow the bit down the hole because of the rough wall irregularities if such stabilizers are of substantially the same "gauge" or diameter as the bit. When used, they must be of smaller gauge and thereby must be less efficient in performing their intended function of centering the pipe in the hole.

The rubber ribbed conventional device, the one now most commonly used, is far superior to the first two mentioned and enjoys much greater success in the performance of its intended functions. This rubber stabilizer, usually freely and rotatably disposed about a mandrel which is made up as part of the drill collar string several feet above the bit contacts the well walls with its rubber ribs. This stabilizer remains substantially stationary while the drill string rotates therewithin a fluted bushing which is lubricated by the well fluid. Although this device overcomes many of the difficulties encountered with the other devices discussed, several disadvantages have lessened its efficiency and shortened its life. The greatest problem encountered in the use of this device has been the tearing or shearing of the exterior ribs by contact with abrasive formations and the tendency of the well circulating fluid to lodge abrasive particles or cuttings between the ribs and the walls of the well. Although the rubber ribs are easily milled off to enable use of a wash over or overshot tool, it has not been found possible to limit the tearing of such rubber ribs to the extent desirable in view of the expense of an otherwise unnecessary pulling of the drill string to renew the devices.

An object of the invention is to provide a drill string or drill collar stabilizer that will cause the centering of the drill string in the hole without an erosion of, or damage to, the hole wall.

Another object of the invention is to provide a drill collar stabilizer which is much more durable in contact with the well wall and the rotating drill string.

Another object of the invention is to provide a drill collar stabilizer which, upon stuck pipe or loss in the hole, is easily washed over or overshot and the debris thereof easily removable from the well by the circulation of the well fluid.

Another object of the invention is to provide a stabilizer with durable metal ribs, which stabilizer retains enough

flexibility and resiliency to allow it to go down into the hole without sticking in the contiguous directional irregularities of the hole.

Another object of the invention is to provide a stabilizer having axial flexibility, combined with abrasion resistance, sufficient to enable its use in relatively soft and abrasive formations to prevent pressure differential sticking, and the debris of which stabilizer, when washing over or overshooting thereof is necessary, is light enough to be removed from the hole by the circulation of well fluid.

Another object of the invention is to provide a drill collar stabilizer, the means for contacting the well's walls thereof being of such design and construction, that the usual erosion of the well wall contacting means caused by the abrasive cutting and tearing action of particles carried by the well fluid, does not take place.

Another object of the invention is to provide a stabilizer with resiliently mounted wall contacting ribs not subject to the tearing and shearing failures caused by contact with abrasive formations forming the well wall.

Briefly, the invention comprises a new type of drill string stabilizer sleeve to be rotatably disposed on the mandrel of a stabilizer body and comprising a fairly light and flexible tubular steel barrel with clutch means on the lower portion thereof and having a molded rubber inner liner forming a lubricated bearing around the mandrel of a drill collar sub body and a plurality of light metal alloy ribs for engaging the wall of the hole and which have their ends shaped in a prow-like hydrodynamic configuration. The ribs are either vertical or have a vertical component so as to provide passages therebetween for fluid to flow up and down past the stabilizer. These ribs, are bonded to the outside of the steel body by an intervening layer of resilient rubber. The light metal, or alloys thereof used in the ribs have properties of ductility lying within the range of 10 to 45% elongation, hardness within the range of Brinell 20 to 150, 500 kg. loading, 10 mm. ball, and specific gravity within the range of 1.5 to 3.2.

Foremost among the advantages of the invention is the fact that these ribs will not tear and are much more resistant to shearing and scuffing than the rubber ribs and the configuration of such metal ribs is such that the circulation of the well fluid therebetween does not tend to lodge abrasive cuttings or particles, carried in the well fluid, between the well wall and the engaging ribs in the areas of contact therebetween. This combination accomplishes much more than the mere addition of metal ribs, or rubber ribs with metal tips, or metal ribs not mounted on a resilient base. The invention combines the tearing resistant metal ribs with resiliency of mounting that allows the stabilizer to be used full gauge with the bit. This is true because of the hydrodynamic shape of the end faces of the ribs and the resiliency of the mountings which allows the stabilizer to "squeeze" through the tight places in the hole. The invention obtains all the advantages of resiliency between the stabilizer body, the well wall and the rotating drill string passing therethrough, which enables the stabilizer to be run to the bottom without sticking in the irregular or crooked hole. The advantages of greater durability over the use of exterior rubber ribs and the still greater advantage of enabling the stabilizer body to be in prolonged contact with the walls of the well without the erosion thereof caused by the lodging of cuttings heretofore encountered, constitute major advances in the art.

Another advantage of the invention is that the milled off debris of the ribs can be further disintegrated by a drilling bit, is light in weight and can be easily removed from the bore of the well by the circulation of the well fluid.

Another advantage of the device is that the configuration of the metal engaging rib, which makes such ribs hydrodynamic in shape, also allows the device to be moved more easily up and down in the hole because the shape of the engaging ribs avoids hanging and sticking on the

rough walls of the well. Thus, the flexibility of the whole stabilizer may be more effectively used.

Another advantage of the hydrodynamic configuration is that the well fluid, usually carrying abrasive cuttings, is channeled between the ribs and therefore does not tend to lodge cuttings between the ribs and the well wall, thereby causing abrasion of the rib and wall.

Another advantage of the invention is that the vertically oriented hydrodynamic shape of the upper and lower ends of the vertical rib and the relative rigidity and strength of the metal rib reduces the effect of the shearing stresses acting thereon because the metal ribs distribute the shearing force acting on the upper or lower faces of the ribs over the entire length of the rib, maintaining the integrity of the bond of the ribs and stabilizer body under the impact of much greater shearing forces than has been heretofore thought possible.

Referring now to the drawings, FIGURE 1 is a partially elevational and partially vertical section of the preferred embodiment of the device.

FIGURE 2 is a cross sectional view of the device taken at lines 2—2 of FIGURE 1.

FIGURE 3 is a sectional view of a portion of the composite vertical rib at line 3—3 which forms a plane normal to the outermost line of the hydrodynamic faces 34 and 36.

Referring now to FIGURE 1, the steel barrel or structural member 10 is disposed about a mandrel 12 of stabilizer body 11 which has upper and lower annular shoulders 14 and 16 respectively. Upper shoulder 14 is threadably attached to mandrel 12 of body 11. Rubber (natural or synthetic or compounds thereof) inner layer 18 and outer rib base strip 20 are bonded to barrel 10 and communicates therethrough by ports 22. Annular rubber flanges 24 and 26 are formed at the top and bottom of the barrel 10 respectively as shown and are continuations of inner layer 18. A milling interlock or jaw is formed by clutch dog 28 on barrel 10 and slots 30 in lower shoulder 16 in the lower end of the device. The metal well wall engaging ribs 32, made of aluminum or other metal light enough to be carried by circulating well fluid and soft enough to be milled off by the overshot shoe, are bonded to outer rib base strips 20. The composite fins formed by ribs 32 and rubber base strips 20 are formed with hydrodynamic faces 34 and 36, at the upper and lower ends of the fins respectively. The bevel 38 between hydrodynamic faces 34 and 36 and the axis of the barrel 10 is less than 45°. (The bevel 37 between the most remote edge 39 of the lateral surfaces of the hydrodynamic faces and the axis of barrel 10 is usually approximately 60°.) It will be noted that the fins are made entirely of non-ferrous materials, namely, rubber or a non-ferrous metal. Only the steel barrel is made of ferrous metal.

Referring now to FIGURES 2 and 3, inner layer 18 and outer base strip 20 are shown formed around and communicating through barrel 10. The outer faces of metal ribs 32 are laterally curved, having a radius substantially equal to the radius of the bore of the well 38. Inner layer 18 has vertical channels or grooves 40 therein for the purpose of lubricating the stabilizer on the mandrel of the drill collar sub by the well fluid.

In operation, the stabilizer sleeve is disposed around mandrel 12 of the stabilizer body when such body is broken out of the drill string. Upper annular shoulder 14 is removable, enabling the stabilizer sleeve to be slipped over the mandrel 12. The drill collars and drill string with the stabilizer sleeve in position around the mandrel is run into the hole to the point where drilling is to begin. This running in can easily be accomplished because of the hydrodynamic configurations of the faces of the fins aforementioned and the flexibility and resiliency of the whole stabilizer sleeve. The stabilizer body is located at a calculated height above the bit. When the actual drilling begins, the drill string turns and mandrel 12 rotates inside of stabilizer sleeve and the fluted

inner layer 18 acts as a bearing. The stabilizer body is held in a more or less fixed position by means of metal ribs 32 engaging the wall 38 of the hole and resisting the tendency of the rotating mandrel to cause rotation of the stabilizer body. The hydrodynamic faces 34 and 36 of the well engaging fins causes well fluid being circulated in the hole to be diverted around such well engaging fins in such manner that there is no tendency of the well fluid to flow over the engaging surfaces of the metal ribs 32 so that abrasive particles which are carried in such fluid and which otherwise tend to lodge between the ribs and the well wall in the vicinity of such engagement, do not lodge therebetween. The resilient outer rib base strip 20 of the stabilizer body allows resilient engagement of the comparatively hard metal ribs with the well wall without the susceptibility to shearing and tearing suffered when engaging ribs are constructed entirely of rubber, and allows the metal ribs to retract or flex enough to allow passage of the stabilizer through crooked and irregular portions of the hole.

While a preferred embodiment has been shown and described herein, many modifications thereof may be made by a person skilled in the art without departing from the spirit of the invention and it is intended to protect by Letters Patent all forms of the invention falling within the scope of the following claims.

We claim:

1. A stabilizer sleeve comprising a tubular barrel, bearing means carried by the barrel concentric therewith adapted to support a member extending axially through the barrel for rotation therewithin, a plurality of elongated metal ribs around the outer periphery of the barrel disposed with their lengths having at least a component in the direction of the axis of the barrel, said ribs being spaced apart circumferentially providing passage for fluid flow therebetween, and resilient mounting means securing said ribs to said barrel against radially outward displacement beyond a certain amount while allowing radially inward displacement thereof toward said barrel, said resilient mounting means being integrally bonded to said bearing means so that said resilient means can provide for inward deflection of said ribs while said bearing means provides for supporting a member extending axially through the barrel for rotation therewithin, the inward movement of said ribs allowed by said resilient mounting means therefor allowing the stabilizer sleeve to pass through tight places in a well bore, said resilient mounting means including strips of rubber between the metal ribs and the barrel and bonded to the metal ribs and affixed to the portion of the barrel directly radially inside the metal ribs, the metal ribs protecting the outer surface of the rubber strips against cutting and distributing throughout the lengths of the rubber strips such shear loads as are imposed by forces against the ends of the strips so as to tend to prevent the strips from tearing longitudinally in normal use, said metal ribs being made of a light weight drillable material of a specific gravity of the order of 1.5 to 3.2 and said metal ribs being independent of said sleeve except to the extent connected thereto by said rubber strips so that if the stabilizer gets stuck in a well it is possible upon application of end forces against the ribs sufficient to shear the rubber strips to free the sleeve from the ribs and the ribs can thereafter be drilled up for removal from the well.
2. A stabilizer sleeve comprising a tubular barrel, bearing means carried by the barrel concentric there-

- with adapted to support a member extending axially through the barrel for rotation therewithin, a plurality of elongated metal ribs around the outer periphery of the barrel disposed with their lengths having at least a component in the direction of the axis of the barrel, said ribs being spaced apart circumferentially providing passage for fluid flow therebetween, and resilient mounting means securing said ribs to said barrel against radially outward displacement beyond a certain amount while allowing radially inward displacement thereof toward said barrel, said resilient mounting means being integrally bonded to said bearing means so that said resilient means can provide for inward deflection of said ribs while said bearing means provides for supporting a member extending axially through the barrel for rotation therewithin, the inward movement of said ribs allowed by said resilient mounting means therefor allowing the stabilizer sleeve to pass through tight places in a well bore, said resilient mounting means including strips of rubber between the metal ribs and the barrel and bonded to the metal ribs and affixed to the portion of the barrel directly radially inside the metal ribs, the metal ribs protecting the outer surface of the rubber strips against cutting and distributing throughout the lengths of the rubber strips such shear loads as are imposed by forces against the ends of the strips so as to tend to prevent the strips from tearing longitudinally in normal use, said metal ribs being made of a light weight drillable material of a specific gravity of the order of 1.5 to 3.2, and said metal ribs being independent of said sleeve except to the extent connected thereto by said rubber strips so that if the stabilizer gets stuck in a well it is possible upon application of end forces against the ribs sufficient to shear the rubber strips to free the sleeve from the ribs and the ribs can thereafter be drilled up for removal from the well, said stabilizer sleeve being further characterized by the outer peripheries of the ribs being each a segment of a cylindrical surface concentric with the axis of the barrel, said ribs being made of ductile material so that the outer peripheral surfaces thereof will indent rather than cut upon contact with sharp particles in the well, the ends of said ribs being of gradually reduced circumferential outer peripheral extent progressing toward the ends providing prow like shapes to direct fluid into said passages between the ribs.
3. In a drill collar stabilizer comprising a sleeve and a tubular mandrel rotatably mounted therein, said sleeve including a tubular metal barrel having a bearing provided at the interior of the barrel adapted to receive said mandrel and having fins projecting radially outward from said barrel extending from nearer one end of the barrel toward the other end thereof and spaced apart circumferentially to provide fluid passages therebetween, the improvement according to which said fins each comprise an outer strip of aluminum and an inner strip of resilient rubber bonded to said barrel and to said metal strip, and means at the end of the fins for guiding fluid into said passages away from the outer periphery of said fins, said means comprising ends on said fins of reduced circumferential extent

flaring out gradually to the full circumferential width of the fins,
 whereby said rubber strips are protected by said aluminum strips against the tearing action of projections from the surface of a well wall and said aluminum strips can move inwardly relative to said barrel by deformation of said rubber strips in order to pass by such projections and erosion of said aluminum strips due to flow of abrasive fluid between the outer periphery of said ribs and surface of the well wall is reduced, and whereby said aluminum strips can be sheared off and drilled up in case of necessity.

4. In a drill collar stabilizer sleeve comprising a tubular metal barrel having a bearing provided at the interior of the barrel adapted to rotatably support a mandrel therein and having fins projecting radially outward from said barrel extending from nearer one end of the barrel toward the other and spaced apart circumferentially to provide fluid passages therebetween, the improvement according to which said fins each comprise an outermost portion of light weight drillable metal of a specific gravity of the order of 1.5 to 3.2 and an inner portion of rubber bonded to said outer portion and to said metal barrel directly radially inside said metal portion, whereby said outer metal portions of the fins can be sheared off and drilled up in case of necessity.

5. In a drill collar stabilizer comprising a sleeve a tubular mandrel rotatably mounted therein, said sleeve including a tubular metal barrel having a bearing provided at the interior of the barrel adapted to receive said mandrel and having ribs projecting radially outward from said barrel extending from nearer one end thereof toward the other end thereof, the improvement according to which said ribs are made of ductile, drillable, non-ferrous material having a specific gravity of the order of 1.5 to 3.2, each of said ribs being connected to the portion of said barrel nearest thereto by means of rubber bonded to such portion and to the rib.

6. In a drill collar stabilizer sleeve comprising a tubular barrel having a bearing provided at the interior of the barrel adapted to rotatably support a mandrel therein, and having fins extending from nearer one end thereof toward the other end thereof and spaced apart circumferentially to provide fluid passages therebetween, the improvement according to which said fins each comprise an inner strip of rubber and means covering the outer periphery of said rubber strip, said means comprising a strip of ductile metal bonded thereto, said metal having a ductility in the range of ten percent to forty-five percent elongation, whereby said rubber strips are protected against the tearing action of sharp projections on the interior surface of a well wall.

7. In a drill collar stabilizer sleeve comprising a tubular barrel having a bearing provided at the interior of the barrel adapted to rotatably support a mandrel therein, and having

fins extending from nearer one end thereof toward the other end thereof and spaced apart circumferentially to provide fluid passages therebetween, the improvement according to which said fins each comprise an inner strip of rubber and protective means at the outer periphery of said rubber strip, said protective means comprising a strip of ductile alloy of a light metal bonded thereto said metal being aluminum, the metal strip protecting the rubber therebeneath against cutting and tearing.

8. In a drill collar stabilizer comprising a sleeve and a tubular mandrel rotatably mounted therein, said sleeve including a tubular metal barrel having a bearing at the interior of the barrel adapted to receive said mandrel and having fins projecting radially outward from said barrel extending from nearer one end of the barrel toward the other end thereof and spaced apart circumferentially to provide fluid passages therebetween, the improvement according to which said fins each comprise an outer strip of aluminum and an inner strip made of rubber bonded to said aluminum strip and to said barrel directly radially inwardly of said aluminum strip.

9. A stabilizer sleeve comprising a tubular barrel, bearing means carried by the barrel concentric therewith adapted to support a member extending axially through the barrel for rotation therewithin, a plurality of elongated metal ribs around the outer periphery of the barrel disposed with their lengths having at least a component in the direction of the axis of the barrel, said ribs being spaced apart circumferentially providing passage for fluid flow therebetween, and means mounting said ribs on said barrel, said stabilizer sleeve being further characterized by the outer peripheries of the ribs being each a segment of a cylindrical surface concentric with the axis of the barrel, said ribs being made of ductile material so that the outer peripheral surfaces thereof will indent rather than cut upon contact with sharp particles in the well, the ends of said ribs being of gradually reduced circumferential outer peripheral extent progressing toward the ends providing prow-like shapes to direct fluid into said passages between the ribs.

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