Feb. 26, 1963 D. G. HUGLEY 3,079,205

EXPANSIBLE SWAB CUPS

Filed July 5, 1961 2 Sheets-Sheet 1

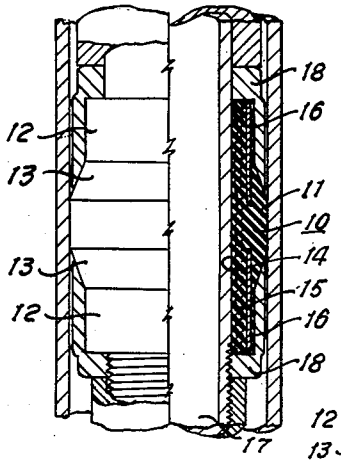


Fig. 1

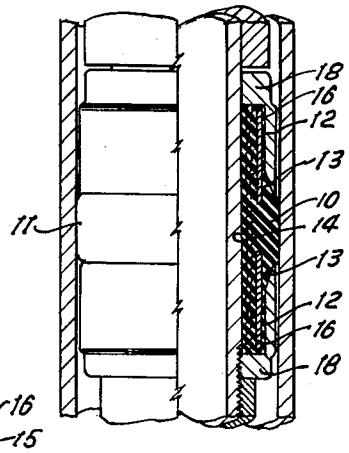


Fig. 2

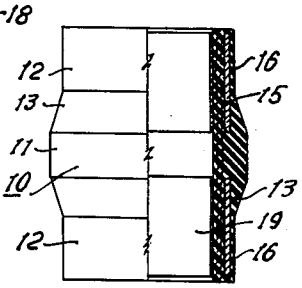


Fig. 3

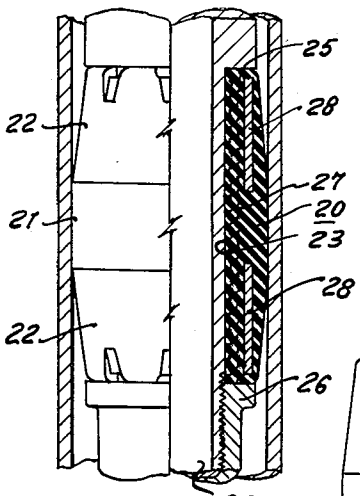


Fig. 4

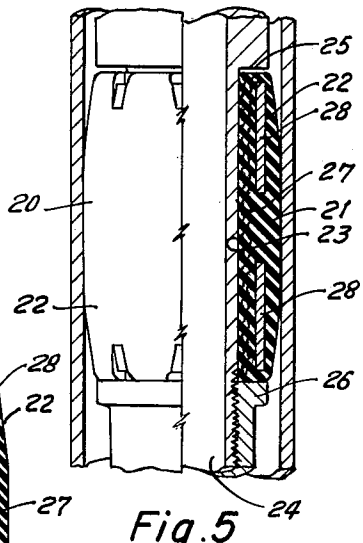


Fig. 5

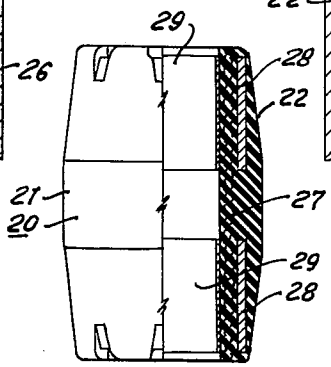


Fig. 6

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EXPANSIBLE SWAB CUPS

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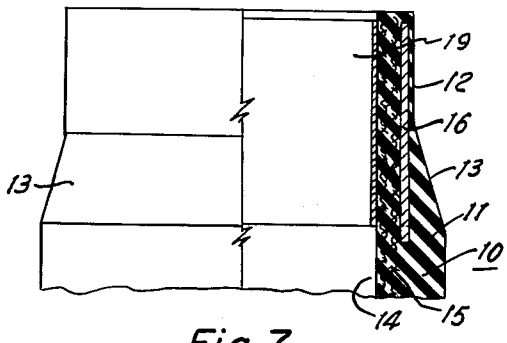


Fig. 7

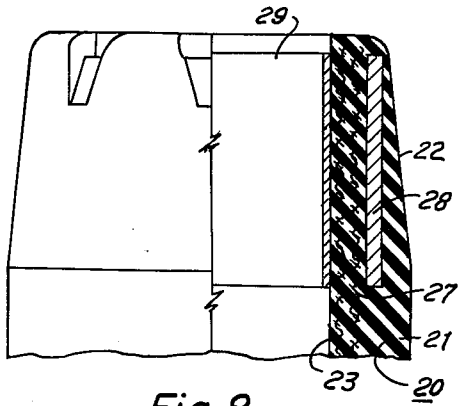


Fig. 8

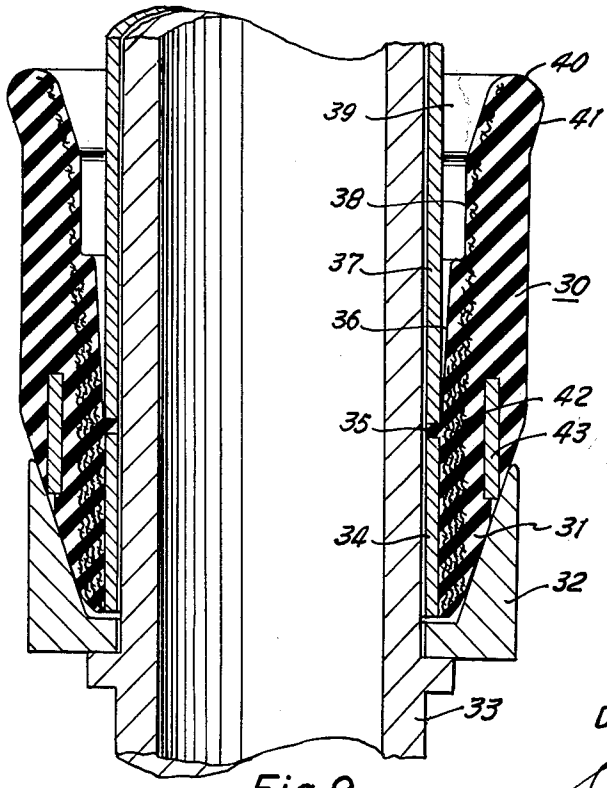


Fig. 9

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United States Patent Office

3,079,205
Patented Feb. 26, 1963

3,079,205

EXPANSIBLE SWAB CUPS

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Filed July 5, 1961, Ser. No. 121,873
13 Claims. (Cl. 309—54)

This invention relates to new and useful improvements in expansible swabs.

The invention is directed in particular to swabs for use primarily in petroleum wells for swabbing operations, and to swabs of the so-called "solid" variety as well as the "cup" variety.

In the past, it has been conventional to form swabs of various types with internal reinforcing consisting usually of layers of a suitable fabric such as canvas embedded in the swab, and to form the swab of an elastomer such as rubber, any of the several synthetic rubbers, and other similar flexible or expansible materials. The swab is mounted upon a suitable mandrel and is run into the well bore, usually through the well tubing, upon a pipe or cable, there normally being included in the assembly a downwardly closing check or ball and seat valve which will permit movement of liquid present in the well bore upwardly through or past the assembly. Upon reverse and upward movement of the swab assembly, the check valve closes, and the swab expands under hydrostatic load to a greater or lesser extent to prevent downward escape of liquid and resulting in the withdrawing upwardly through the well bore or pipe of relatively large quantities of liquid in one operation. Such swabbing operations are carried out on various occasions for conventional and well known purposes in the cleaning or producing of a well, usually a petroleum well.

Thus, as the swab is moved upwardly through the well bore or pipe, it is subjected to relatively heavy hydrostatic loads as well as to wearing or abrading effects, and some difficulty has been experienced in obtaining the desired useful life from a swab or a set of swabs, and in preventing the premature destruction or cutting out of the walls of the swab due to the loads applied thereto.

Swabs of this type are normally formed with tapered end portions or end portions of lesser diameter than the medial portions of the swab so as to constitute an approximately barrel shaped element, and are provided with an axial bore for receiving the mandrel upon which the swabs are mounted. To strengthen the swab, it has been customary to provide metallic sleeves or ferrules embedded in or bonded to the swab and disposed in or closely adjacent the upper and lower ends of the axial bore. Such structures have been found to cut out or wear excessively in the area intermediate the medial portion of the swab and the lower reduced end thereof, and it has long been sought to provide swab of this type in which the wear and abrasion would be directed to the thicker medial portion thereof, resulting in a swab of a prolonged useful operating life.

I have now found that by moving the reinforcing sleeves or ferrules outwardly in the body of the swab and extending them approximately into the central part of the middle or medial wall of the swab, the wear and abrasion, and the hydrostatic loads, are directed principally to the medial portion of the swab resulting in a longer useful life for the swab. In the case of swabs of the type having upper and lower necks joined through bevelled portions with the medial part of the swab, the reinforcing ferrules may desirably be placed closely adjacent the outer walls or peripheries of the upper and lower necks, whereas in the type of swab having tapered upper and lower ends, the ferrule is moved outwardly but is not placed as closely adjacent the outer wall of the tapered

upper and lower ends. In either case, however, the inner ends of the ferrules extend slightly into the thick medial portions and are spaced approximately equidistantly between the outer wall of the medial portion and the wall of the axial bore.

It is, therefore, one object of this invention to provide an improved swab having a longer useful or operating life than previously obtainable, and in which the swab successfully resists over greater periods of time the wearing and abrasive forces, as well as the hydrostatic loads, applied thereto.

A further object of the invention is to provide an improved swab having an inner liner which facilitates its placing on and removal from a mounting mandrel.

A still further object of the invention is to provide an improved swab having a body formed of a resilient material in which reinforcing material such as layers of fabric are embedded and in which metallic reinforcing sleeves or ferrules are also embedded in the resilient material but outwardly of the fabric reinforcing rather than inwardly thereof.

Yet another object of the invention is to provide an improved swab in the use of which the wearing and cutting forces normally encountered are effectively controlled and directed to the portion of the swab having the greatest resistance thereto and the greatest capacity to accommodate such wearing and cutting forces.

An additional object of the invention is to provide improved swab structures which may be utilized in conjunction with either single ended or double ended swabs to provide greater wear resistance and useful operating life.

Other and more particular objects of the invention will be apparent from a reading of the following description and by reference to the accompanying drawing.

A construction designed to carry out the invention will be hereinafter described, together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawing, wherein examples of the invention are shown, and wherein:

FIG. 1 is a view of a swab constructed in accordance with this invention, the swab being mounted on a mandrel and being shown in the position it assumes during its downward passage through the well bore or pipe,

FIG. 2 is a view similar to FIG. 1 showing the swab and mandrel assembly in the position it assumes during upward travel of the swab,

FIG. 3 is a view partly in elevation and partly in section of a modified form of the swab shown in FIG. 1,

FIG. 4 is a view partly in elevation and partly in section of another form of the swab showing the swab mounted upon a mandrel assembly and illustrating the swab in its downward passage,

FIG. 5 is a view similar to FIG. 4, showing the swab in its upward passage,

FIG. 6 is a view partly in elevation and partly in section of a further modification of the swab of FIG. 4,

FIG. 7 is an enlarged, fragmentary view, partly in elevation and partly in section, of the upper end of the form of swab shown in FIG. 3,

FIG. 8 is an enlarged, fragmentary view, partly in elevation and partly in section, of the upper end of the form of swab shown in FIG. 6, and

FIG. 9 is an enlarged, vertical, sectional view illustrating an additional type of swab constructed in accordance with this invention and having this invention applied thereto.

In the drawings, the numeral 10 designates a swab body formed of rubber, synthetic rubber, or some other suitable resilient and expansible elastomer and provided

with a central or medial cylindrical portion 11 and end portions or necks 12 of reduced diameter, the sections or necks 12 joining the medial portion 11 through tapered or bevelled intermediate portions 13. The swab body is also formed with an axial bore 14 extending throughout the length of the swab, the swab being longitudinally symmetrical so that it may be employed with either of the necks in a downward position. Suitable layers of reinforcing material, such as the fibrous elements 15 are desirably embedded in the body 10 of the swab adjacent the wall of the bore 14 and extend throughout the length of the swab. Woven fabric such as canvas has been found quite suitable to employ for this purpose. Outwardly of the layer or layers of reinforcing material 15, cylindrical metallic ferrules 16 are embedded in the body of the swab closely adjacent the outer walls or peripheries of the necks 12 and extend in alined relationship from the upper and lower ends of the swab into the enlarged medial portion 11. It will be noted that the inner ends of the sleeves or ferrules 16 are spaced apart and are disposed approximately equidistantly from the outer periphery of the medial portion 11 and the wall of the axial bore 14.

In previous swabs of this type in which the metallic reinforcing ferrules are disposed adjacent the wall of the bore 14, and particularly where such ferrules do not extend into the relatively thick walled medial portion, it has been found that the swabs tend to fail, sometimes prematurely, in the intermediate tapered portions 13, the body of the swab being forced outwardly over the inner end of predominantly the lower ferrule and resulting in cutting, abrasion, and premature loss of effectiveness of the swab in the zone of the lowermost intermediate portion 13. With the present structure, such cutting, wearing and abrasive forces are effectively directed into the area of the medial portion 11, which, presenting a greater wall thickness, more effectively resists such forces resulting in prolonged wear and a longer effective operating life for the swab. The tendency of the swab to cut and tear outwardly over the upper edge of the lowermost reinforcing ferrule, at which point the greatest load is applied, is effectively resisted, and yet the desired flexibility of the swab is retained permitting it to distort to some extent under an applied load as illustrated in FIG. 2 of the drawing. In use, the swab is mounted in the conventional fashion upon any type of suitable mandrel 17 carrying the usual upper and lower thimbles 18 which receive and confine the neck portions 12 of the swab.

In some instances, the body of the swab may tend to swell while in contact with certain types of liquids, and some difficulty may be encountered in replacing a swab on a mandrel or primarily, in removing a swab from such mandrel. For this reason, the swab of FIG. 1 may be modified as illustrated in FIG. 3 by including therein a pair of thin metallic liners 19 of cylindrical configuration and extending from each end of the axial bore 14 toward the medial portion thereof. Desirably, the liners 19 are bonded, vulcanized or otherwise adhered to the wall of the bore 14 so as to prevent their displacement therefrom although such adhering is not necessarily essential. In addition, the liners 19 should be coextensive with and radially alined with the ferrules 16.

It is pointed out that the ferrules 16 should be of approximately the same length in order that the swab will be fully reversible upon the mandrel 17 and employable with either of the neck portions 12 disposed or extending downwardly, and that the spacing between the inner ends of the ferrules should be such that the swab will carry both heavy and light liquid loads. If the spacing is too large the swab may fail under high loads, and if such spacing is too small, the swab becomes too rigid and will not always pick up relatively light loads. In the case of a swab for two inch well tubing, the spacing between the inner ends of the ferrules should be of the magnitude of ½ of one inch.

A modified form of the swab is shown in FIGS. 4 and 5 which includes a cylindrical body 20 formed of rubber, synthetic rubber, or any other suitable elastomer and having a more or less cylindrical center or medial portion 21 adjoined at each end by bevelled or tapered end sections 22 of lesser outside diameter than the medial portion 21. The swab is formed with an axial bore 23 which receives the mandrel 24 carrying an upper shoulder 25 and a lower removable shoulder member 26 between which the swab is confined. One or more layers of fibrous reinforcing material 27, such as a suitable cotton fabric of the nature of canvas, are embedded in the swab body 20 adjacent the wall of the axial bore 23, the layers desirably extending approximately throughout the length of the swab body. Outwardly of the layers of fibrous reinforcing material, a pair of cylindrical, metallic reinforcing sleeves or ferrules 28 are embedded or bonded in the body of the swab, one of the ferrules being disposed at one end of the swab and the other at the other end of the swab. The outer ends of the ferrules 28 are spaced slightly from the ends of the swab so that relatively thin sealing layers of the resilient material from which the swab is formed are provided at each end of the swab for sealing against the upper and lower shoulders. This arrangement also completely encases the outer ends of the ferrules 28 so as to eliminate the possibility or likelihood that the application of hydrostatic pressure or other forces will cause the resilient material in the swab to tend to tear away from the outer ends of the ferrules. As shown in FIG. 4, the ferrules are positioned in the outer half of the end sections 22 of the swab, but are not as closely adjacent the outside wall of such end portions as the ferrules 16 of the first form of the invention.

The inner ends of the ferrules 28 are spaced apart and extend into the thick medial section 21 of the swab, said inner ends being substantially equidistantly spaced between the outer wall of the medial portion 21 and the wall of the axial bore 23, similarly to the spacing of the inner end of the ferrules 16 of the first form of the invention.

In all those forms of the invention, there is desirably a slight clearance, of the magnitude of 1/32 of an inch between the outer wall of the medial portions of the swabs and the inner wall of the pipe or conductor through which the swab is being passed, this clearance being present when the swab is in its relaxed position during its downward passage through the pipe or conductor. Upon upward movement of the swab, however, such clearance, which is deemed too small to be illustrated in the drawing, is insufficient to accommodate the body of liquid attempting to flow downwardly, and hence, a hydrostatic pressure is applied to the swabs causing them to distort slightly downwardly, as shown in FIGS. 2 and 5 and to seal against the inside wall of the pipe or conductor in which the swab is positioned. In the case of the form of the invention shown in FIGS. 4 and 5, this is illustrated by the slight dropping of the upper end of the swab from the upper shoulder 25 when the swab is in its sealing and lifting position. The modification of FIGS. 4 and 5 functions in much the same manner as the first described modification, and the outward shifting of the reinforcing metallic ferrules 28 accomplishes the same desirable result of concentrating the destrictive forces applied to the swab in the relatively thick medial portion and preventing premature or early failure of the swab due to cutting or abrading in the thinner sections of the swab.

Similarly to the first form of the invention, the form just described may receive upper and lower liner sleeves 29 positioned in the axial bore 23 and desirably vulcanized or bonded to the wall thereof. Again, these relatively thin liner sleeves minimize any tendency of the swab to stick or seize upon the outer wall of the mandrel 24, and should be coextensive with the ferrules 28.

A further form of the swab as a swab cup is shown in

FIG. 9 and includes a body 30 having a tapered or bevelled lower end 31 for reception in the usual thimble 32 carried upon the mandrel 33. An inner sleeve 34 is bonded in the bore 35 of the body 30, similarly to the sleeves 19 and 29 of the previously described forms of the invention, for ease of removal of the cup from the mandrel. Upwardly of the sleeve 34, the bore 35 is enlarged to a first counterbore 36 adapted to receive the lower end of an elongate sleeve 37 which spaces the cup from the next upper cup. Toward the upper portion of the body 30, the bore is further enlarged to form a second counterbore 38 extending upwardly to the upper end of the cup and flaring outwardly as shown at 39 to merge into a rounded upper lip 40 which, as shown at 41, flares slightly outwardly from the main body of the cup 30. One or several layers of reinforcing material such as conventional reinforcing fabric or canvas 42 are embedded in the body 30 and extend from the lower end thereof upwardly past the outer surface of the sleeve 34 and upwardly through the body into the lip 40.

The reinforcing ferrule 43 is embedded in the lower portion of the swab cup body outwardly of the fabric 42 and extending from approximately the medial part of the tapered lower end thereof upwardly into the substantially cylindrical medial portion well above the juncture between said medial portion and the tapered lower end. It is to be noted that the ferrule 43 is spaced approximately medially between the outer wall of the main cylindrical portion of the cup body and the wall of the first counterbore 36. Here again, the inclusion and positioning of the ferrule 43 shifts the area of most severe wear incurred by the outer wall of the swab cup upwardly from the point at which the tapered lower end 31 enters the thimble 32, and transposes the area of severe wear to the thickest portion of the cup wall, the portion most capable of withstanding prolonged and severe wearing conditions. It will be seen that in all the forms of the invention the dimensioning and positioning of the ferrules 16, 28 and 43 move the point of wear away from the thinner walled portions of the swab, and in the case of the first and last modifications, shifts the point of wearing away from the point at which the tapered end of the swab enters the supporting thimble.

In all forms of the invention, there has been provided a new and different swab having its metallic reinforcing ferrule or ferrules shifted radially outwardly and extended into the medial portion of the swab for concentrating destructive forces therein. In addition, the fabric reinforcing layers have been shifted inwardly of the metallic ferrules so as to provide swabs of maximum resistance to applied loads and destructive forces as well as extended maximum sensitivity to both light and heavy loads.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

What I claim and desire to secure by Letters Patent is:

1. An expansible swab including, a resilient swab body having an axial bore, the body having a medial portion and an end portion, the medial portion being larger in diameter than the end portion, a metallic reinforcing member embedded in the swab body and extending from the end portion into the enlarged medial portion of the body, the reinforcing member encircling the end portion and being disposed closely adjacent the outer wall thereof, and fibrous reinforcing embedded in the swab body between the axial bore and the metallic reinforcing member.

2. An expansible swab including, a resilient swab body having an axial bore, the body having a medial portion and an end portion, the medial portion being larger in diameter than the end portion, a cylindrical metallic reinforcing member embedded in the outer wall of the end portion and extending into the enlarged medial portion of the swab body, and fibrous reinforcing embedded in the swab body between the axial bore and the metallic reinforcing member.

3. An expansible swab including, a resilient swab body having an axial bore, the body having a medial portion and an end portion, the medial portion being larger in diameter than the end portion, a cylindrical metallic reinforcing member embedded in the outer half of the end portion and extending into the enlarged medial portion of the swab body, and fibrous reinforcing embedded in the swab body between the axial bore and the metallic reinforcing member.

4. An expansible swab as set forth in claim 3 wherein the fibrous reinforcing is at least one layer of reinforcing cloth.

5. An expensible swab as set forth in claim 3, and a metallic liner within the axial bore.

6. An expansible swab including, an approximately barrel-shaped swab body formed of an elastomer and having an axial bore, the swab body having reduced end portions and a medial portion of greater diameter than the end portions, cylindrical metallic reinforcing members embedded in each end portion of the swab body and extending into the medial portion, the inner ends of the reinforcing members being spaced apart and being disposed approximately equidistantly from the wall of the axial bore and the periphery of the medial portion, and fibrous reinforcing embedded in the swab body between the axial bore and the metallic reinforcing members.

7. An expansible swab as set forth in claim 6, and metallic liners within the axial bore.

8. An expansible swab as set forth in claim 6, wherein the reinforcing members are disposed closely adjacent the outer peripheries of the end portions and extend substantially to the ends of the swab body.

9. An expansible swab as set forth in claim 6, and a pair of metallic liners in the axial bore, the liners being coextensive with and radially alined with the metallic reinforcing members.

10. An expansible swab including, a resilient swab body having an axial bore, the body having a medial portion and an end portion, the medial portion having a greater wall thickness and being larger in diameter than the end portion, a metallic reinforcing member embedded in the swab body and extending from the end portion into the enlarged medial portion of the body, the reinforcing member encircling the end portion and having its outer end closely adjacent the outer wall thereof, the inner end of the reinforcing member being disposed approximately equidistantly from the wall of the axial bore and the periphery of the medial portion, and fibrous reinforcing embedded in the swab body between the axial bore and the metallic reinforcing member.

11. An expansible swab including, a resilient swab body having an axial bore, the body having an enlarged medial and reduced end portions, the medial portion having a greater wall thickness than the end portions, metallic reinforcing members embedded in the swab body and extending from the end portions into the enlarged medial portion of the body, the reinforcing members encircling the end portions and having their outer ends closely adjacent the outer walls of the end portions, the inner ends of the reinforcing members being disposed approximately equidistantly from the wall of the axial bore and the periphery of the medial portion, and fibrous reinforcing embedded in the swab body between the axial bore and the metallic reinforcing members.

12. An expansible swab as set forth in claim 11 wherein the fibrous reinforcing is at least one layer of reinforcing cloth.

13. An expansible swab cup including, a resilient swab body having an axial bore, the body having a tapered lower end and a medial portion of greater wall thickness

than the lower end, the axial bore being enlarged in the upper portion of the body to form a sealing lip on the upper end of the cup, a metallic reinforcing member embedded in the swab body and extending from the tapered lower end of the body into the medial portion, the reinforcing member encircling the tapered lower end of the body and having its lower end closely adjacent the outer wall thereof, the upper end of the reinforcing member being disposed approximately equidistantly from the wall of the axial bore and the periphery of the medial portion, and fibrous reinforcing embedded

in the swab body between the axial bore and the metallic reinforcing member.

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