Dec. 24, 1968 H. E. BOWERMAN 3,417,673

SWAB CUP

Filed Aug. 1, 1966

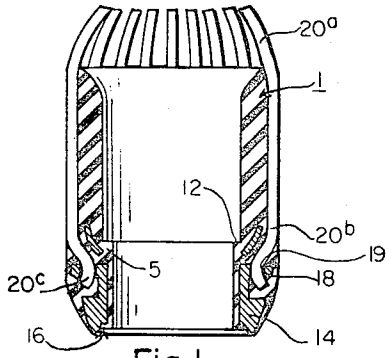

Fig.1

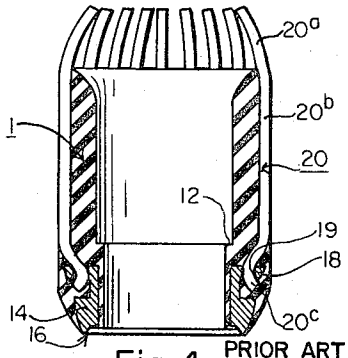

Fig.4 PRIOR ART

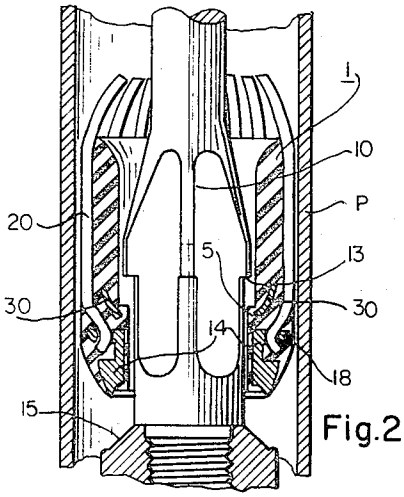

Fig.2

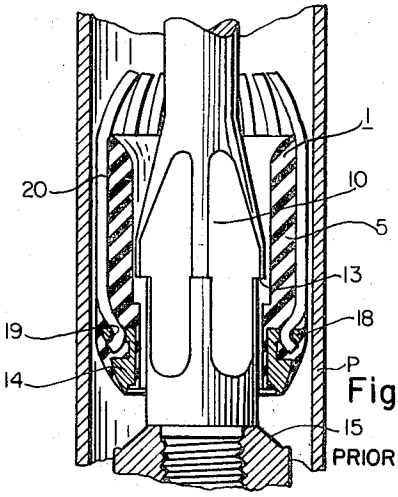

Fig.5 PRIOR ART

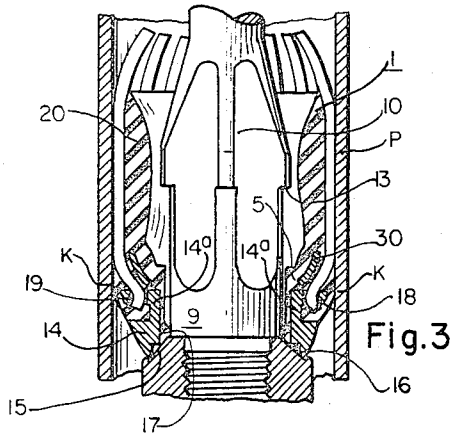

Fig.3

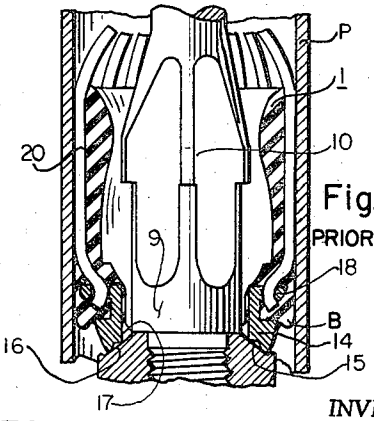

Fig.6 PRIOR ART

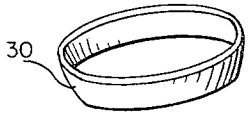

Fig.7

INVENTOR

ZORA MAE BOWERMAN

EXECUTRIX OF HULIE E. BOWERMAN

BY Alexander & Dowell

ATTORNEYS

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SWAB CUP

Hulie E. Bowerman, deceased, late of Tarrant County, Tex., by Zora Mae Bowerman, executrix, Tarrant County, Tex., assignor to Oil States Rubber Co., a corporation of Texas

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ABSTRACT OF THE DISCLOSURE

A resilient swab cup body having a rigid base and having reinforcing wires embedded axially in the periphery of the cup and pivotally captivated in the base, and reinforcing means to uniformly distribute loading pressures in the lower end of the cup body and to control the degree of extrusion of the body material downwardly and outwardly between the lower ends of the wires, the reinforcing means comprising a rigid cup-shaped ring member embedded in the body just above the base and opposite the lower ends of the wires, the ring being displaceable toward the base to thereby flow a controlled amount of base material toward and between the wires before the ring contacts the base.

This invention relates to improvements in well swab cups, and particularly in the type of cup employing reinforcement of the cup elastomer by wires extending axially of the cup and secured in a metal base.

An object of the invention is to provide a reinforced swab cup which will function properly under a wider range of fluid loading conditions than has previously been possible with conventional cups of the type shown in my Patent 2,862,776, wherein the reinforcing elements are captivated at their lower ends in the flange of a metal base in order to secure the lower ends against dislodgment, but wherein the upper ends of the wire elements are allowed radial movement to insure the best possible sealing the cup against the well pipe to provide optimum swabbing action, as is well known in the prior art.

More specifically, it is the object of this invention to improve the load carrying capability and the life of a cup of the above type by inserting an additional reinforcing ring into the elastomeric portion of the cup just inside of the wire reinforcements and just above their lower ends but out of contact therewith, this novel ring being advantageously shaped to prevent or limit the downward and outward flow of the elastomer between the reinforcing wires, as occurs when a conventional swab cup is heavily loaded and is "slumping." Such outflow of elastomer leads to pinching of the flowed material between the swab and the wall of the pipe and to chewing off of the pinched material in a manner well known to those skilled in the art. Various expedients have been used to try to avoid this loss of elastomer, mostly comprising sleeves of harder material disposed outside and around the lower periphery of the cup, but the present ring is believed to be an improvement, both functionally and from the point of view of protecting the added ring from deterioration by corrosion, the ring being embedded within and bonded to the elastomer.

An advantage of the present ring, which is preferably separate from and spaced above the metal base, is that when the cup is highly loaded the pressure will be uniformly distributed in a controlled manner around the base ring and reinforcing wires, thereby reducing the tendency toward mechanical failure both of the elastomer and of the metal parts.

My invention will be readily understood by those skilled in the art from the following description read together with the accompanying drawing, in which:

FIG. 1 is a half-sectioned elevation view of a preferred cup embodiment;

FIG. 2 is a similar view of this swab cup, associated with a cooperating mandrel assembly, and shown within well tubing or pipe;

FIG. 3 is a view similar to FIG. 2, but showing the cup heavily loaded;

FIGS. 4, 5, and 6 correspond respectively with FIGS. 1, 2, and 3 but show a conventional swab cup lacking the present improved reinforcing ring; and

FIG. 7 is a perspective view of the reinforcing ring itself.

Proceeding now with a detailed description, in which like reference characters indicate similar parts among all the figures, the swab cups **1** shown in the drawing are intended to be mounted on a mandrel **10**, similar to that set forth in my issued Patent 2,518,275, and having fluid passageway flutes **11**. During downward travel of the assembly through the well fluid the swab cup **1** slides up along the mandrel **10** as shown in FIGS. 2 and 5 until shoulder **12** of the swab cup **1** contacts shoulder **13** of mandrel **10**. This positioning allows well fluids to by-pass the cup through flutes **11**, and thereby permits the swab assembly to have a fast rate of fall. After the cup has reached a satisfactory depth in the well fluids, the ascent of the swab is begun, and the mandrel will move upwardly through the cup so that the seating face **16** of the metal base **14** comes into contact with seating face **15** of mandrel **10** as shown in FIGS. 3 and 6. When this has been accomplished the downward load of fluid above the swab assembly causes the upper portion of the swab cup to distend radially outwardly into contact with the inner surface of the well pipe P, as illustrated in FIGS. 3 and 6. The well fluid, thus contained, is then iifted upwardly as the swab assembly is raised in the pipe by the operator. A fluid-tight seal between base **14** and surface **15** is accomplished by the mating of the machined seating faces **15** and **16**, together with the annulus **17** of resilient material within the swab cup, which is in sealing contact with the mandrel surface **9**.

The metal base **14** has at its upper end an outwardly extending annular flange **18** which is provided with an annular series of holes **19** for receiving the lower ends of the individual reinforcing wires **20** which are hooked as at **20***c*. These reinforcing wires **20** are curved inwardly as at **20***a* at their upper ends to prevent snagging in the pipe joints, and the wires are relatively straight in their middle portions **20***b* to provide axially lengthy contact areas with the pipe walls. These wires are provided with hook portions **20***c* at their lower ends which curve radially inwardly, downwardly and then radially outwardly below the flange **18**, thus creating a captivating hook lying in a radial plane of the swab cup.

As illustrated in FIGS. 2, 3, 5, and 6 this configuration permits each reinforcing wire **20** to be hooked into a flange hole **19** by tilting the wire radially outwardly as its hook is passed through the hole and then tilting the wire back toward vertical position. Resilient material, comprising the remainder of the cup assembly, is then molded and bonded by conventional techniques to form a known type of swab cup as illustrated in FIG. 4.

The conventional swab cup described to this point is improved according to the present invention by inserting an annular continuous cup-shaped rig **30**, FIG. 7, into the elastomeric portion **5** of the cup just above the flange **18** and inside of the wires **20**. The ring **30** is preferably out of contact with the other metal parts and is bonded to the elastomeric material in a position which leaves a small amount of the resilient material between the ring **30** and the base **14** to act as a cushion therebe-

tween, this cushion having the advantage of distributing pressures in the material above the ring more evenly against the wires **20** and flange **18**. In such structures as this bending or pivoting of the wires must take place in order that the cup can expand to seal against the tubing along a significant axial length of the cup as viewed in FIGS. 3 and 6 when the cup is placed under heavy fluid load. The wires **20** can pivot outwardly around their hooked lower ends **20***c* to respond to light loads, but as the loading increases, the wires must distort to provide a greater axial-contact length with the well pipe P.

The wires are fairly close together so that the elastomer does not tend to bulge therebetween toward the pipe P under light loading, but under heavy loading as viewed in FIG. 6, the elastomer extrudes between and through the wires **20** to provide a bulge B of elastomer at the flange level, which bulge is then pinched and cut on edges of pipe joints until the elastomer is lost and the cup thereby weakened. Eventually the cup blows out and may even break away part of the flange **18** which is inherently weakened by the holes **19** which captivate the wire ends **20***c*.

On the other hand, it is desirable to let the elastomer expand freely into contact with the pipe P above the level where the portions **20***b* of the wires begin to contact the pipe when the cup is heavily loaded as shown in FIG. 3. Therefore the ring **30** should begin at and extend below this contact level, which has been marked K in FIG. 3. The reinforcement ring **30** is cup-shaped so that it approximates the inside contours of the wires **20** where they taper inwardly toward the hook portions **20***c*. Although the ring is separated from the wires **20** by thin intervening elastomeric material, the upper periphery of the ring **30** is disposed close enough to the wires so that the main bulk of the elastomer is radially inside the ring rather than between it and the wires.

For the sake of convenience of manufacture it is attractive to permit the ring **30** to lie on top of the metal base **14** near its inner sleeve portion **14***a* where the base is strong enough to support the ring so that any pressure exerted on the ring is carried by it and by the sleeve portion **14***a*, while the weaker flange portion **18** is protected therefrom and need only support the lower ends of the wires themselves which are no longer directly forced outwardly by the full pressure of the elastomer in which the lower ends are embedded.

However, this is not the most advantageous embodiment where the ring **30** lies on the metal base **14**. Rather, it is better to have the lower periphery of the ring **30** spaced above the base **14** by a small thickness of elastomeric material. In either case, when the cup loading is increased the portions **20***b* of the wires just above the hooked ends **20***c* must expand outwardly to assume contact with the walls of the pipe P. When these portions of the wires move outwardly, the space vacated by the wires should be filled by downwardly-flowed elastomer. This elastomer can be supplied in correctly controlled quantity only if the ring **30** can move downwardly somewhat before being stopped by the base ring. By careful proportioning of the elastomer beneath the ring **30** and of the axial increment through which the ring can move down before being stopped by the base **14**, the amount of elastomer introduced into the zone vacated by the wires can be made adequate to insure freedom of the wires to move outwardly while at the same time preventing a large enough flow of elastomer into this region to cause the undesirable bulging which this invention is designed to cure.

The separation between the ring and the base and between the ring and the wires, in the relaxed condition of the cup, should be less than either the diameter of the wires or the spacing therebetween.

The present invention is not to be limited to the exact form shown in the drawing, for obviously changes may be made within the scope of the following claims.

I claim:

1. In a load-lifting swab cup having a flexible annular body extending in the direction of a longitudinal axis, the cup having a rigid base below said body and bonded thereto, and having wire members disposed longitudinally of the body and embedded in its outer surface and mutually spaced therearound, and the lower ends of the wire members being hooked and pivotally attached to said base, reinforcing means for uniformly distributing the load in the body near the base and for controlling the degree of extrusion of the body material outwardly between the wire members near the base comprising, a rigid annular ring separate from the base and embedded in free-floating relationship inside said flexible body radially within said wire members opposite their lower ends and spaced out of contact therewith, the ring having a lower periphery disposed just above said base and spaced out of contact therewith, and the ring being cup-shaped to approximately conform with the composite contour presented by the hooked lower ends of said wire members.

2. In a cup as set forth in claim **1**, said base including an outwardly extending flange having an annular series of spaced axially-disposed holes therethrough, the hooked lower ends of said wire members extending downwardly through the holes, and said cup-shaped ring tapering inwardly and downwardly, and its lower periphery terminating within the resilient body just above the base and radially inside of said annular series of holes.

3. In a cup as set forth in claim **1**, the wire members each having a portion tapering inwardly toward their lower ends where they are pivotally attached, and the ring being substantially axially coextensive with said inwardly tapering portion and being spaced from the wire members by a distance no greater than the mutual spacing therebetween.

4. In a cup as set forth in claim **1**, the circumferential spacing between the wires approximating the diameter of a wire, and the ring being separated from the wires and from the base by distances smaller than said spacing.

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MARTIN P. SCHWADRON, *Primary Examiner.*

GEORGE N. BAUM, *Assistant Examiner.*

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