

Oct. 10, 1967

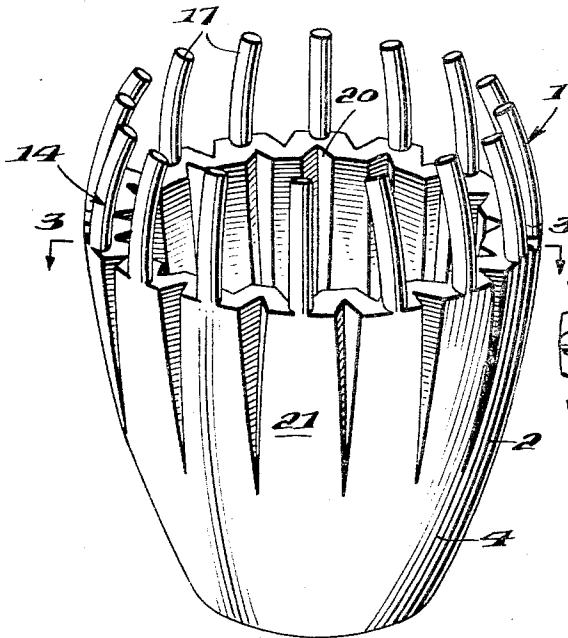
D. L. FARLEY

3,346,267

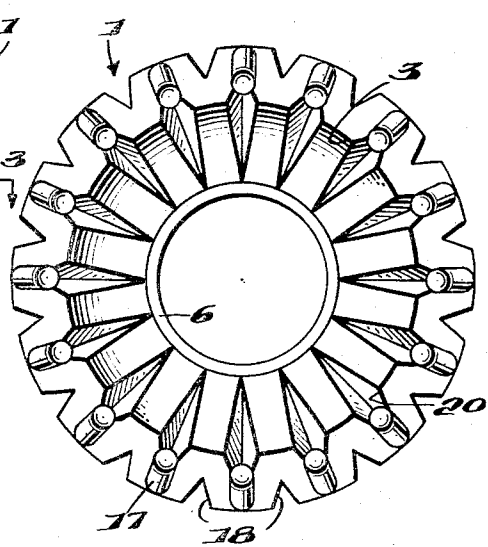
CUP FOR MULTI-SIZE PIPE STRING

Filed Sept. 30, 1964

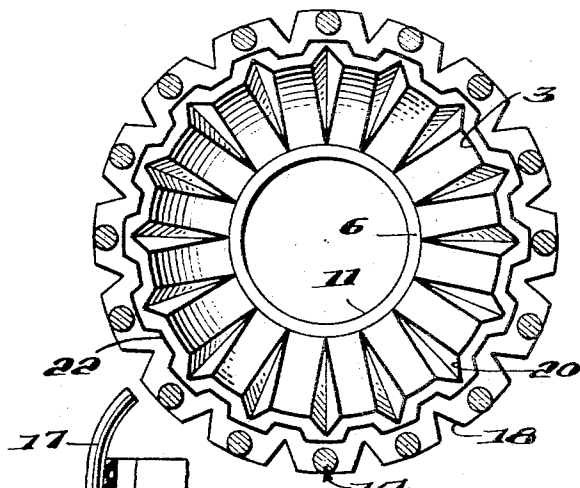
*Fig. 1.*



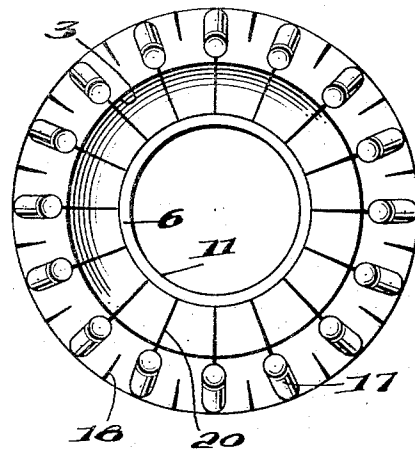
*Fig. 2.*



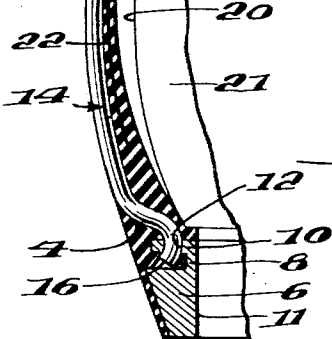
*Fig. 3.*



*Fig. 4.*



*Fig. 5.*



INVENTOR

DAVID L. FARLEY,

BY Burns, Doane, Benedict, Sweetser & Mathis

ATTORNEYS

1

2

3,346,267

**CUP FOR MULTI-SIZE PIPE STRING**

David L. Farley, Duncan, Okla., assignor to Halliburton Company, Duncan, Okla., a corporation of Delaware  
 Filed Sept. 30, 1964, Ser. No. 400,536  
 4 Claims. (Cl. 277-212)

**ABSTRACT OF THE DISCLOSURE**

A swab or packer cup adapted for use in well pipe strings of a varying diameter. The cup comprises a cup-shaped body having a plurality of circumferentially spaced, longitudinally extending reinforcing members. A plurality of longitudinally extending grooves are included on the inner and outer peripheries of the cup to provide an accordion-shaped wall, the grooves extending to the free end of the cup and terminating short of the other end thereof.

This invention relates to sealing apparatus and, more particularly, to sealing apparatus for use as a well pipe string swab or packer cups or as a seal for use in conjunction with retrievable valve testers in such strings.

Heretofore, well pipe string sealing apparatus such as swab cups or the like have been available which include a flexible, cup-like body portion construction of rubber, or the like, having a plurality of circumferentially spaced, longitudinally extending reinforcing wires. Such devices are usually designed to have a specified, relaxed minimum external diameter permitting free passage of the device through a pipe string of a given internal diameter and also to permit expansion of the device to an increased external diameter to provide effective sealing contact with the string when required. While such devices have been generally satisfactory in some applications, they are not always satisfactory when used in pipe strings of a varying internal diameter. Difficulties are encountered because no practical means has heretofore been provided for compressing the swab cup or the like to a size having an external diameter less than that of the cup in its normal relaxed condition upon encountering a string of internal diameter less than the relaxed diameter of the cup and, at the same time, providing an effective seal between the expanded cup and the pipe string over a range of internal diameters thereof. When utilizing the cups heretofore available, in strings of a varying internal diameter, a cup is often selected that provides an effective seal in the portion of the string of the largest internal diameter in its expanded condition, this cup in a relaxed condition, being forced through the portions of the string having a small internal diameter. However, this procedure often results in damage to the cup. When smaller diameter cups are utilized to circumvent damage, it is sometimes difficult to maintain an effective, fluid-tight seal over the full range of the various internal diameters of the pipe string.

It is an object of this invention to provide a sealing apparatus for use in well pipe strings having a varying internal diameter.

Another object of this invention is to provide such a sealing apparatus that is sufficiently flexible to provide the desired sealing effect in its expanded condition but also is sufficiently strong to resist damage.

It is another object of this invention to provide such a sealing apparatus which may be compressed to a size having a smaller external diameter than that of the apparatus in a relaxed condition without causing damage to the apparatus.

It is further object of this invention to provide a sealing apparatus which may be expanded or compressed from its relaxed condition but which provides an effective seal

through a substantial range of the expanded, relaxed or compressed conditions.

It is still another object of this invention to provide a sealing apparatus for use in well bores, the apparatus having a shape inducing free movement in either direction in the string.

In achieving these and other objects which will be apparent hereinafter, the present invention provides an expandable seal for use in well bores, the seal comprising a flexible cup-shaped body having a longitudinally extending bore therein, the body including a lower portion and a relatively enlarged upper portion of an increased diameter, a plurality of circumferentially spaced reinforcing members fixed about the bore and extending between the lower and upper portions of the body and a plurality of circumferentially spaced, longitudinally extending grooves extending from adjacent said lower portion to said upper portion on both sides of each of the reinforcing members.

The longitudinally extending grooves may be provided on both the inner and outer peripheries of the cup body, the grooves increasing in depth and width as they extend from adjacent the lower portion of the body towards the upper portion thereof. Further, a flexible band may be provided internally of, and conforming to the shape of the body. In operation, as the cup is urged through a portion of a drill string of a decreased diameter, generally accordion-shaped vertical walls of the body of the cup are free to be compressed from their normally relaxed condition to a collapsed condition wherein the cup has a reduced external diameter.

Other novel features of my invention will be readily understood by those skilled in the art from the following description together with the accompanying drawings in which:

FIGURE 1 is a vertical, perspective view of a sealing apparatus according to my invention;

FIGURE 2 is a horizontal, top view of the sealing apparatus shown in FIGURE 1;

FIGURE 3 is a horizontal, cross-sectional view of the sealing apparatus shown in FIGURE 1 and taken along lines 3-3 thereof;

FIGURE 4 is a horizontal top view of the sealing apparatus shown in FIGURE 1, the apparatus shown in a compressed condition; and

FIGURE 5 is a vertical, cross-sectional view of a cut-away portion of the sealing apparatus shown in FIGURE 1.

Referring in more detail to FIGURE 1 of the drawings, the present invention provides a sealing apparatus 1 for use in well pipe strings, or the like, as the swab or packer cup or as a seal for use in conjunction with a retrievable valve tester, the apparatus comprising a flexible, frustoconical body 2 constructed of molded rubber or the like having a frustoconical bore 3 therein. As shown in FIGURE 5, fixedly connected to a lower portion 4 of the body 2 is a metallic, frustoconical bushing 6 having a reduced diameter neck portion 8 and a flange 10 of increased diameter adjacent the upper end of the bushing 6. The bushing is provided with a bore 11, the vertical axis of which is aligned with the vertical axis of the frustoconical bore 3 in the body 2. A plurality of circumferentially spaced apertures 12 are provided in the flange 10 and a curved, longitudinally extending, metallic reinforcing wire 14 is movably received in each aperture 12. In assembling the present sealing apparatus, the lower end 16 of each of the reinforcing wires 14 is loosely positioned in an aperture 12 of the bushing 6 prior to molding the flexible body 2 about these elements to fixedly retain the reinforcing wires within the apertures 12. The upper end 17 of each reinforcing wire 14 extends above the upper portion of the body 2 and is curved inwardly towards the longi-

3

tudinal axis of the body 2 for purposes that will become apparent hereinafter.

To facilitate compression of the body 2 of the sealing apparatus 1, a plurality of longitudinally extending, circumferentially spaced, V-shaped grooves 18 and 20 are provided on the outside and inside peripheries, respectively, of the circular walls 21 of the body 2. The grooves 18 and 20 defined by angularly disposed, adjacent portions of the walls 21 and are designed to increase in both width and depth as the grooves extend from the lower reduced diameter portion of the body 2 towards the upper portion thereof. The grooves have a minimum dimension adjacent the lower portion 4 and the minor diameter of the frustoconical body 2 and a maximum dimension, as to depth and width, adjacent the upper portion and the major diameter of the frustoconical body 2. As will be apparent from FIGURE 2 of the drawings, longitudinally extending grooves are provided on the outside periphery of the body 2 on either lateral side of each reinforcing wire 14. Similar longitudinally extending grooves 20 are provided on the inside periphery of the body 2 diametrically inwardly of each wire 14 and intermediate each pair of grooves 18 on the outside periphery. This arrangement of grooves in the walls 21 of the body 2 imparts an accordion-shape and action to the walls that lends itself to compression. It should be noted that although the grooves 18 and 20 are depicted as being substantially V-shaped in cross section, it has been found that grooves of a truncated V-shape may be utilized with good results.

Referring to FIGURE 3 of the drawings, the body 2 may also include a circular, accordion-shaped band 22 of nylon fabric or the like molded internally on the walls of the body 2 and conforming to the accordion-shape thereof. In this manner structural integrity and rigidity of the sealing apparatus may be enhanced as desirable in some applications.

In operation, the sealing apparatus of the present invention may be lowered in a pipe string, the sealing apparatus being relaxed as shown in FIGURE 1 of the drawings. Upon expanding the sealing apparatus as by the transfer of weight or the application of fluid pressure thereto, ambient fluid pressure may act internally of the bore and within the inside grooves 20 to thereby extend the walls of the body 2 into fluid sealing contact with the walls of the string. The grooves 20, by virtue of the fact that they are closed on their lower ends and/or closed along their length by deformation of surrounding wall portions defining the grooves, do not permit an appreciable amount of fluid leakage therethrough. However, if the apparatus encounters a pipe string portion of reduced diameter, the grooves 18 and 20 may be compressively collapsed, as shown in FIGURE 4 of the drawings. In this condition, the apparatus assumes a size of decreased external diameter, permitting passage of the apparatus through portions of the pipe string having an internal diameter less than the external diameter of the apparatus in the relaxed condition without damage to the apparatus.

Withdrawal of the device is enhanced because the upper ends 17 of the reinforcing wires 14 are curved inwardly and therefore do not interfere with upward movement of the sealing apparatus.

Because the dimensions of the grooves increase as the diameter of the frustoconical body 2 increases, maximum compressibility to a degree consistent with optimum seal-

4

ing qualities of the device is induced. Similarly, because the shape of the sealing apparatus of this invention is that of a frustum, deformation of the walls defining the grooves of at least at one portion thereof is provoked thereby reducing leakage of fluid along these grooves. Finally, because of the orientation of the reinforcing wires and band relative to the grooves, advantages in structural integrity are made available, without interfering significantly with compression of the apparatus.

While the invention has been described with reference to preferred embodiments, those skilled in the art will recognize that certain additions, deletions, modifications and substitutions may be made in the preferred and disclosed embodiment while falling within the purview of this invention.

I claim:

1. An expandable seal for use in a well pipe string, said seal comprising a flexible cup-like body having major and minor diameters, a portion adjacent said major diameter being free for movement in a radial direction, said body having a longitudinally extending bore therein, a plurality of circumferentially spaced, longitudinally extending reinforcing members connected to and extending above said body, said body including a plurality of longitudinally extending outside grooves circumferentially spaced on the outside periphery of said body adjacent each of said members, and a plurality of longitudinally extending inside grooves on the inside periphery of said body defining said bore, each of said inside grooves positioned diametrically inwardly of one of said members, said inside and outside grooves extending to said portion adjacent said major diameter and terminating in spaced relation to a portion adjacent the minor diameter.

2. An expandable seal according to claim 1 wherein said grooves have a maximum width and depth adjacent said major diameter and a minimum width and depth adjacent said minor diameter.

3. An expandable seal according to claim 1 further including a circular band of reinforcing material positioned about said bore, adjacent portions of said band being angularly disposed relative to each other to thereby provide an accordion shape conforming to the shape of said body.

4. An expandable seal according to claim 1 further including a bushing fixed to said body adjacent said minor diameter.

#### References Cited

##### UNITED STATES PATENTS

274,061	3/1881	Voglesong	277—212 X
1,735,264	11/1929	Crickmer	277—235 X
2,013,903	9/1935	Thaheld	277—235 X
2,388,520	11/1945	Bowie	277—212
2,609,258	9/1952	Taylor et al.	277—212 X
2,746,709	5/1956	Minor	277—34 X
3,152,809	10/1964	Waldrop	277—212

##### FOREIGN PATENTS

405,351 2/1934 Great Britain.

SAMUEL ROTHBERG, *Primary Examiner.*

J. S. MEDNICK, *Assistant Examiner.*