

[54] PACKER SLEEVES

[72] Inventor: Allen E. Harris, Duncan, Okla.
[73] Assignee: Halliburton Company, Duncan, Okla.
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[51] Int. Cl. E21b 33/128, E21b 33/129
[58] Field of Search 277/116.2, 116.4, 116.6, 116.8,
277/125; 166/118, 179, 191, 192, 196, 202, 203,
134

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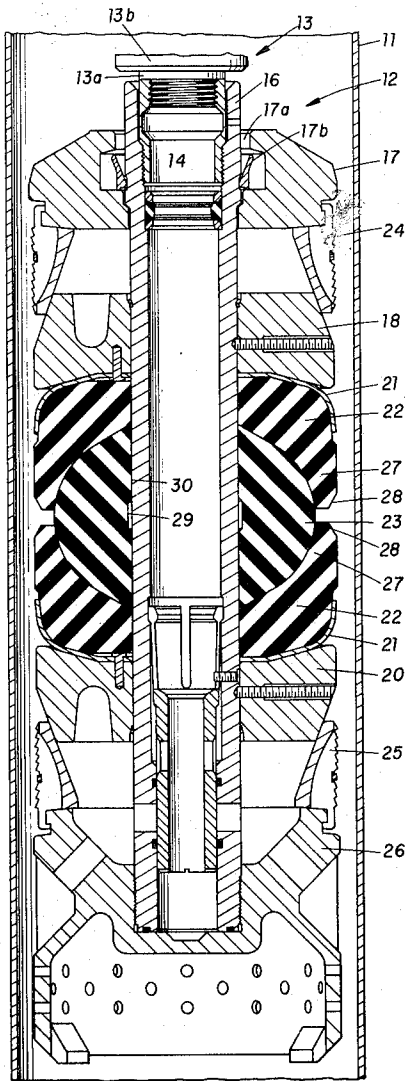
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Primary Examiner—David H. Brown
Attorney—John H. Tregoning

[57] ABSTRACT

This invention relates to resilient packer sleeves which when expanded laterally in a well, provides a seal separating the well into the isolated sections.

6 Claims, 4 Drawing Figures



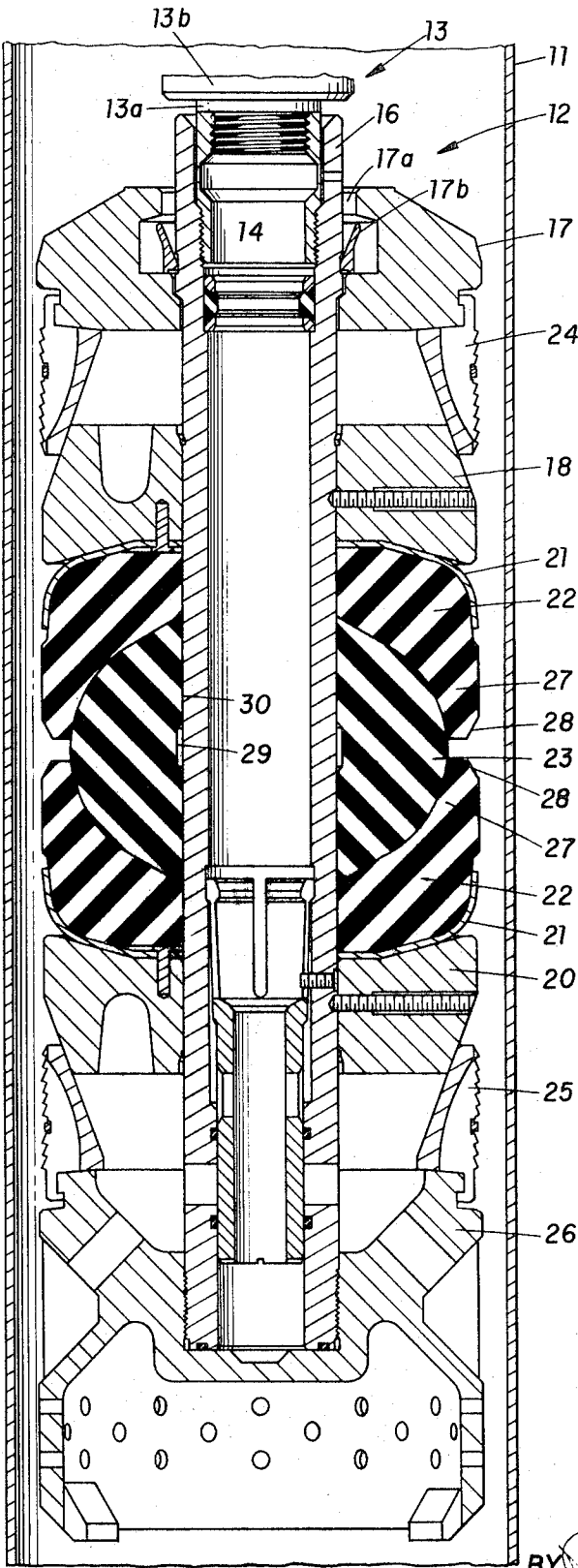
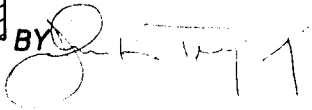


FIG. 1.

Allen E. Harris
INVENTOR

BY 
ATTORNEY

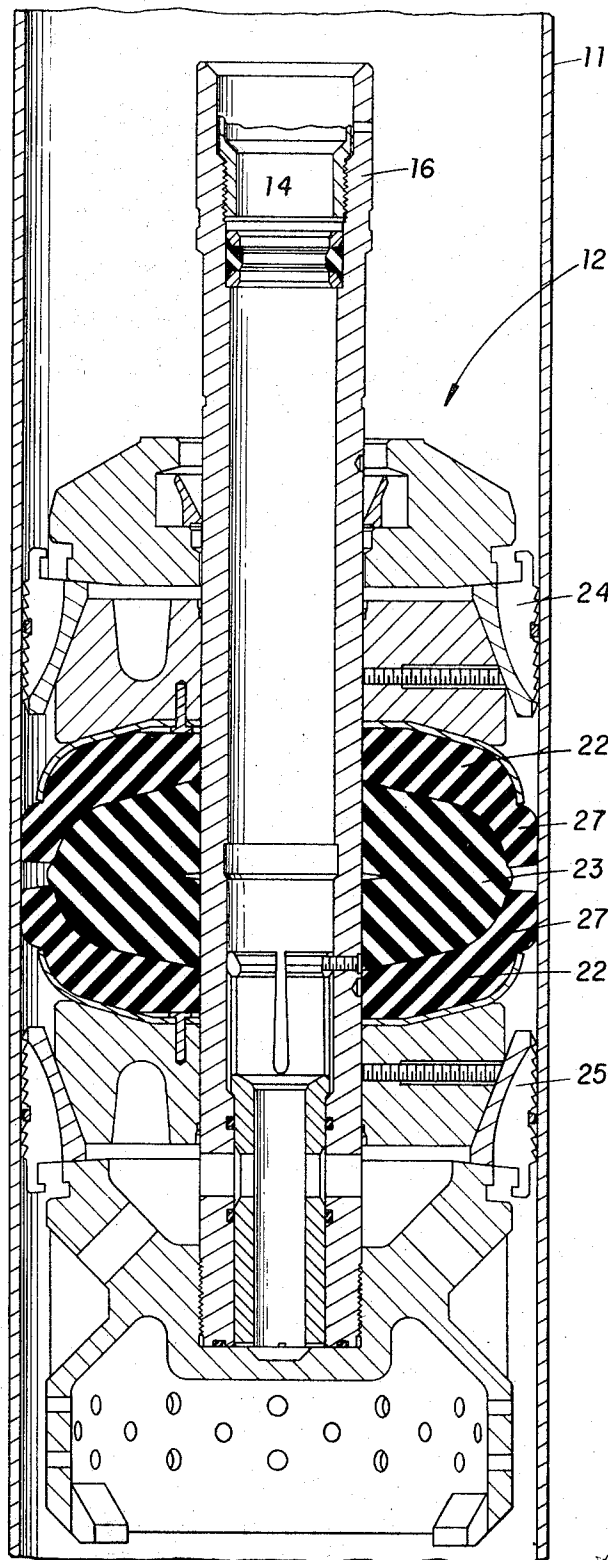


FIG. 2.

Allen E. Harris
INVENTOR

BY *[Signature]*
ATTORNEY

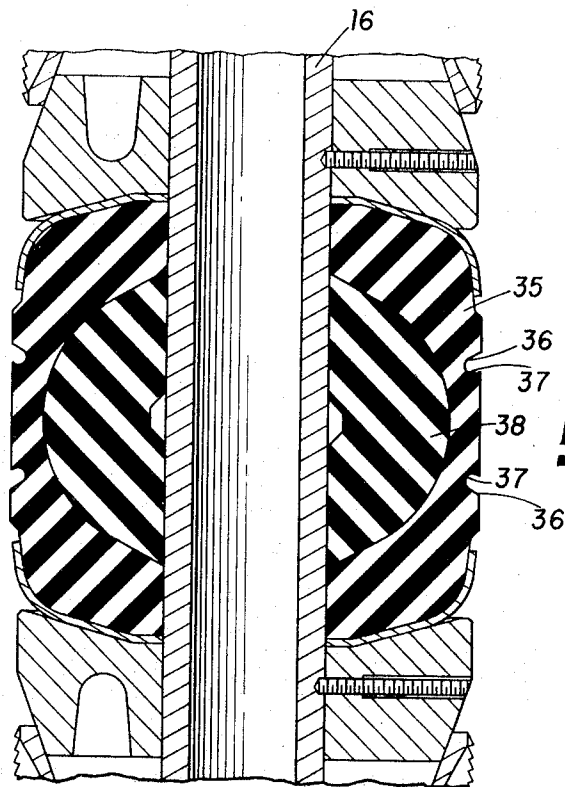


FIG. 3.

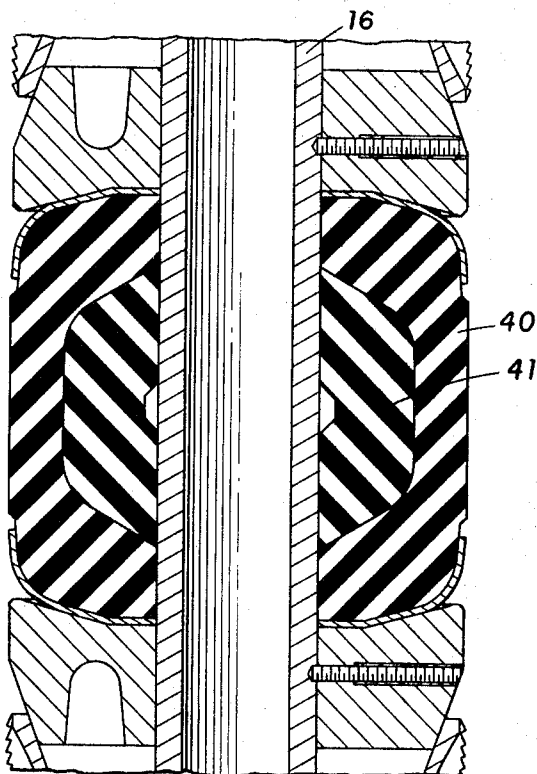
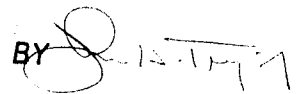


FIG. 4.

Allen E. Harris
INVENTOR

BY 

ATTORNEY

PACKER SLEEVES

BACKGROUND OF THE INVENTION

In the drilling, operating, or reworking of oil and gas wells, it is sometimes necessary to isolate one zone or section of a well from another. Packers and bridge plugs having rubber sealing elements mounted coaxially thereon are used for this purpose. The operation of such require that the rubber sealing elements expand laterally into sealing engagement with the walls of the well. The expansion results from a compressive force applied to the ends of the sealing elements. This compressive force is derived from a setting tool such as disclosed in U.S. Pat. No. 3,057,406.

The sealing elements, hereinafter referred to as "sleeves", must be made of resilient material but with a viscosity sufficient to resist extrusion around the supporting packer components. Extrusion occurs when pressures in the well exceed the resistance of the rubber to "flow". But sleeves made of rubber that can resist such flow are of such hardness that the available compressive forces are not adequate to expand the sleeves into a positive sealing engagement with the wall of the well. To overcome this problem, an elongated sleeve of the same hardness could be used. However, this would require a longer packer body which in turn presents undesirable problems in setting and retrieving the packer.

In current practice, packers having three separate sleeves are used. An easily compressible sleeve is positioned between two less compressible sleeves. The available compressive force is adequate to expand the center sleeve into sealing engagement with the well bore wall. The outer sleeves are expanded to a degree by the setting tool but well pressures are relied on for the further expansion necessary to confine the center sleeve in sealing contact with the wall. This arrangement performs satisfactorily provided the proper relative lateral expansion between all three sleeves are maintained. This requires matching the rubber compounds used as well as having correct mating angles machined onto the sleeves. However, experience has shown that temperature changes such as occurs in running the packer into deep wells quickly upsets such matching and mating with adverse effects.

SUMMARY OF THE INVENTION

The present invention provides, in a packer of the type having a mandrel, expansible slip-type anchors on the mandrel, a plurality of resilient sleeves slidably mounted coaxially on the mandrel, and means for expanding the slips and sleeves against the well casing, the improvement comprising:

- a. a resilient inner sleeve slidably mounted coaxially on the mandrel, and
- b. two resilient bowl-shaped outer sleeves positioned one on either side of said inner sleeve so that said inner sleeve is cupped within said two outer sleeves.

In order to more fully describe the present invention, reference is made to the accompanying drawings wherein:

FIG. 1 is a vertical cross sectional view of a packer assembly. The view shows the assembly before it has been set in its operation position;

FIG. 2 is a cross sectional view of the packer assembly shown in FIG. 1. This view shows the packer set in its operation position in the well casing;

FIGS. 3 and 4 are cross sectional views of the packer sleeve portion of the packer assembly of FIG. 1 depicting different embodiments of the resilient packer inner and outer sleeves.

DETAILED DESCRIPTION

In FIG. 1 a well casing is illustrated at 11. Within casing 11 is packer 12 as it would appear while being lowered into the well suspended from a setting device 13 of the type shown in the aforesaid U.S. Pat. No. 3,057,406. Setting device 13 includes trip sleeve 13b and plunger 13a which attaches to packer 12 by tension sleeve 14. Slidably mounted on mandrel 16 is upper slip support 17, upper wedge 18, lower wedge 20, packer shoes 21, outer sleeves 22 and inner sleeve 23. Outer

sleeves 22 include thin walls 27 girdling inner sleeve 23. The beveled rims 28, occurring at the ends of walls 27, provide a parallel mating surface to casing 11 when sleeves 22 are expanded laterally. Channel 29, positioned about inner surface 30 of sleeve 23, provides a pocket for lubricant as well as to guide the folding of sleeve 23 as it is compressed. Slips 24 and 25, which are the anchoring members of packer 12, have one end resting on wedges 18 and 20 respectively and the other end hooked to slip supports 17 and 26 respectively. Slip support 26 is threadedly engaged to mandrel 16.

FIG. 2 illustrates packer 12 after it has been set. Slips 24 and 25 have been wedged out against casing 11 to anchor packer 12 in place. Sleeve 23 has been expanded, forcing walls 27 into sealing engagement with casing 11. Sleeves 22 have been compressed so that walls 27 confine and prevent inner sleeve 23 from extruding out. As sleeves 22 were compressed, walls 27 pivoted slightly outward, permitting beveled rims 28 to contact casing 11 in a parallel relation.

FIGS. 3 and 4 illustrate alternate embodiments of the invention. In FIG. 3, outer sleeves 22 (FIGS. 1 and 2), have been replaced by a single outer sleeve 35 which surrounds and encases inner sleeve 38. Grooves 36 encircle sleeve 35. Edges 37, located on grooves 36, provide a surface against which well pressures can impinge.

FIG. 4 illustrates outer sleeve 40 encasing inner sleeve 41. In this embodiment outer sleeve 40 differs from outer sleeve 35 in FIG. 3 by the absence of grooves. All other packer components as described in FIGS. 1 and 2 remain the same in FIGS. 3 and 4.

The setting and operating of packer 12, being similar to those known in the art, is generally described as follows:

Referring to FIGS. 1 and 2, packer 12, connected to setting device 13 is lowered into the well bore on a wire line (not shown). Setting device 13 is actuated to drive trip sleeve 13b into recess 17a to expand lock ring 17b, thus allowing support 17 to move down on mandrel 16. Support 17, being urged downward by trip sleeve 13b, drives slips 24 out over wedge 18 and into anchoring engagement with casing 11 as shown in FIG. 2. At this point, packer 12 cannot move upward. Slips 24, in riding out on wedge 18, pulls wedge 18 down, compressing sleeves 22 and 23. As slips 24 set, piston 13a, shown in FIG. 1, starts to pull mandrel 16 and attached support 26 upward. This action forces slips 25 out over wedge 20 and into anchoring engagement with casing 11 as shown in FIG. 2. At this point packer 12 is firmly anchored to casing 11 and cannot move in any direction. Slips 25, in riding out on wedge 20 pulls wedge 20 up, compressing sleeves 22 and 23. Due to the compressive forces applied by wedges 18 and 20, inner sleeve 23 expands laterally, forcing walls 27 into sealing engagement with casing 11 thus separating the well bore into two sections, each section isolated from the other.

After slips 24 and 25 have set, continued upward exertion by piston 13a causes tension sleeve 14 to rupture, (FIG. 2), releasing setting device 13 from packer 12.

The present invention employs an easily compressible rubber for inner sleeves 23, 38, and 41 so that the available compressive force will cause the maximum lateral expansion. The present invention also employs a less compressible rubber for outer sleeves 22, 35, and 40 so that well pressures will not be able to extrude sleeves 22, 35, and 40 out around packer 12. In one embodiment, inner sleeves 23, 38, and 41 have a hardness of about 50 Shore A Durometer points, and outer sleeves 22, 35, and 40 have a hardness of about 85 to about 90 Shore A Durometer points. (Hardness is related to compression moduli of rubber, that is, as the hardness of a rubber increases, the resistance of the rubber to be compressed also increases. While the relationships are not linear, it is close enough so that the rubbers used in the present invention can be adequately described by one of the several characteristics, in this case, hardness.) Rubbers having different hardnesses can and are employed in the invention and the above example is not intended to limit the invention thereto.

Referring now to FIG. 2, it can be seen that formation fluids or cement slurry being pumped into the well can flow past slips 24 or 25 and press against sleeves 22. Where the pressure is of a great enough magnitude, the fluid causes the upstream sleeve 22 to press inwardly, allowing the fluid to flow between that sleeve 22 and casing 11. However, as the fluid hits the end of wall 27 of the downstream sleeve 22, the fluid will lift that wall 27 outwardly and press it against casing 11. An increase in pressure will press that sleeve 22 harder against casing 11. Thus, well pressures will complement the force exerted on walls 27 by inner sleeve 23 and the sealing engagement between sleeves 22 and casing 11 is intensified by well pressures rather than diminished.

Edges 37 of grooves 36 found on sleeve 35 in FIG. 3 serve to "catch" the fluid in the same manner as the ends of walls 27 on sleeves 22 (FIG. 2). The fluid pushes edge 37 against casing 11, thus augmenting the force exerted from within by sleeve 38. The effectiveness of the fluid pushing on edge 37 is depended on the angle at which grooves 36 are cut in sleeve 35. A 60° angle is preferred but other angles suffice.

A long piece of rubber can be expanded laterally a greater distance than a short piece with the same compressive force, provided the rubbers have the same physical and mechanical characteristics. The embodiment illustrated in FIG. 4 utilizes this principal in that inner sleeve 41 is longer than inner sleeves 23 and 38 (FIGS. 1, 2, and 3). Using the available compressive force, inner sleeve 41 presses outer sleeve 40 into a tight seal with casing 11. Under most conditions, a pressure tight engagement can be maintained by the lateral expansion of inner sleeve 41 alone.

The rubber used in the present invention can be one of several different elastomers. The two kinds commonly used and preferred are Buna N or Neoprene, both of which resist ozone, heat, weathering and oil. However, inner sleeve 23, 38, or 41 need not be made of a solid rubber such as shown in the drawings. For example, a resilient container, filled with a non-compressible fluid such as a silicon-based grease or hydraulic oil, can also be used as an inner sleeve.

The present invention may also be employed in areas other than the example used in the foregoing descriptions and drawings. For instance, the invention may be used in car bumpers to absorb shock forces generated in collisions.

Another use may be in an area where longitudinal force must be converted to a lateral force of lesser magnitude.

It will be understood that other and further forms of the invention may be devised without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a packer of the type having a mandrel, expandable slip-type anchors on the mandrel, a plurality of sleeves slidably mounted coaxially on the mandrel, and two inclined means for expanding the slips and sleeves against the well casing, the improvement comprising:

a. a resilient inner sleeve, adapted to be expandable outwardly; and

b. two resilient, outer sleeves adapted to sealingly engage said casing, each of said outer sleeves having one end positioned adjacent one of said inclined means and a second end having a concave surface positioned adjacent to and partially enveloping said inner sleeve thereby preventing said inner sleeve from engaging said casing.

2. The improvement of claim 1 wherein said inner sleeve is a sealed resilient container filled with a noncompressible fluid.

3. The improvement of claim 2 wherein said noncompressible fluid is a silicon-based grease.

4. In a packer of the type having a mandrel, expandable slip-type anchors, resilient sleeves slidably mounted coaxially on the mandrel and inclined means for expanding the slips and sleeves outwardly against oil well casing, the improvement comprising:

a. an inner sleeve having an annular fold-guiding recess in its inner wall, said inner sleeve adapted to be expanded outwardly away from said mandrel; and

b. an outer sleeve, having a higher durometer than and encasing said inner sleeve, positioned between and immediately adjacent to said inclined means, said outer sleeve adapted to be expanded outwardly into sealing engagement with said casing, said expansion being accomplished by said inclined means and aided by said inner sleeve.

5. The improvement of claim 4 wherein said inner sleeve is a sealed resilient container filled with a noncompressible fluid.

6. The improvement of claim 5 wherein said noncompressible fluid is a hydraulic oil.

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