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Anderson et al.

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[54] **SUCKER ROD CONSTRUCTION**

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[73] Assignee: **Morrison Molded Fiber Glass Company**, Bristol, Va.

[21] Appl. No.: **821,874**

[22] Filed: **Jan. 24, 1986**

Related U.S. Application Data

[63] Continuation of Ser. No. 532,920, Sep. 16, 1983, abandoned.

[51] **Int. Cl.**[4] **F16B 11/00**

[52] **U.S. Cl.** **403/268**; 403/265; 403/41

[58] **Field of Search** 403/268, 267, 266, 265, 403/368, 41

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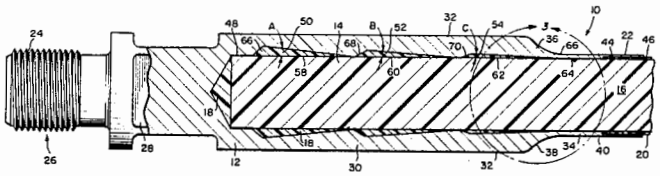
[57] **ABSTRACT**

A sucker rod construction including a connector member being formed to define a rod receptacle having a closed axially inner end and an open axially outer end. The rod receptacle has a plurality of axially spaced, tapered annular surfaces. The end of a cylindrical fiberglass rod is received within said rod receptacle through the outer end and cooperates therewith to define an annular chamber between the outer surface of the end of the rod and the tapered annular surfaces. A bonding material is positioned in the annular chamber and bonds the outer surface of the end of the rod and the tapered annular surfaces. Each of the annular surfaces has an angle of taper with respect to the outer surface of the fiberglass rod, and each angle of taper is progressively less toward the open end by at least one and one-half degrees. A collet is connected to the connector member adjacent the open axially outer end of the rod receptacle and it has an axial bore therethrough retaining the end of the rod in coaxial position within the rod receptacle. A protective sleeve is disposed between the collet and the rod. The collet has an axially extending tubular portion having an outside diameter which is smaller than the outside diameter of the connector member, and a joining portion joins the outside surface of the collet and the adjoining outside surface of the connector member. The joining portion has an outer surface with a smooth curve extending between the collet and the connector member.

28 Claims, 4 Drawing Figures



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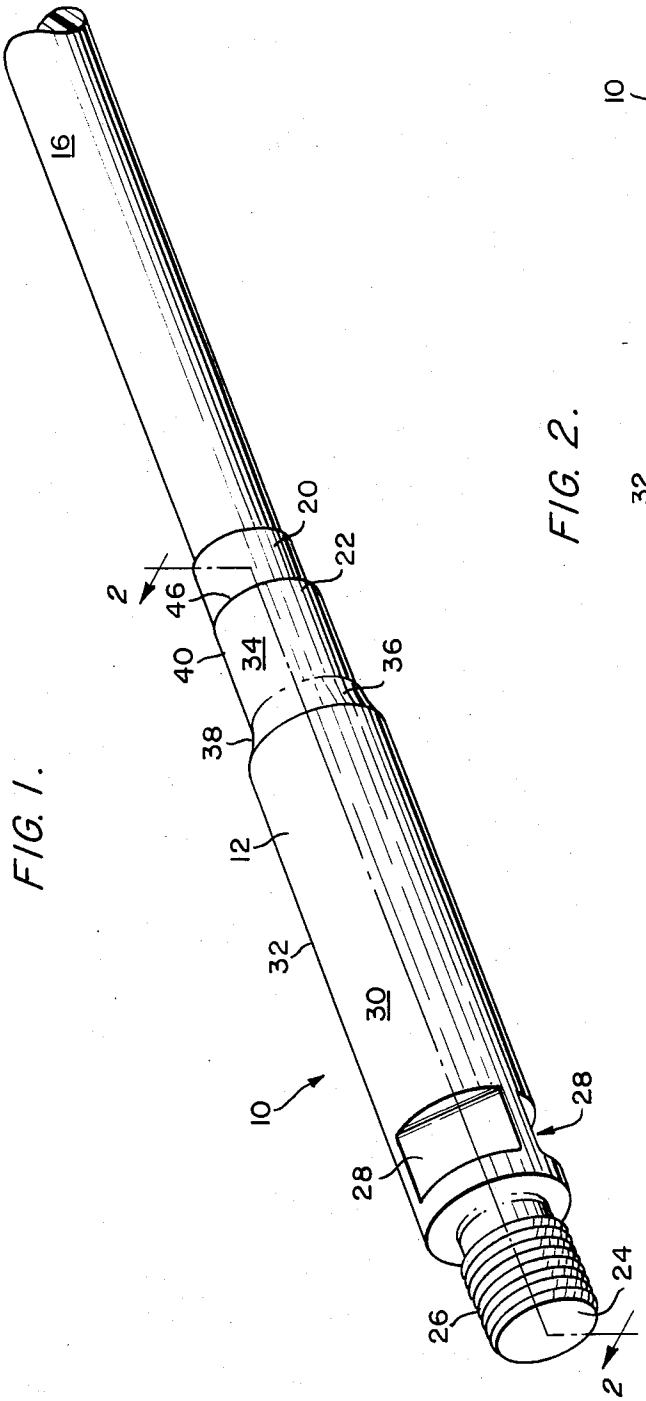

FIG. 1.

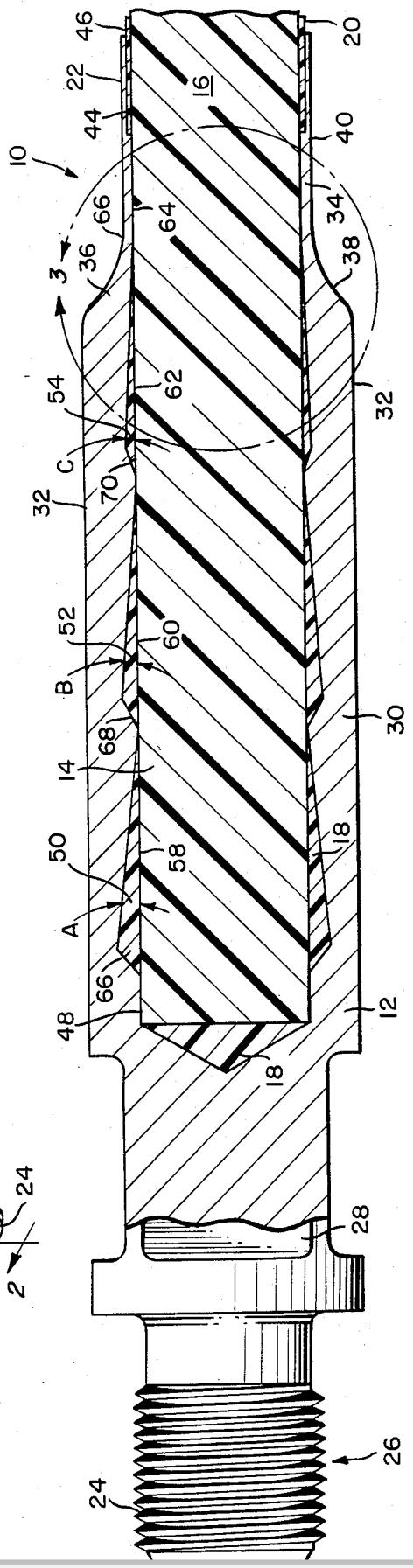

FIG. 2.

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FIG. 3.

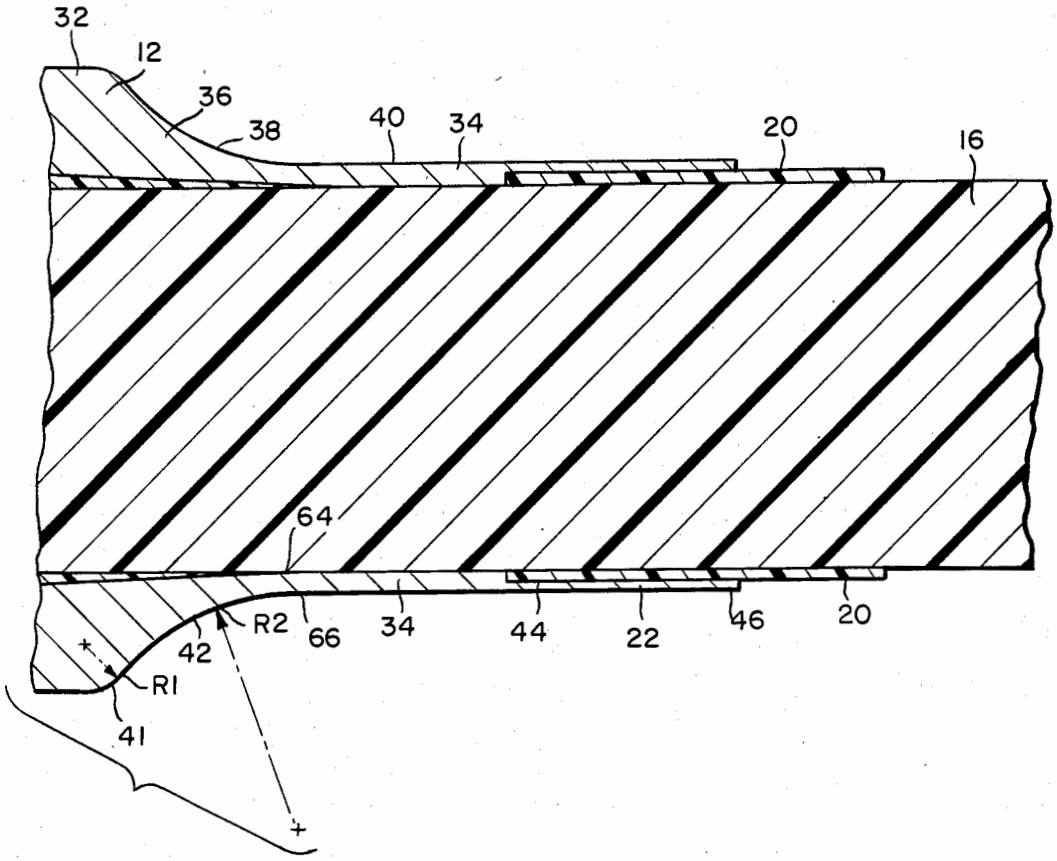
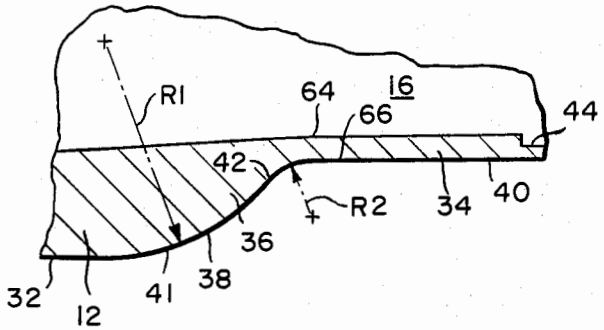


FIG. 4.



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SUCKER ROD CONSTRUCTION

This is a continuation of co-pending application Ser. No. 532,920 filed on Sept. 16, 1983, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to sucker rod constructions and more particularly to fiberglass sucker rods. Sucker rods are joined together to form a sucker rod string which connects a sub-surface well pump to a surface pumping unit. This string imparts a reciprocating pumping motion to the sub-surface well pump. Although the sucker rods were generally for decades constructed from steel, it is now known to construct them with a fiberglass rod portion. An example of such a fiberglass sucker rod construction is found in U.S. Pat. No. 4,360,288, the contents of which are hereby incorporated in their entirety by reference.

In the early 1970s, a solution was sought for the chemical and stress corrosion problems related to the use of steel sucker rods. It was found that, in addition to significantly reducing corrosion problems of steel sucker rods, the use of fiberglass rods resulted, in many cases, in increased production. The lighter weight of the rods cuts the pumping unit loads significantly and the reduced pumping unit load allows the pumping unit to operate faster. Also, the elasticity of the prestressed fiberglass rods string generates significant production increases due to the "overtravel." A weight is attached on the bottom of the fiberglass sucker rods, such as steel sucker rods or sinker bars, and this weight causes a higher upstroke relative to the surface stroke and a lower downstroke, that is, overtravel. This provides for a maximum overtravel whereby the pump stroke generates a greater production. The lighter fiberglass rods also allows for a longer string to be used and thus deeper wells to be dug.

Although the fiberglass sucker rods have resulted in greatly increased production and associated reduced pumping costs, premature fatigue failures has been a problem. These premature fatigue failures have occurred both in field applications and in cyclic duty tests of sample rods. It has also been experienced that the ends of the connector members would cut into the fiberglass rods thereby cutting the fibers and weakening the rod.

OBJECTS OF THE INVENTION

Accordingly, it is the principal object of the present invention to provide an improved fiberglass sucker rod construction.

Another object of the present invention is to provide an improved fiberglass sucker rod construction which is not subject to premature fatigue failures.

A further object of the present invention is to provide a novel fiberglass sucker rod construction design.

A still further object of the present invention is to provide an improved fiberglass sucker rod construction for the one-inch and the one and a quarter inch diameter fittings.

Another object of the present invention is to provide a novel construction for preventing the connector member from digging into and thereby weakening the fiberglass rods.

Other objects and advantages of the present invention will become more apparent to those persons having ordinary skill in the art to which the present invention pertains from the foregoing description taken in conjunction with the accompanying drawings.

THE DRAWINGS

FIG. **1** is a perspective view of a sucker rod construction embodying the present invention.

FIG. **2** is an enlarged cross-sectional view taken along line **2—2** of FIG. **1**.

FIG. **3** is an enlarged fragmentary view of the portion of FIG. **2** illustrated by line **3**.

FIG. **4** is a fragmentary view similar to the lower left corner of FIG. **3** illustrating a second embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. **1** and **2**, a sucker rod shown generally at **10** embodying the present invention is illustrated. Sucker rod **10** generally comprises four basic members: a connector member shown generally at **12** formed of a single, continuous piece of steel and having a rod receptacle **14** therein; a cylindrical fiberglass rod **16** which fits in rod receptacle **14**; a body of adhesive material **18** positioned within rod receptacle **14** and between fiberglass rod **16** and connector member **12**; and a plastic, cylindrical sleeve **20** positioned at the outer end **22** of connector member **12** and at least partially positioned between connector member **12** and fiberglass rod **16**.

Connector member **12** at its inner end **24** has a coupling member shown generally at **26**. Although shown as a male coupling, this coupling will screw into a generally identical connector member differing only in coupling member **26** being a female coupling. The fiberglass rods will then have a connector member at one end with a male coupling and one with a female coupling at the other end and will measure 37 feet 6 inches, including threaded end fittings. Generally adjacent coupling member **26** are a plurality of wrench flats **28** to which a standard sucker rod wrench is attached for coupling and uncoupling adjacent sucker rods from one another. A long cylindrical portion **30** having outside surface **32** extends from wrench flats **28** toward outer end **22**. A cylindrical collet **34** having a diameter smaller than the diameter of cylindrical portion **30** forms the outer end portion of connector member **12**. A joining means shown generally at **36** joins cylindrical portion **30** and collet **34** and more particularly forms an annular surface **38** joining outside surface **32** and collet outside surface **40**.

Referring to FIGS. **3** and **4**, joining means **36** and annular surface **38** are illustrated in greater detail. As shown, joining means **36** is a portion of connector member **12**, in other words, cylindrical portion **30**, collet **34** and joining means **36** are formed from one continuous solid piece of metal. It is further, and perhaps more importantly noted, that annular surface **38** defines a smooth curve defined by a first curve **41** with radius R1 tangent at one end to outside surface **32**. At its other end it is generally tangent to oppositely curving second curve **42**, and second curve **42** with radius R2 is tangent at its other end to collet outside surface **40**. While the embodiment of FIG. **3** illustrates R1 being smaller than R2, it is also within the scope of the present invention, as shown in FIG. **4**, for R1 to be larger than R2. The prior art "joining means" had sharp beveled edges which were subject to cracking and breaking when stressed. By contrast, the present invention eliminates

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this problem by providing for a novel configuration of annular surface **38** employing a smooth curve and more specifically a pair of joined and oppositely facing curves.

Rod receptacle **14** defines a unique configuration. At its outer end, as best shown in FIG. **2**, collet **34** has an inner recessed, annular surface **44** which extends a short distance from the end. Annular surface **44** is provided to hold sleeve **20** between collet **34** and fiberglass rod **16**. Although collet **34** is adapted to snuggly hold rod **16** in rod receptacle **14**, non-axial relative movement of collet **34** and fiberglass rod **16** has in the past caused collet outer edge **46** to bite into the fiberglass and damage and weaken the rod. Sleeve **20** provides a protective material between collet outer edge **46** and the rod thereby preventing damage to the rod.

At the end of rod receptacle **14** opposite collet **34** is a bore **48**, best shown in FIG. **2**, fitting closely with the surface of the end of the rod and together with the collet supporting the rod in rod receptacle **14**. Wrench flats **28** ideally should be even with the outer diameter of bore **48**. Positioned between bore **48** and collet **34** in rod receptacle **14** are a plurality of integrally-formed, axially-spaced-apart, outwardly-converging, tapered frusto-conical annular surfaces. Although three such annular surfaces **50**, **52** and **54** are illustrated in FIG. **2**, it is within the scope of the present invention to provide up to seven annular surfaces. These annular surfaces, which are recessed from rod **16**, provide a series of wedge shaped cavities or chambers into which adhesive material **18** is positioned. Adhesive material **18** is initially liquid when placed in the cavities and cures to bond to the outer surface of rod **14** and hardens to form a plurality of shear and compression resistant frusto-conical wedges which cooperate with the annular surfaces **50**, **52** and **54** and prevent the movement of rod **16** axially out of rod receptacle **14**.

Each of the wedge shapes is defined by (1) annular surfaces **50**, **52** or **54**, (2) rod surfaces **58**, **60** or **62**, respectively, each of which intersects at its outer end with its annular surface **50**, **52** or **54**, respectively, and (3) slanted ends **66**, **68**, and **70**. Each slanted end terminates at the inner end of its rod surface and the inner end of its annular surface. The intersection of annular surface **50** and rod surface **58** defines taper angle A, annular surface **52** and rod surface **60** defines taper angle B, and annular surface **54** and rod surface **62** defines taper angle C. In the prior art it is known to make taper angles A, B and C equal. However, as previously discussed, these prior art sucker rods have experienced premature fatigue failures.

The present invention, therefore, provides for sucker rods having different taper angles within each rod receptacle. More particularly, the angles progressively increase from the outer to the inner end of the receptacle by at least one and one half degrees between adjacent angles and preferably two degrees. For instance, it has been found, as shown below, that surprisingly increased fatigue failure resistance is experienced when angles within the above guidelines are as follows: angle A=6°±30′, angle B=4°±30′ and angle C=2°±30′. Most significantly, the present invention is most evident when the angles are 6°, 4° and 2°, each ± about 5 minutes also as shown below. These angles have been found to "even" the stresses at each of the three rod/connector interfaces and thereby reduce the maximum equivalent stresses experienced. Thus, it is possible with the present invention to have vastly greater number of cycles before stress fatigue results.

In fact, in a test conducted by the Inventors, the following results were obtained:

FITTING TEST	*AVG. CYCLES TO FAILURE
Controls - Fitting with 4½° tapers (All cracked)	42,364
TM-648 Fitting (2½°–4°–5½° tapers) (All cracked)	87,750
TM-648 Fitting with longer sleeve (All cracked)	136,105
TM-648 Fitting with Tuff Tubing in sleeve (All cracked)	189,488
TM-650 Fitting (2°–4°–6° tapers) (5 of 12 cracked)	1,025,935

*Average cycles is to first crack except for TM-650 fitting, contains data from 7 good rods.

It is thus seen from these test results that by having the tapers progressively increased by 1½° degrees the cycle life of the sucker rod (before all of the test rods crack) increases by over 100%. Further, the use of the Inventors longer smooth curving sleeve increases the cycle life an additional 50% plus, and with the tuff tubing an additional 40%—making for a total cycle improvement of about 350% over the prior art. An example of the preferred embodiment, wherein the tapers increase progressively by 2°, was also tested. The 2°–4°–6° embodiment was chosen and after over a million cycles the test was concluded even though less than half of the test rods had cracked.

To further improve the stress fatigue life of the sucker rod, the outer end of annular surface **54** shown at **64** is positioned directly radially inward of the tangent point of second curve **42** which collet outside surface **40** shown at **65**. The tolerance of the placement of outer end **64** and tangent point **65** should be within ⅛ inch.

From the foregoing detailed description, it will be evident that there are a number of changes, adaptations, and modifications of the present invention which come within the province of those persons having ordinary skill in the art to which the aforementioned invention pertains. However, it is intended that all such variations not departing from the spirit of the invention be considered as within the scope thereof as limited solely by the appended claims.

What is claimed is:

1. A sucker rod construction comprising:

a connector member being formed to define a rod receptacle having a closed axially inner end and an open axially outer end,

said rod receptacle having a plurality of axially spaced, tapered annular surfaces,

a cylindrical fiberglass rod having an end having an outer surface being received within said rod receptacle through said outer end and cooperating therewith to define an annular chamber between said outer surface of said end of said rod and said tapered annular surfaces, and

a bonding means positioned in said annular chamber for bonding to said outer surface of said end of said rod to confront said tapered annular surfaces,

each said annular surface having an angle of taper with respect to the outer surface of said fiberglass rod, and

each said angle of taper being progressively and uniformly less toward said open end by an amount

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