March 15, 1932. A. M. THOMSON 1,849,122

SUCKER ROD

Filed May 24, 1930

Fig. 4.

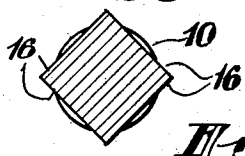


Fig. 1.

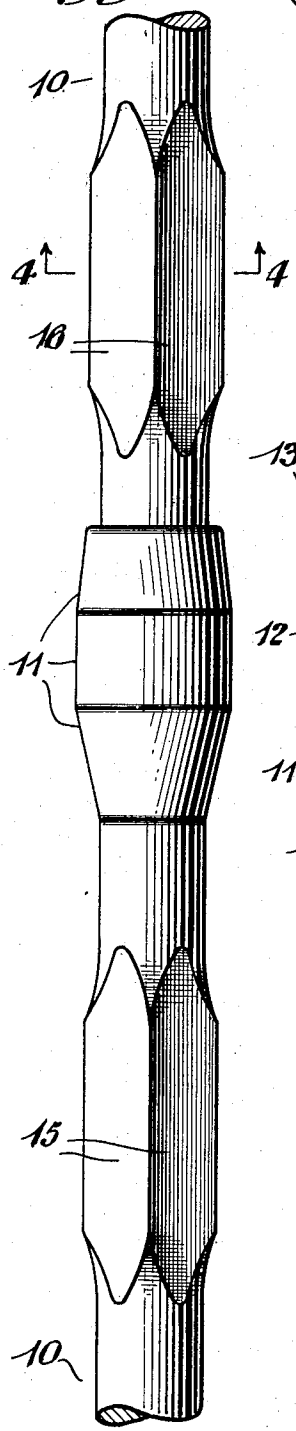


Fig. 3.

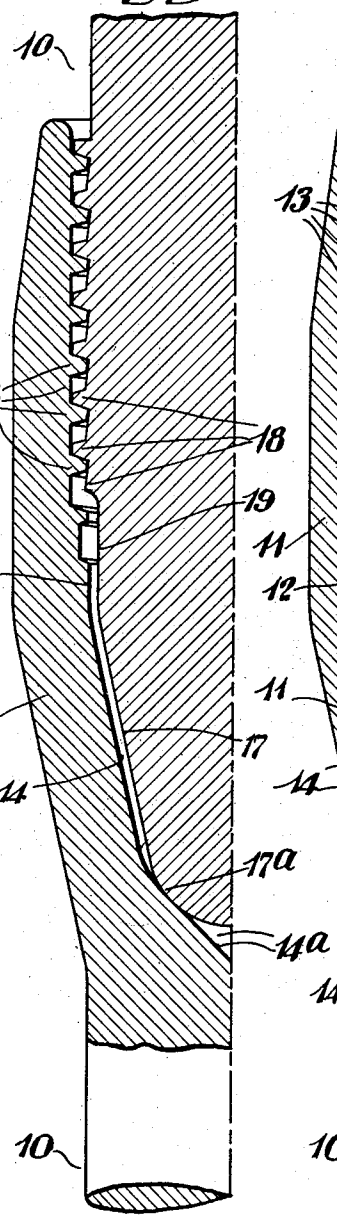
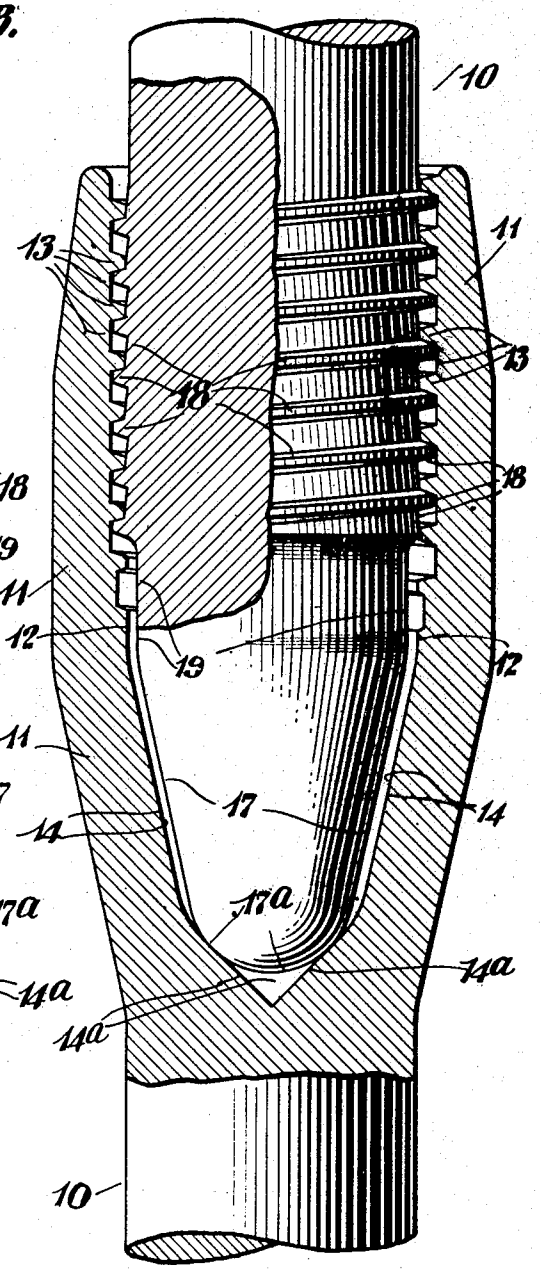


Fig. 2.



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UNITED STATES PATENT OFFICE

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SUCKER ROD

Application filed May 24, 1930. Serial No. 455,267.

This invention relates to improvements in sucker rods for oil well pumps and the like.

The invenion has for its principal objects to provide a sectional sucker rod of less weight per unit of length, offering less obstruction to the oil flow, and less resistance to reciprocation of the rod in the well tubing than standard sucker rods now in use and which will, at the same time, successfully withstand the large axial, lateral and twisting stresses to which the rod is subjected in use and which are the principal sources of the frequent breakage of the present standard sucker rods; and to provide such a rod wherein the parts or sections are thread coupled in such manner as to prevent accidental unscrewing of the parts which is a frequent source of trouble with the present standard rods.

Other objects of the invention are to provide an efficient streamlined sucker rod comprising thread coupled sections self-held against accidental disconnection; to provide a sucker rod comprising thread coupled sections of small diameter through the joints and wherein the mass of metal at the joints is much less than in standard sucker rod joints; to provide a screw joint for sucker rod members so constructed as to substantially reduce the weight and rigidity of the rod in the joint and throw the bending stresses into the rod beyond the joints in such manner as to substantially eliminate liability of breakage of the rod in the threaded joint; to provide a self-locking thread joint for sucker rods wherein the joint is so constructed as to increase the factor of safety of the rod with respect to axial load resistance; to provide a thread jointed sucker rod wherein abrupt changes of section and concentration of breaking stresses are avoided in all parts of the rod; to provide a sectional thread-jointed sucker rod all parts of which have substantially the same area in cross-section at all points in their length; and to provide a thread coupled sucker rod joint wherein the externally threaded end or ends of each rod section are formed without the usual collar, shoulder and pin portions.

The preferred embodiment of the invention is illustrated in the accompanying drawings in which

Fig. 1 is a fragmentary side elevation of the rod in the position in which it extends into the well;

Fig. 2 is a view on an enlarged scale, partly in central longitudinal section, through the joint between two like sections of the rod with the parts fully coupled;

Fig. 3 a view similar to Fig. 2 showing the parts partly coupled, just prior to the locking displacement between the coupling threads; and

Fig. 4 a transverse sectional view on the line 4—4 of Fig. 1.

The particular sucker rod shown is somewhat similar to the single pin and box type of sucker rod in that it consists of like sections each externally threaded at one end and having an internally threaded box at its opposite end to receive the externally threaded lower end of the next above section of the rod. It will be noted, however, that the rod sections while having a box at one end do not have the usual collar and threaded pin at the opposite end, but simply carry a raised external thread adjacent, but spaced from, the latter end of the rod section, which is the lower end of the section as the rod is assembled in the well, and that the usual abrupt box shoulder is also omitted.

The rod consists of like rod sections 10 each consisting of a single unitary member formed of steel or other suitable metal. Except as hereinafter set forth each rod section has a circular cross-section of constant diameter from end to end. In Fig. 1, wherein is illustrated full size a ¾ inch sucker rod, the diameter referred to is three-fourths of an inch.

At its upper end each rod section is formed with an integral box 11 for the reception of the lower end of the next higher rod section. The maximum diameter of this box is preferably kept relatively small. For this purpose, without weakening the rod as an entirety, the maximum diameter should preferably be such that the area of the box metal in cross-section at the root of the box thread is, as in the case of the illustrated construction, the same or substantially the same as that of

the remainder of the rod. The bore of the box has a cylindrical form as at 12 from the box mouth down for a distance preferably slightly greater than the normal rod diameter and this cylindrical bore portion has cut or otherwise formed therein from end to end an internal screw thread 13. By making this bore portion slightly longer than the rod diameter the length of the threaded portion is such as to afford a perfect thread on a length of the box equal to or slightly greater than the rod diameter, which will be sufficient to withstand stripping of the thread under tensions up to one sufficient to break the rod outside the thread. The length of bore portion 12 for the ¾ inch rod is preferably 1¼ inches, as shown, and from the inner end of portion 12 the bore is gradually and slightly tapered to form a gradually contracting unthreaded bore portion or chamber 14 preferably having a conical bottom wall 14ª the apex of which is a point at the rod axis, for the purposes hereinafter set forth. If desired wall 14ª may be rounded to hemi-spherical or less than hemi-spherical contour. The maximum depth of chamber 14 is preferably made as great as possible with the rod and maximum box diameters used and in the rod size shown is preferably $\frac{3}{16}$ths of an inch as illustrated.

The gradual enlargement of the external diameter of the rod to form the box preferably starts substantially at the bottom of the box, i. e. about two inches from the upper end of the rod section for the ¾ inch rod shown, and the internal and external taper of the box wall are preferably the same above the bottom wall 14ª of the box. The threaded and unthreaded portions of the box wall merge substantially at the inner end of thread 13 and said wall portions are of the same or substantially the same thickness except where the wall is cut by the thread groove, and preferably, also except for a short distance down from the mouth of the box. The exterior of the threaded portion of the box is cylindrical as shown and of constant diameter except for a short distance downward from the box mouth where the wall thickness is reduced by tapering the exterior of the box gradually upward and inward to streamline the box mouth and increase the flexibility of the joint at the mouth of the box. The maximum external diameter of the box for a ¾ inch rod is preferably 1⅛ inches and the external diameter at the box mouth is preferably 1 inch, while the length of the externally tapered mouth portion is preferably about ½ inch. The cross-sectional area of the box metal at all points is thus substantially the same as that of the main cylindrical portion of the rod section and practically identical therewith except at the mouth of the box.

From the foregoing it will be observed that the external and internal form of the box is such that abrupt shoulders or changes of cross-section are eliminated and such that the box end of the rod is streamlined, and is also of much smaller over-all diameter and has much less mass of metal than in the standard forms of sucker rod boxes, but has greater strength.

A short distance below the box 11 the cylindrical rod is pressed into square cross-section, by a suitable forging operation, to form a wrench receiving portion 15. It will be obvious that the cross-sectional area of the rod through the wrench receiving portion 15 is the same, or substantially the same, as that of the main cylindrical portion of the rod section. For the ¾ inch rod shown, the portion 15 preferably measures $\frac{11}{16}$ths of an inch over flats and $\frac{13}{32}$nds of an inch over corners as illustrated, and the lengths of the flats are about 1½ inches. It will be noted that the usual abrupt shoulders and collars at both ends of the wrench receiving portion are omitted and that the wrench receiving portion thus formed gradually merges into the cylindrical rod section so that this portion of the rod is streamlined and so formed as to avoid concentration of breaking stresses in the rod at this portion. The rod is formed with a second and identical wrench receiving portion 16 about 2½ inches above its lower end.

At its lower end each rod section is gradually tapered inward as the end of the rod is approached said tapered portion 17 being preferably slightly longer than the side wall of chamber 14 and terminated in a rounded point 17ª of substantial surface area adapted to seat on the conical bottom wall 14ª of chamber 14 preferably near the outer edge of the bottom wall, as shown, to afford a substantial abutting end-thrust-taking contact area for taking thrust in coupling the sections and on the down pumping strokes, and a universally rockable step bearing for the lower end of one rod section at the bottom of the box of the next lower rod section, for the purposes hereinafter set forth. Point portion 17ª is somewhat less than a hemisphere. For the ¾ inch rod shown the maximum length of the tapered and unthreaded lower end portion of the rod section is preferably ⅞ths inches. The degree of taper of this rod portion is preferably identical with that of portion 14 of the box, and the size of said rod portion is such as to afford a slight clearance between its periphery and the side wall of portion 14 of the box when the rounded point 17ª is seated on the bottom wall 14ª of chamber portion 14, as shown, the maximum diameter of rod portion 17 for the ¾ inch rod shown being $\frac{11}{16}$ths of an inch.

Between wrench-receiving portion 16 and tapered portion 17, each rod section is formed with an external thread 18 over a portion of

its length corresponding substantially with or slightly less than the length of the threaded portion of box 11, preferably, for the ¾ inch rod, for a distance of ⅞ths of an inch. Thread 18 preferably terminates about ¼th of an inch from the upper end of portion 17 so that it may be screwed fully into thread 13 without engaging the usual unfinished or imperfect inner end turn of thread 13. The short cylindrical rod portion 19 is preferably reduced to slightly less than the normal rod diameter to maintain a slight clearance between the same and the turn or turns of imperfect thread on the box. The diameter of portion 19 for the ¾ inch rod is preferably $\frac{11}{16}$ths of an inch. It will be observed that the portion 19 substantially merges with thread 18.

The thread 18 may be cut or otherwise formed on the rod and its root diameter is the same as the diameter of the main cylindrical portion of the rod, namely ¾ths of an inch for the ¾ inch rod shown.

From the foregoing, it will be observed that the lower portion of each rod section is also without abrupt shoulders, collars or change of section and is of the same or substantially the same cross-sectional area throughout its threaded connection with the box of the next lower section as it is through the main body portion thereof.

It will be obvious that the invention is capable of embodiment in the type of sucker rod wherein rod sections are joined by union sections having boxes at both ends separated by a common bottom wall or partition, and in other styles of sucker rods than that shown.

The threads 13 and 18 are complementary threads of constant and equal pitch, and, as shown, are preferably the well known self-locking Dardelet type of screw thread. The crest of the thread 13 and the root of thread 18 make an angle of six degrees with the thread axis or the axes of the rod sections, the ribs being much narrower than the grooves, so that the slightly conical locking surfaces of the threads will be forced one across the other while in contact from the free-screwing relation shown in Fig. 3, into the self-locked relation shown in Fig. 2 upon a slight further turning between the rod sections in the coupling operation after point 17^a seats against wall 14^a and arrests the screwing advance of the upper rod section into the box of the lower rod section. The rod sections are thus securely and automatically locked against accidental unscrewing.

In screwing together the usual sucker rod sections the coupling force places the threaded pin under severe tension to which in service is added the great tension pull incident to the weight of several thousand feet of rod and oil resistance on the up strokes of the rod. This coupling tension quite frequently stresses the pins to, or substantially to, the limit of tensile strength, so that little or nothing is left to withstand the service load, and is a serious defect in the present standard rods. It will be observed that one of the several functions of the present joint is that the coupling stress after the parts 14^a—17^a of the large area step-bearing are brought into contact compresses the externally threaded end of the rod axially, thereby neutralizing, or partly neutralizing, the stretching stress of the service load and greatly increasing instead of decreasing the factor of safety in this respect. This is an important feature as the factor of safety with respect to tensile strength in standard sucker rods is extremely small, and necessarily so.

Another important feature of the present joint, apart from those heretofore mentioned, is that the enforced tendency to bend in the threaded portions common to existing joints is eliminated and a flexure point provided remote from the coupled threads by the large area universal rocking step bearing 14^a—17^a and the clearance between extension 17 and chamber 14, which throws the bends into the main bodies of the adjacent rod sections so that the entire rod section tends to bow and distribute and absorb the lateral and twisting breaking stresses, thus greatly reducing liability of rod breakage. This is a radical departure from the past practice in sucker rod manufacture. It is well known that in existing forms of sucker rods the most frequent failures have always been breakage through the threaded portions and accidental unscrewing. The past commercial practice in attempting to eliminate these failures has been to constantly increase the diameter, metal mass and rigidity of the joint relatively to the diameter of the main bodies of the connected rod sections until for a ¾ inch rod, such as shown, and most commonly used, the threaded pin diameter is $1\frac{1}{16}$ inches and the collar and box diameters 1½ inches or 1⅝ inches, thus doubling, or more than doubling, the outside diameter of the joint and the metal mass and weight at the joint without solving the problems, and it has been proposed to still further increase these diameters. These rigid and heavy joints with their squarely abutting shoulders not only seriously reduce the oil flow through the tubing, which is most commonly 2 inch tubing, but serve to accentuate the lateral vibrations and twisting stresses and the tensile load and thereby increase the breaking and unscrewing tendencies and the pumping effort.

The present invention provides a strong sectional rod whose sections will not become accidentally unscrewed; a rod which is of minimum weight per unit of length, and of minimum diameter through the joints, and which is streamlined, so that the tensile breaking load and pumping effort are reduced to a minimum and the oil flow increased to a max-

imum; and a sectional rod which is of substantially uniform strength throughout and so constructed and assembled that vibration and liability of breakage are reduced to a minimum and bending stresses widely distributed and absorbed in the main body portions of the rod sections and not concentrated in the threaded parts of rigid threaded joints.

What I claim is:

1. In a sucker rod comprising two units arranged end to end, means for coupling said units so as to distribute bending stresses, comprising a pair of screw threads on said units screwed together to provide a screw thread connection between the units, and two portions of said units that extend from one end of the screw thread connection and have a pair of engaged abutment surfaces thereon, one of which abutment surfaces is a segment of a sphere generated about a center located on the axial line of the rod unit on which it is formed, and the second one of which abutment surfaces is so shaped and coactive with the first abutment surface as to maintain its abutting engagement therewith during relative angular movements of said portions of the units under bending stresses, one of said portions being radially free from and enclosed within the other portion from the engaged abutment surfaces to the adjacent end of the screw thread connection.

2. A sucker rod comprising members separably jointed end to end, said rod being characterized in that, at each rod joint, one member is provided with an axial bore in which the adjacent member is screwed, said adjacent member is provided with a non-threaded end portion having a peripheral clearance in said bore and terminating in a rounded tip which is a segment of a sphere generated about a center located on the axial line of said member, and the first-mentioned member has formed thereon within its said bore a conoidal seat against which said rounded tip of said adjacent member is abutted.

3. A rod comprising members separably jointed end to end, wherein each two adjacent rod members are held together, contact each other, and are normally urged into axial alignment, all solely through the engagement between a pair of coupled screw threads formed on said members, and the engagement between a pair of abutment surfaces formed on said members and engaged entirely around the axial line of the screw thread connection formed by the coupled threads, at a distance from the adjacent end of the screw thread connection at least equal to the length of said connection, one of which abutment surfaces is a segment of a sphere whose center is on a line coincident with the axial line of the screw thread connection.

4. A jointed sucker rod comprising two members directly coupled end to end, one of which members has an axial bore into which the second member extends, said members being engaged solely through the medium of a pair of coupled screw threads on the members and a pair of engaged endwisely facing abutment surfaces on the members, one of which surfaces is spheroidal and the other conoidal, the conoidal abutment surface being generated about an axis coincident with the axial line of the screw thread of the member on which said surface is formed, and the spheroidal abutment surface being generated about a center located on a line coincident with the axial line of the screw thread of the member on which said surface is formed, whereby a limited universal flexibility is provided in the rod joint, concentration of rod bending stresses in the rod joint is prevented, and the rod members are normally urged into axial alignment.

5. A jointed sucker rod as claimed in claim 4, wherein said abutment surfaces are spaced from the nearest end of the screw thread connection a distance at least equal to the length of said connection and are formed on integral portions of the members that are free for limited universal angular movement therebetween laterally of the axial line of the screw thread connection.

6. A jointed sucker rod comprising rod units screwed together end to end wherein, at each rod joint, one unit has an axial chamber into which the other unit extends, which chamber has an internally threaded outer portion and a non-threaded inner portion terminating in a conoidal end wall tapering abruptly toward the rod axis in a direction away from the outer end of the chamber, while the other unit has an external thread screwed in the chamber thread and also has a non-threaded end portion peripherally free from the non-threaded inner portion of the chamber and terminating in a rounded tip which is a segment of a sphere and is abutted against said conoidal end wall of the chamber, said internal thread having a conoidal crest and said external thread having a conoidal root, which crest and root are wedged together and taper toward the thread axis in the direction of the outer end of the chamber at a slight angle to the thread axis, said threads having a pair of steep engaged sides extending from the edges of greater diameter of said wedged crest and root, and said threads also having sufficient clearance between the other pair of sides therof to permit unwedging of said crest and root.

7. A sucker rod comprising a plurality of threaded units screwed directly together end to end, in which each two adjacent units are coupled and flexibly held in axial alignment solely through the medium of the coupled screw threads thereon and two integral portions of said units extending from one end of the screw thread connection, which unit

portions are adapted for limited anglar movement therebetween laterally of the axis of the screw thread connection in all planes and have a pair of opposed abutted surfaces thereon adapted for universal relative wiping movement during such relative angular movements of said portions, whereby localization of bending stresses in the rod joints is prevented and the jointed rod is made self-straightening.

8. A jointed rod comprising two members arranged end to end and having screw threaded portions screwed together, said members having two non-threaded portions at one end of their screw thread connection, loosely interfitted for limited universal relative angular movement therebetween, one of said non-threaded portions being an end portion of one of the members, and means on the other member shiftably abutted with said end portion to maintain contact therewith entirely around the rod axis during relative angular movements of said non-threaded portions and while said portions are axially aligned, whereby rod bending stresses are distributed along said members.

9. In a rod comprising a plurality of axially aligned members, means jointing the adjacent end portions of each two adjacent members to avoid localization of rod bending stresses in the rod joints, said jointing means for each two adjacent members consisting solely of a pair of coupled screw threads on said members and means adapting the members for limited universal relative angular movement about a single center that is located beyond their screw thread connection, said last mentioned means being located at one end of the screw thread connection and being associated with said threads to limit screwing together of said members.

In testimony whereof I hereunto affix my signature.

ALFRED MORRIS THOMSON.