March 15, 1932. H. L. DARDELET 1,849,075

SUCKER ROD

Filed July 16, 1930

Fig. 1.

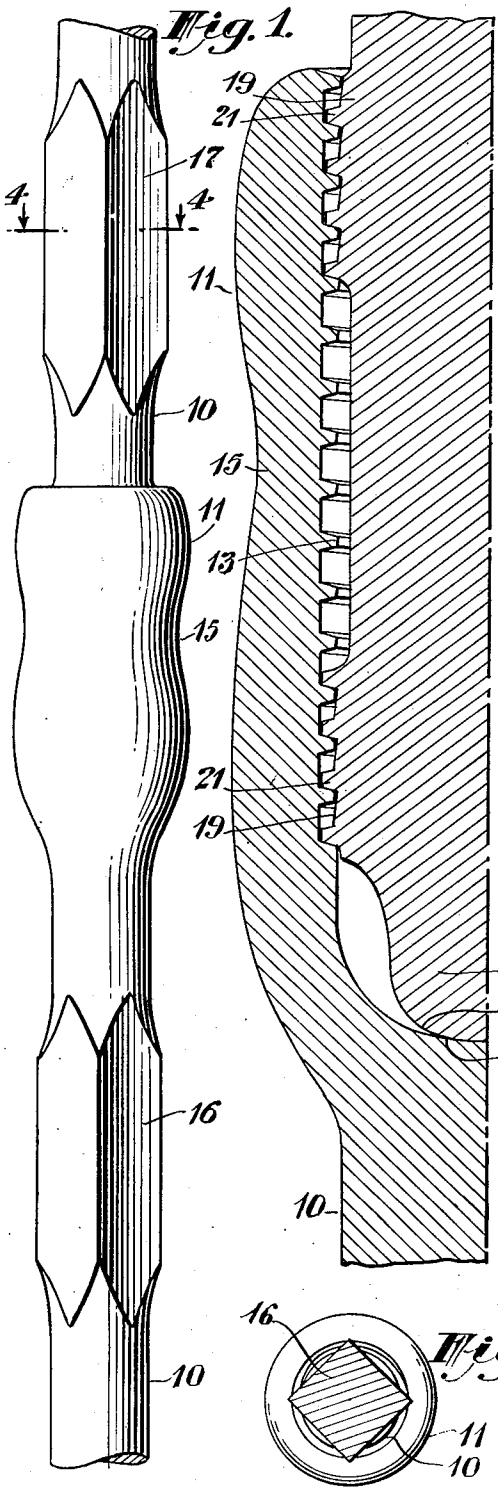


Fig. 3.

Fig. 2

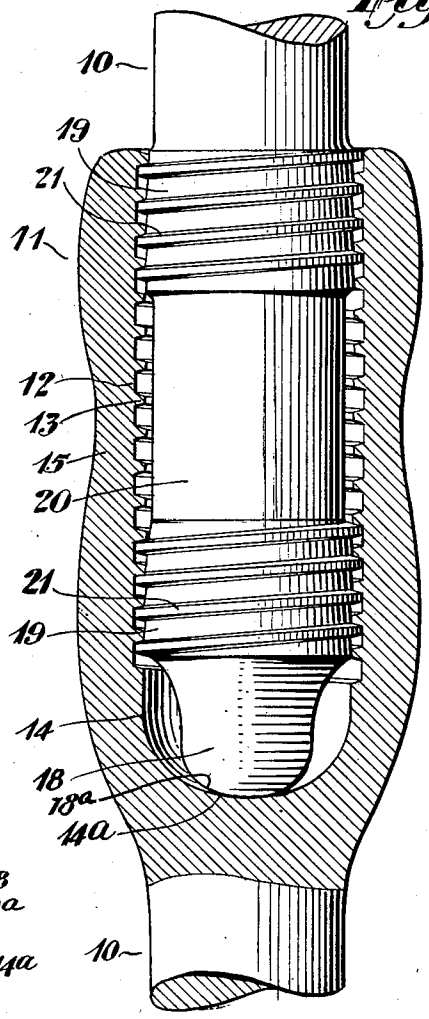


Fig. 4.

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SUCKER ROD

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

Important objects of the invention are, to provide an improved sectional sucker rod of less weight per unit of length than standard sucker rods offering less obstruction to the oil flow and less resistance to reciprocation of the rod in the well tubing, and capable of successfully withstanding the large axial, lateral and twisting stresses to which sucker rods are subjected in use and which are the principal causes of the frequent breakage of standard rods; to provide such a rod wherein the parts or sections are thread coupled in an improved manner to prevent accidental unscrewing of the parts and thereby eliminate a source of frequent trouble with the present standard rods; to provide an improved joint for sucker rod sections of much less bulk and weight than standard joints and possessing adequate strength; to provide a thread coupled sectional sucker rod designed for distribution of flexure in such manner as to protect the threaded connections from breaking and unscrewing strains; to provide an improved self-locking thread joint for sucker rods; to provide an improved threaded sucker rod coupling including a plurality of threaded connections materially spaced apart longitudinally within the coupling; and, to provide such a threaded coupling designed for flexing between the longitudinally spaced threaded connections, to protect the latter from bending strains.

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

Fig. 2 a side 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 a standard single pin and box type of rod in that it consists of like sections each externally threaded at one end and having an internally threaded box or socket portion at its opposite end to receive the externally threaded lower end of the next above section of the rod. The rod sections, however, while having a box at one end do not have the usual collar and threaded pin at the opposite, lower end but are simply externally threaded, as will be described hereinafter. Also, the usual abrupt box shoulder is 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 constant diameter referred to is three-fourths of an inch.

At its upper end each rod is enlarged to form an integral box 11 for the reception of the lower end of the next higher rod section. The maximum diameter of the box is preferably kept relatively small. The bore of the box has a cylindrical form as at 12 from the box mouth downward for a material distance, and this cylindrical bore portion has cut or otherwise formed therein, from end to end, an internal screw thread 13. In the present instance the depth of the threaded bore is more than twice the normal rod diameter. From the inner end of portion 12 the bore is gradually tapered to form a gradually contracting unthreaded bore portion or chamber 14 having a curved, concave bottom wall 14ª.

The external diameter of the rod is enlarged gradually to from the box, beginning preferably from the bottom of the box. Thence upward the diameter is in succession gradually enlarged to a maximum, gradually decreased to a minimum, again gradually increased to maximum and decreased gradually toward the mouth of the box. The side contour lines of the box are continuous, compound, stream line curves extending from end to end of the box. Thereby the box is formed with upper and lower, slightly enlarged, end portions and a reduced interme-

diate neck portion 15. The external and internal form of the box is such that abrupt shoulders or changes of cross section are eliminated and the box is so proportioned that its mass of metal is much less than that of standard forms of boxes, while its strength is greater.

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 16. The cross-sectional area of the rod through the wrench-receiving portion 16 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 16 preferably measures $\frac{11}{16}$ of an inch over flats and $\frac{13}{16}$nds of an inch over corners, and the length of the flats are about 1½ inches. The usual abrupt shoulders and collars at both ends of the wrench-receiving portion are omitted and the wrench-receiving portion merges into the cylindrical rod section. Thereby 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 also formed with a second identical wrench-receiving portion 17 spaced above its lower end.

At its lower end each rod section is formed with an end portion 18 which terminates in a rounded tip 18^a of substantial area adapted to seat centrally on the dished bottom wall 14^a of chamber 14 to form a substantial abutting end-thrust-taking contact area for taking thrust in coupling the sections and also on the down pumping strokes. Lateral clearance within chamber 14 is provided around the end portion 18 and the curvature of the concave bottom wall 14^a is materially less than that of the rounded tip 18^a to permit a certain amount of lateral shifting of said tip in all directions while remaining in contact with said bottom wall. The purpose of this lateral clearance will be explained hereinafter.

Between wrench-receiving portion 17 and end portion 18, each rod section is formed with a pair of slightly enlarged cylindrical portions 19 spaced apart longitudinally of the rod. The diameter of each cylindrical portion is preferably $\frac{1}{16}$ of an inch greater than that of the body of the rod and the portion 20 of the rod connecting said enlarged portions is cylindrical and has a uniform diameter preferably equal to that of the rod body, that is, ¾ of an inch. Each enlarged portion 19 is formed with an external thread 21 designed for screwing into the internal thread 13 of the box. The major diameter of said thread 21 forms a basis for proportioning the parts of the coupling. Preferably the length of each threaded portion 19 is .6 of the major diameter of the thread 21, that is, slightly greater than one half of said diameter; the length of the connecting portion 20 is equal to said diameter; and the maximum diameter of box 11 is 1.5 times said diameter. The cross-sectional area of the most reduced portion of the box neck 15 of the box is preferably the same, or substantially the same, as that of the cross-sectional body area of the rod sections. The depth of chamber 14 and of the rod end 18 may be varied. In the present instance said depth is approximately equal to one of the threaded portions 19. The box thread 13 preferably extends below the lower engaging thread 21 so that the latter may be screwed fully into thread 13 without engaging the usual unfinished or imperfect inner end turn of thread 13. The end portion 18 at its juncture with the lower of the two portions 19 preferably has a diameter slightly less than the root diameter of the thread 21 to avoid contact with the turn or turns of the imperfect thread 13. It will be observed that the end portion 18 practically merges with said thread 21 and that the portions 19 are merged gradually with the body of the rod and with portion 20.

The threads 21 may be cut or otherwise formed on the rod. They are identically formed and preferably extend over the same length of rod, that is, .6 of the major diameter of the thread.

It will be observed from the foregoing that the lower portion of each rod section is also without abrupt shoulders, collars or change of section and that its cross-sectional area at its threaded connections with the box vary only slightly from the cross-sectional body area of the rod sections.

The threads 13 and 21 are complementary threads of constant 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 threads 21 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 18^a seats against wall 14^a and arrests the 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 their tensile strength, so that little or nothing, is left to withstand the service load.

This is a serious defect in the present standard rods. In the present joint the coupling stress after the stop surfaces 14ª and 18ª 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 important 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 is that the enforced tendency to bend in the threaded portions, common to existing joints is resisted in such manner as to protect the threaded connections from breaking and unscrewing strains. For example, a powerful force tending to flex the joint at the point of its upper threaded connection within the box 11 is resisted by a powerful moment of resistance offered by the lower threaded connection which is joined to and longitudinally spaced from said upper connection for good mechanical advantage. Thereby the flexure is thrown 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 and unscrewing strains.

The threaded connections are further safeguarded by the form and proportions of the box 11 which is designed to cooperate with the longitudinally separated threaded connections for causing any slight flexure of the joint under an exceptional stress to occur at an intermediate point longitudinally spaced from said connections. The slightly enlarged end portions of the box, combined with the threaded portions of the rod which they enclose, are thicker and more stiff than the intermediate neck portion 15 of the box and the enclosed rod neck 20. Consequently the joint may flex slightly at said intermediate point and thereby protect the threaded connections from strain.

The nature of the engagement of the rod tip 18ª with the concave bottom wall 14ª, providing lateral clearance for said tip permits the tip to shift slightly under the influence of joint flexure which may occur under certain conditions. It furthermore accommodates the tip to any slight want of axial alignment which may exist between the three longitudinally spaced points of rod engagement within the box, said points being the upper threaded connection, the lower threaded connection and the tip engagement.

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 $1\frac{1}{2}$ inches or $1\frac{5}{8}$ 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 problem, 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 flow of oil through the tubing, which is 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 properly streamlined, so that the tensile breaking load and pumping effort are reduced to a minimum and the flow of oil increased to a maximum; 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 are so distributed as to cause the least damage.

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

What I claim is:

1. A sucker rod comprising separably jointed units coupled by screw threads thereon, wherein at each rod joint the two units have screw threads of equal size and pitch forming two longitudinally spaced screw thread connections therebetween of approximately equal length and also have a substantial radial clearance therebetween from one of said connections to the next, the distance between said screw thread connections being approximately equal to the total length of both connections, and the area of metal in each unit in transverse section being greatest through said two screw thread connections of each joint and being reduced to a substantially uniform area approximately from joint to joint and to a similar area between the two screw thread connections of each joint, whereby a slight flexibility is provided within the confines of the joint between the two screw thread connections and uniformity of flexibility of the rod throughout its length is provided to a substantial degree.

2. A sucker rod as claimed in claim 1,

wherein the units have a circular transverse section of constant diameter approximately from joint to joint of the rod, and the two screw thread connections of each rod joint are formed by an internal screw thread on one unit engaged throughout opposite end portions thereof with two longitudinally spaced external screw threads of equal length on the other unit throughout the length of the latter threads, the diameter of the latter unit substantially throughout the distance between said screw thread connections corresponding with the aforesaid constant diameter, and the first-mentioned unit having its external diameter reduced substantially throughout the distance between said connections, and the major and minor diameters of all said screw threads exceeding the aforesaid constant diameter.

3. A sucker rod comprising identical rod units each having a box at one end into which the adjacent unit extends and having a reduced non-threaded rounded tip at its opposite end and two longitudinally spaced external screw threads of equal length, size and pitch adjacent said tip, said box having a chamber provided with an internal screw thread of the same size and pitch as said external screw threads and also having a non-threaded inner end portion terminating in a concave end wall, the rod units being coupled with the box thread of one unit engaged with both external threads of the adjacent unit and the concave end wall of the box chamber abutted by the rounded tip of said adjacent unit and with said two units free from all other contact and connection, each unit having a substantially constant area of metal in transverse section at all points in its length from the inner end of the box to the reduced non-threaded end portion except throughout the externally threaded portions thereof, the box of each unit being of maximum external diameter between the ends of each of the two screw thread connections and of a reduced external diameter between said two connections that affords an area of box metal in transverse section intermediate said two connections corresponding with said constant area, and the minor diameter of said external and internal threads of each unit being greater than the diameter of the non-threaded portion of the unit between its externally threaded portions.

4. A sucker rod as claimed in claim 1, wherein the rod units have a circular cross-section of constant diameter substantially from joint to joint of the rod and have endwise abutting contact portions at the inner end of each joint universally shiftable laterally of the rod axis, and the screw threads of each joint have a minor diameter slightly exceeding the aforesaid diameter and form two relatively short screw thread connections each of which is approximately as long as the major diameter of said threads.

In testimony whereof I hereunto affix my signature.

HUGUES LOUIS DARDELET.