Dec. 4, 1956 S. EVANS 2,772,899

THREADED OIL WELL DRILL STEM CONNECTION WITH THE THREADS HAVING INCLUDED CREST ANGLE OF 90 DEGREES

Filed May 15, 1948

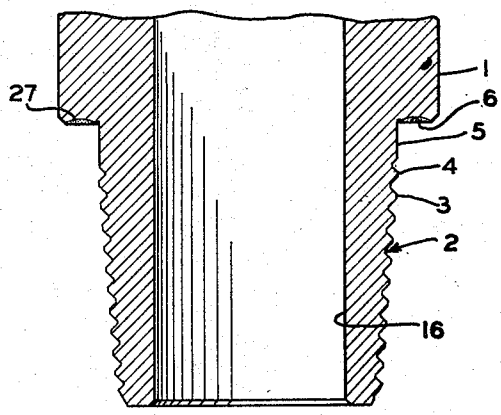

FIG. 1

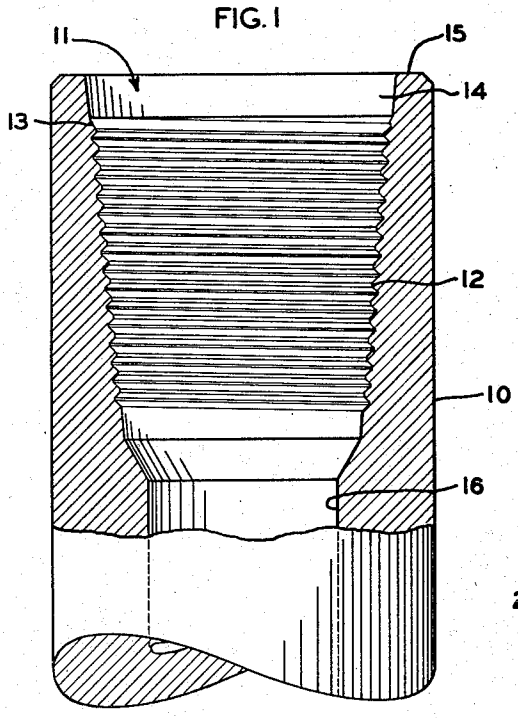

FIG. 2

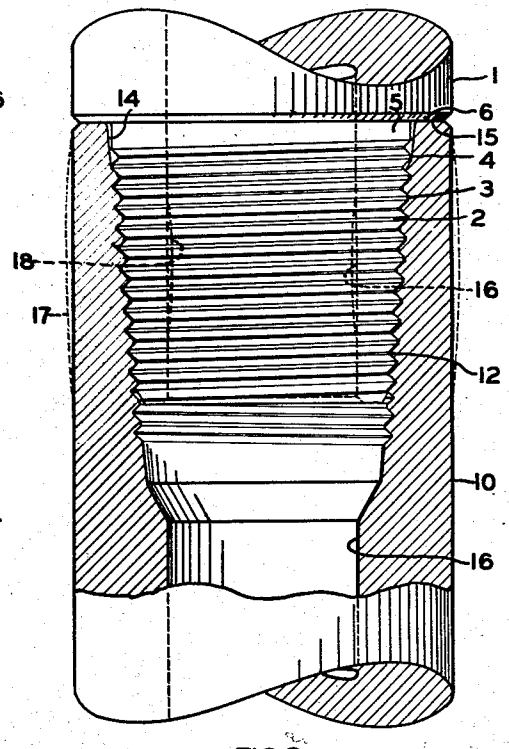

FIG. 3

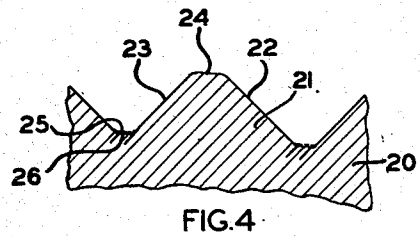

FIG. 4

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United States Patent Office 2,772,899 Patented Dec. 4, 1956

2,772,899

THREADED OIL WELL DRILL STEM CONNECTION WITH THE THREADS HAVING INCLUDED CREST ANGLE OF 90 DEGREES

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Application May 15, 1948, Serial No. 27,247

3 Claims. (Cl. 285—333)

This invention relates to an improved threaded connection of the shouldered, pin and box type and is of particular utility where such a structure is subjected to severe bending and impact stresses such as are encountered in tool joints and drill collars in the drill string used when drilling wells by the rotary method.

In the rotary method of drilling, rotative speeds of the drill string from 40 to 300 revolutions per minute are used. Numerous factors set up high stresses in the drill stem and in particular, large amplitude variable bending stresses are established. Failures frequently occur particularly in the threaded pin and box connection between successive sections of drill collars or between the tool joint sections used for interconnecting sections of drill pipe. Such failures contribute greatly to the cost of drilling from loss of time, labor and material and also increase the hazards incident to drilling operations.

It has been found that loosening of a joint during drilling is a common cause of failure. Such loosening may arise from any of numerous causes particularly relaxation of metal in the joint at localized areas of high pressure from redistribution of lubricant and/or foreign matter in the joint, wearing away of metal from relative movement between parts, and the like. There then follows wabbling, galling and washout failure. In some cases actual breakoff of the threaded portion of drill string takes place and such break-off requires a fishing operation or sidetracking, before drilling can be resumed. If such failure is temporarily averted by withdrawal of the drill string and tightening, yet the damage theretofore inflicted prevents subsequent proper make up of the connection and ultimate failure follows.

Frequently, when lowering a drill stem section to effect a connection with a preceding section in the hole, an impact of the pin with the shoulder on the box member or with the threads in the box member causes a blemish which prevents proper alignment of parts and initiates galling either of which gives rise to localized areas of high pressure and from which relaxation may result as above indicated. Furthermore, such conditions lead to difficulty in making up or breaking out the joint and to a cumulative effect resisting subsequent efforts to make up a joint that will resist the destructive stresses set up from normal use.

It is the primary object of the invention to provide an improved joint, of the type indicated, that will overcome the difficulties to which reference has just been made.

Another object is to provide a threaded connection of the pin and box type that utilizes the material of the connection or joint to a maximum of efficiency by distributing the stresses uniformly within the material surrounding the working surfaces.

Still another object is to provide a pin and box connection having an enhanced tendency to make up or tighten in normal service.

A further object is to provide a connection having improved self centering characteristics thereby facilitating make up and break out operations.

A still further object is to decrease the tendency for

tearing and slivering of the mating surfaces of the joint and to thus minimize galling of parts of the joint.

It is also an object to provide a joint including complemental V-type threads with an improved thread angle of approximately 90° whereby it is possible to readily move the parts from initial mating to final make up under high pressure without injury to any of the component parts of the joint.

Still another object is to provide localized hardening of at least one of the shoulders of the connection to minimize galling, to effect desired distribution of the shoulder-to-shoulder stresses in the completed joint and to cooperate with the improved thread above indicated to provide a joint which obviates difficulties heretofore experienced.

The foregoing objects, together with other objects and advantages of the invention, will be more fully apparent from the following description, considered in connection with the accompanying drawings in which:

Fig. 1 is a section through the pin member of a device embodying the invention;

Fig. 2 is a fragmentary view, partly in section, showing the complementary box member;

Fig. 3 is an elevational view, partly in section, showing the assembled joint comprising the pin and box elements of Figs. 1 and 2;

Fig. 4 is an enlarged detail showing the thread structure of the connection.

As already indicated, the invention is of particular utility in making connections in a drill string where great difficulty is experienced in providing a connection that can be readily made up or broken out in the field and which will at the same time utilize the material of the joint to a maximum efficiency throughout a long life and without either fatigue failure at or near the last engaged thread or loosening followed by wabbling, galling and ultimate failure.

The present invention is based in part upon the discovery that highly improved characteristics are imparted to a joint where the complementary V-type threads thereof have their flanks converge to the crest at an angle of approximately 90°. Cooperatively improving such threads and further improving the characteristics of the joint the invention also comprehends rolling or cold working of the thread roots and, as well, surface hardening of the shoulder of at least the pin member.

It should be noted that, in a joint of this type the overall strength, and hence the ability to successfully resist all stresses to which it is subjected throughout a long period of normal and intended use is dependent upon the maintenance of the shoulder compression above a critical minimum tightness. The invention is directed to a joint in which such a condition is maintained.

In Fig. 1 there is shown a male member **1** having a reduced end portion **2** provided with threads **3**. Upwardly of the end thread **4** is an annular surface **5** which terminates in the shoulder **6**.

The female member **10** shown in Fig. 2 has a cavity or box **11** therein and such box has threads **12** which are complemental to the threads **3** on the pin member. Outwardly from the outermost thread **13** is an annular surface **14** which in the completed joint, lies proximate the surface **5** on the pin member as best seen in Fig. 3 and to which further attention will be directed. The end of the box comprises shoulder **15** adapted to engage the shoulder **6** on the pin member **1**.

When the invention is utilized in a drill string, as illustrated, each of the members **1** and **10** has a central bore **16** to accommodate the flow of fluid therethrough. Although the invention is illustrated for use in a particular environment it is to be understood that it is not

confined to such use but may be used in any environment where resistance to the types of stresses indicated must be resisted.

In Fig. 3 the members 1 and 10 are shown threadedly interconnected with the shoulders 6 and 15 in engagement. When the joint is to be fully made up, further relative rotation is effected whereby there is produced a high compressive stress between the shoulders. At the same time elastic deformation of the pin and box members 1 and 10 takes place and the contours thereof are modified in the manner indicated in dotted outline at 17 and 18. Such elastic deformation is shown exaggerated to more clearly illustrate this feature which is an important factor in the invention. This elastic deformation enables sufficient relative rotation of the joint members during makeup to permit the requisite relaxation in the joint and yet maintain an adequate makeup of the joint that safe operating conditions and longevity are assured.

In Fig. 4 there is shown an enlarged fragment of the V-type threads which comprise an important feature of the invention. The body of the threaded member is shown at 20 and the thread 21 thereon has tapered flanks 22 and 23 which terminate outwardly in the flat crest shown at 24. It has been found that greatly improved results accrue where the included angle between the flanks 22 and 23 lies between 85° and 95°.

It has also been found that rolling of the roots of the threads enhances the improved characteristics of the joint. The visual effect of such rolling or cold working is illustrated in Fig. 4 where the contour of the thread roots as initially formed is shown in dotted outline at 25. Following rolling the final root contour is as shown at 26.

Rolling of the thread roots, particularly proximate the base of the pin 2 and the bottom of box 11, enhances the fatigue strength of these members and complements the advantages obtained of the special complementary threads on the members as above described. It has been found that this operation increases by a factor of at least 2 the fatigue strength of a joint.

To further enhance results it is desirable to eliminate galling of the shoulders 6 and 15 and effect uniform distribution of stress in this shoulder-to-shoulder contact and thus take advantage of the cooperating features heretofore described. To accomplish this, one, or both, of the shoulders is surface hardened, preferably flame hardened, as indicated at 27 on shoulder 6. This of course facilitates relative movement of these surfaces during make up and, as well, resists galling so that adequate make up can be effected. Relaxation within the joint during use is thus insufficient to permit loosening of the joint while in use. In other words all parts of the joint utilize the material to a maximum efficiency and the shoulder compression is maintained above a critical minimum tightness so that loosening, and resulting deleterious effects cannot occur.

The manner of use of the invention will further explain its construction and advantages and for description thereof it will be assumed that a section of drill string, having the lower pin end 1 is to be lowered into and interconnected with the box end 10 of a section already positioned in a well bore. As the pin end 1 enters the box end 10 there will be such interengagement of threads that downward thrust will be assumed by the engaging surfaces. The relatively large cross section of the engaged threads enables them to assume the thrust without damage and hence perfect threads are had for the subsequent make up operation. Also, when interconnecting sections of drill string it is commonplace that the uppermost section is swinging while suspended in the derrick. The threads on the box and pin are likewise such as to prevent binding at opposite sides and hence ease in make up is assured.

The member 1 is next spun to cause the mating threads to make up, with little effort, until the shoulders 6 and 15 engage. Then, torsion is applied to effect further make up whereby the members 1 and 10 are elastically deformed as indicated at 17 and 18 and while the shoulders 6 and 15 slide one upon the other as compression stresses therebetween increase to the point of final make up. In this manner a unitary structure is provided in which all portions of the material are used to a maximum efficiency. The mating threads herein described cooperate to bring about this condition and yet such threads are not of such shallowness that there is danger of pull out when subsequent use stresses tend to further distort the members 1 and 10. The cold working of the thread roots cooperates to strengthen in those areas where the threads tend to weaken. There is thus provided an enhanced over-all strength whereby there is attained the objectives of the invention.

It has been found from practical experience in the use of the invention in the field that the total cost of drill collars alone is reduced from ten cents (10¢) per foot of hole to three cents (3¢) per foot of hole.

The invention claimed is:

1. In an oil well drill stem a threaded connection of the pin and box type, a pin member having a radial shoulder and a conical end portion extending outwardly therefrom, threads on said tapered end portion for engagement with complementary V-type threads in a mating box member, said threads having a crest angle of approximately 90°.

2. In an oil well drill stem threaded connection of the pin and box type, a box member having a tapered counterbore, a substantially radial shoulder at the outer end of the counterbore for engagement with a complementary shoulder on a pin member, and V-type threads on the tapered surface of the counterbore, said threads having a crest angle of approximately 90°.

3. An improved oil well drill stem threaded connection of the shouldered pin and box type comprising, interfitting, tapered pin and box members having complemental transverse radial shoulders in compression when the joint is made up, interfitting V-type threads on said members, the flanks of the threads on the members being complemental and adjacent flanks on each member converging at an angle of approximately 90°, whereby tightness in excess of a predetermined minimum is maintained after relaxation of the made up connection.

References Cited in the file of this patent

UNITED STATES PATENTS

1,141,151	Speller	June 1, 1915
1,562,373	Sheldon	Nov. 17, 1925
2,062,696	Brown	Dec. 1, 1936
2,062,699	Christman	Dec. 1, 1936
2,091,906	Bettis	Aug. 31, 1937
2,160,263	Fletcher	May 30, 1939
2,215,930	Mahla	Sept. 24, 1940
2,320,107	Speckert	May 25, 1943

OTHER REFERENCES

Arnold: "Effect of Screw Threads on Fatigue," pages 497–505, Mechanical Engineering, July 1943, published by the American Society of Mechanical Engineers, New York, N. Y.

Turning and Mechanical Manipulation on the Lathe by Charles Holtzapffel, volume 2, 1847, page 666, published by Holtzapffel and Company, 64 Charing Cross, and 127 Longacre, London, England.

"Mechanikertag-Schranbengewinde, Zeitschrift fur Instrumentenkunde," pages 416 and 417, Nov. 1889.

"Die Gewinde, Ihre Entwicklung, Ihre Messung, und Ihre Toleranzen," by Dr. G. Berndt, mit 395 Abbildungen im text und 287 Tabellen, Berlin 1925, pages 114–115.

Catalog 46–181–R–IM, page 13, published by Jones and Lamson Machine Co., Springfield, Vermont, U. S. A. (1946).