April 27, 1954 E. G. BOICE 2,676,820

DRILL COLLAR

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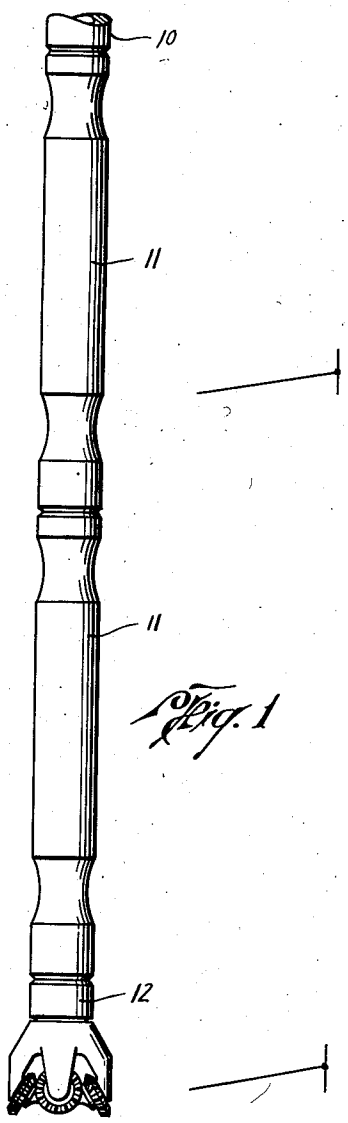

Fig. 1

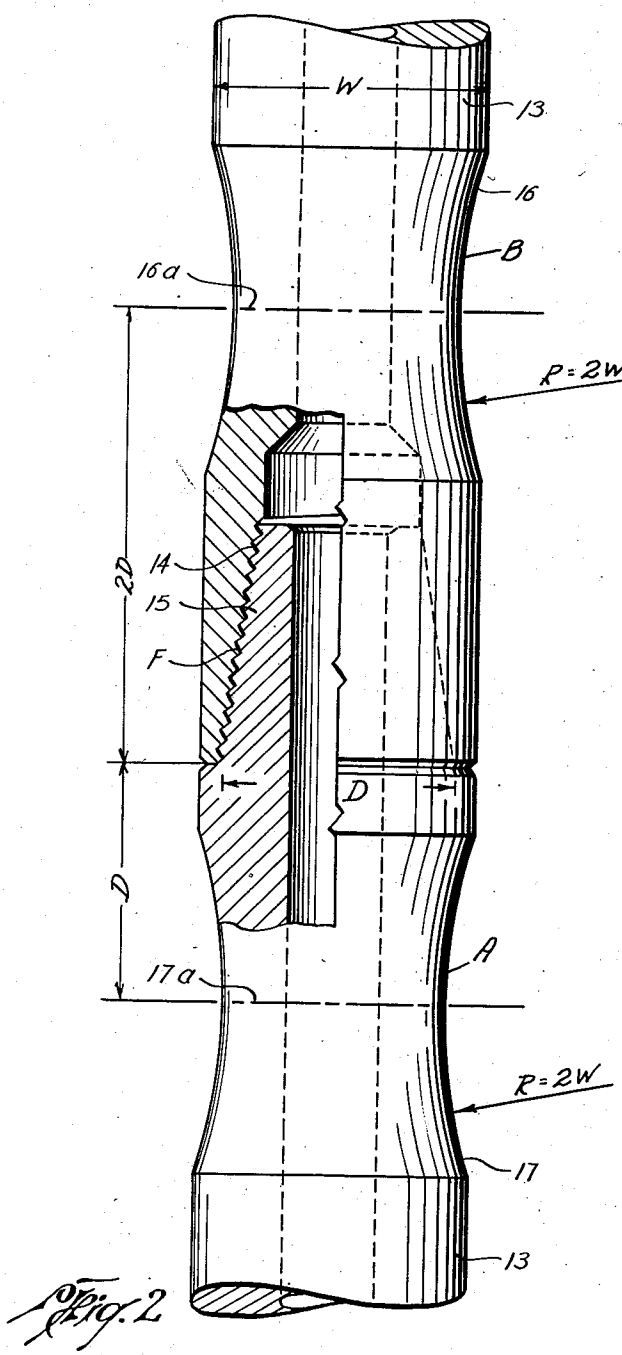

Fig. 2

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DRILL COLLAR

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7 Claims. (Cl. 285—146)

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This invention relates to new and useful improvements in drilling assemblies and particularly to drill collars used in such assemblies.

This application is filed as a continuation-in-part of my co-pending application, Serial No. 65,016, filed December 13, 1948, now abandoned.

The usual drill collar now in general use is constructed with an externally threaded connecting pin at one end with an internally threaded box at its opposite end and it has become the general practice to connect two or more drill collars together in the drilling string. The use of long strings of drill collars has been found to aggravate and magnify the conditions which cause fatigue failures at the drill collar connections, which failures usually occur in the root of the thread on the connecting pin about one or two threads from the base of the pin. Obviously, the connecting pin is integral with the relatively rigid drill collar and when made up into the box of the adjacent drill collar forms a connection between the parts which is, in effect, a rigid and integral one. This rigid or integral connection must absorb all of the stresses occasioned by the drilling operation, and it has been found that the stress concentration occurs in the notch or groove formed at the root of the thread and this is apparently the reason for fatigue failures at this point. Because the fatigue failure occurs in the root of the thread, ultimate parting of the pin takes place rapidly following the presence of the first small fatigue crack or fracture.

If the first indication of fatigue can be ascertained, the drill collar may be replaced but because the first fatigue cracks appear in the root of the thread, it is difficult to detect them with "Magnaflux" or other known detection methods, due to the interference of the thread elements and the machine tool marks usually present in the root of the thread. Therefore, complete fatigue failure usually occurs before the point of possible failure has been located.

It is, therefore, one object of this invention to provide an improved drill collar which is constructed so that the severe concentration of stresses are removed from the pin and box connection and are taken by an area or zone in the drill collar which is spaced from said connection, whereby fatigue failures in the threaded connection are substantially eliminated.

An important object of the invention is to provide an improved drill collar having a recessed or reduced portion spaced from the extremity of the collar whereby deflection within predetermined limits through the recessed portion is possible, which relieves the threaded connection at the extremity of the collar of the extreme concentration of stresses to which said connection would normally be subjected.

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A further object of the invention is to provide an improved drill collar having inwardly recessed sections or portions spaced inwardly from the ends of said collar and of such shape and configuration as to force fatigue failures into said sections, rather than into the threaded end connections of the collar whereby the primary or initial fatigue failure cracks may be readily detected and discovered before complete breakdown or fracturing of the drill collar.

Still another object is to provide a drill collar, of the character described, wherein the recessed portions or sections present a smooth gradually reduced surface which not only eliminates any notch effect for the concentration of stresses but also facilitates immediate discovery of the initial relatively minute fatigue cracks or fractures.

It is another object of the invention to provide a drill collar of the character described wherein the outer surface of the recessed or reduced portions or sections are work hardened by means of peening, rolling or blasting, whereby said surface is placed under compression at the point of flexing and more strength is thereby provided in the outer fibers where fatigue cracks start; the work hardening of said surface also inhibiting corrosion fatigue.

The construction designed to carry out the invention will be hereinafter described together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings, wherein an example of the invention is shown, and wherein:

Figure 1 is an elevation of a pair of drill collars, constructed in accordance with the invention, connected in a drill pipe or stem, and

Figure 2 is an enlarged view, partly in elevation and partly in section, of the connection between the drill collars.

In the drawings, the numeral 10 designates a drill pipe or stem which is illustrated as having a pair of drill collars 11 connected therein. As shown, the drill collars are connected in tandem and a drill bit 12 of any usual construction is connected to the lowermost drill collar.

The drill collars 11 are identical in construction and are arranged to divert the stresses away from the threaded connection so as to eliminate fatigue failure in said connection. Each drill

collar comprises an elongate tubular section 13 having an internally threaded box 14 formed at its lower end. The upper end of each drill collar has an externally threaded connecting pin which is arranged to be threaded into the box 14 of the adjacent drill collar. The uppermost drill collar has its pin 15 connected with the lower end of the drill pipe 10 while the box 14 on the lower end of the lowermost drill collar receives the usual pin (not shown) of the drill bit 12.

In the usual type of drill collar, the external surface of the collar is of the same diameter throughout its length and it has been found that a concentration of stresses causes fatigue failure in the root of the thread on the connecting pin 15, usually at the point indicated at F in Figure 2. This stress concentration is caused by the fact that the fixed diameter drill collar is substantially rigid and the connection at its ends is therefore an integral one. The first fatigue cracks which occur in the root of the thread are difficult to detect with the usual testing methods because of the interference of the threaded serrations and the machine tool marks which are ordinarily present in the root of the thread. Thus, the initial fatigue failure is not evident until a complete fracture of the pin 15 occurs.

In carrying out the present invention, each drill collar has a recessed or reduced portion or section 16 formed at its lower end above the box 14. A similar reduced portion or section 17 is provided at the upper end of each collar adjacent the base of the connecting pin 15. The portion or section 17 is recessed inwardly on an arc A whose radius R is preferably approximately twice the outside diameter W of the drill collar body 13. The center of the section 17 indicated at 17*a* is preferably spaced axially or downwardly from the base of the pin by a distance D which is equal to the diameter D of the pin base.

The recessed or reduced section or portion 16 preferably has the same arc or radius as the section or portion 17, that is, its arc B has a radius R which is twice the outside diameter of the drill collar body 13. Because the box is tubular, the section 16 begins beyond the threads of said box and the center 16*a* of this section is spaced from the end of the collar and therefore from the base of the pin when the collar is in connected position, a distance 2D which is twice the distance of the diameter of the pin base, thereby locating the center line 16*a* of section 16 twice the distance from the pin base.

The recessed or reduced sections or portions 16 and 17 have their outer surfaces work hardened so as to place said surfaces under compression. Work hardening may be effected by any well known method, such as peening, rolling or blasting. By work hardening the surface of each recessed or reduced section or portion, more strength is provided in the outer fibers of the material where fatigue cracks start, and this materially increases the strength of the section. It has also been found that work hardening of these surfaces inhibits corrosion fatigue.

When the pin and box of adjacent drill collars is made up, as shown in Figure 2, the recessed or reduced section or portion 16 is above the connection while the reduced section or portion 17 is below said connection. The recessed portions are formed with smooth surfaces and because of their arcuate contour, no sharp corners or notches are had, the reduction to the minor diameter of each recessed portion being gradual.

It will be evident that the recessed portions 16 and 17 are weaker than the remainder of the drill collars, and therefore, a certain amount of flexibility is imparted to the connected assembly with some deflection being permitted through the recessed portions. In addition, some of the stresses are removed from the pin and box connection and are concentrated in the portions 16 and 17. As a matter of fact, fatigue failure is actually forced into the sections 16 and 17 so that initial fatigue failure will occur in these portions before it will occur in the threaded connection. However, because of the gradual arcuate surface and the elimination of any notch effect, such fatigue failure as occurs in the recessed portions does not occur as quickly therein as would occur in the threaded connections if the drill body 13 were of a constant diameter.

As has been noted, the recessed portions or sections 16 and 17 are subjected to work hardening which materially increases the fatigue resistance of these areas.

The construction relieves the threaded pin 15 from a concentration of stresses, which stresses are absorbed or taken by the recessed sections 16 and 17. Some of the stress on the connection is, of course, eliminated because of the flexibility of the portions or sections 16 and 17. Since fatigue failures will occur in the sections 16 and 17, it is possible to detect the initial fatigue cracks or fractures because such initial cracks will be readily apparent in the smooth portion of the surface 17. As has been previously noted, detection of the initial small fatigue cracks is very difficult in the root of the thread on the pin 15. By detecting the initial relatively small fatigue fractures or cracks, it is possible to replace the drill collar before a complete fracture occurs.

The particular radius of the recessed portions 16 and 17 is subject to some variation. Actual practice has proven that if the radii A and B of the portions 17 and 16 is twice the diameter of the drill collar body 13, efficient results will be obtained and this structure is therefore preferable. With this radii, the section 16 should be located with its center line spaced from the base of the pin 15 twice the distance of the pin base diameter, while the center line 17*a* of the portion 17 is spaced from the base of the pin a distance equal to the diameter of the pin. These distances may be varied within certain limits but the sections 16 and 17 must be sufficiently close to the pin connection to absorb the stresses which would normally be placed on the pin. It is not necessary to make the radii A and B of the reduced sections exactly twice the outside diameter of the drill collar and this radii may be increased or decreased within limits but in any event the radii should be greater than the outside diameter of the pipe; obviously, its lower limit is determined by maintaining sufficient strength in the reduced portions to accomplish the normal function of a drill collar while its upper limit is restricted by a radii which would make the sections 16 and 17 substantially rigid. In other words, the reduced portions are recessed along a gradual line or long arc to eliminate sharp corners or notch effects and the recessing is sufficient to give said portions a certain flexibility while maintaining ample strength to perform the normal drilling function in the use of the drill collar. It will thus be evident that the invention resides in the location of somewhat weakened portions adjacent to the threaded connection whereby such weakened portions provide flexibility and absorb some stress so as to relieve

the threaded connection of a stress concentration. These portions having a smooth surface will not be subject to fatigue failure as quickly as a part having a sharp notch or angle. In addition, the smooth surface of the portions 16 and 17 make it possible to more readily detect the relatively small initial fatigue cracks or fractures, whereby the drill collar may be replaced before a complete breakdown thereof occurs.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

Having described the invention, I claim:

1. A drill collar including, a tubular body having a threaded connecting pin at one end and a threaded box at its opposite end, the major portion of the body having a constant external diameter, and a pair of recessed sections formed in the external surface of the body, one of said sections being spaced from a point adjacent the pin and the other of said sections being spaced from a point adjacent the box, each recessed section having its surface disposed on a radius which is substantially twice the diameter of the external surface of the body.

2. A drill collar as set forth in claim 1, wherein the central portion of the recessed section nearer the connecting pin is spaced axially from the base of the pin by a distance substantially equal to the diameter of the base of said pin and also wherein the central portion of the recessed section nearer the box is spaced from the extremity of the box by a distance substantially equal to twice the diameter of the base of the connecting pin.

3. A drill collar as set forth in claim 1, wherein each recessed section has its outer surface work hardened.

4. A drill collar including, a tubular body having a threaded connecting pin at one end and a threaded box at its opposite end, the major portion of the body having a constant external diameter, and a pair of recessed sections formed in the external surface of the body, each recess having its surface disposed on a radius which is at least greater than the diameter of the external surface of the body, one of said sections being spaced from a point adjacent the pin and the other of said sections being spaced from a point adjacent the box, the central portion of the recessed section nearer the connecting pin being spaced axially from the base of the pin by a distance substantially equal to the diameter of the base of said pin, and the central portion of the recessed section nearer the box being spaced from the extremity of the box by a distance substantially equal to twice the diameter of the base of the connecting pin.

5. A drill collar as set forth in claim 2, wherein each recessed section has its outer surface work hardened.

6. A drill collar as set forth in claim 4, wherein the outer surface of each recessed section is work hardened.

7. A drill collar including, a tubular body having a threaded connecting pin at one end and a threaded box at its opposite end, the major portion of the body having a constant external diameter, and a pair of recessed sections formed in the external surface of the body, one of said sections being spaced from a point adjacent the pin, and the other of said sections being spaced from a point adjacent the box, each recessed section having its surface disposed on a radius which is at least greater than the diameter of the external surface of the body, said radius providing a relatively long arc which is followed by the surface of said section.

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