United States Patent [19]

Bottoms

[11] **3,884,051**

[45] **May 20, 1975**

[54] **BEARING STRUCTURE FOR TELESCOPING WELL TOOL**

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[52] **U.S. Cl.** ..... **64/23.7;** 64/23 R; 175/321; 308/6 A; 403/359

[51] **Int. Cl.** **F16d 3/06**

[58] **Field of Search** ..... 308/6 R, 6 A, 6 C, 6 B; 64/23, 23.7, 9 A; 403/359; 175/321

[56] **References Cited**

UNITED STATES PATENTS

1,721,004	7/1929	Debose	308/6 A
1,877,395	9/1932	Goeser	308/6 A
2,058,331	10/1936	Long	308/6 A
3,319,726	5/1967	Brown	175/321
3,575,246	4/1971	Jones	175/321

Primary Examiner—Samuel Scott
Assistant Examiner—Randall Heald
Attorney, Agent, or Firm—Browning & Bushman

[57] **ABSTRACT**

The present invention relates to telescoping tools used in connection with the drilling of wells for oil, natural gas including mining and oil drilling operations and the like. A tool according to the invention comprises an elongated outer member having a longitudinal bore therethrough and an elongated inner member telescopically mounted therein. A plurality of rotating antifriction bearings are provided between the two members to guide them in their telescopic movement. The bearings have axes of rotation which are disposed normal to the longitudinal axis of the inner member and which are fixed relative to one of the members. Limiting means are provided limiting the axial movement of the outer member relative to the inner member in either direction.

6 Claims, 3 Drawing Figures

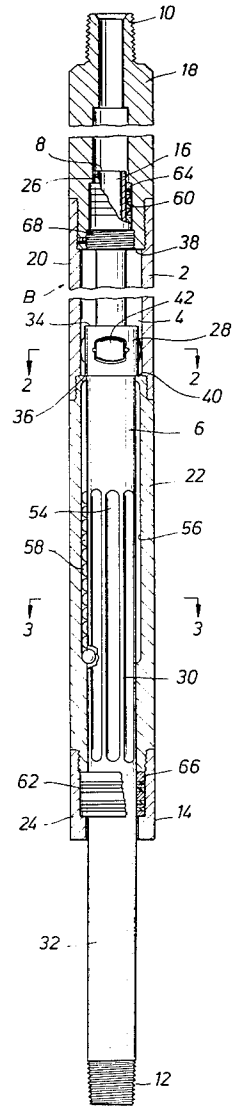
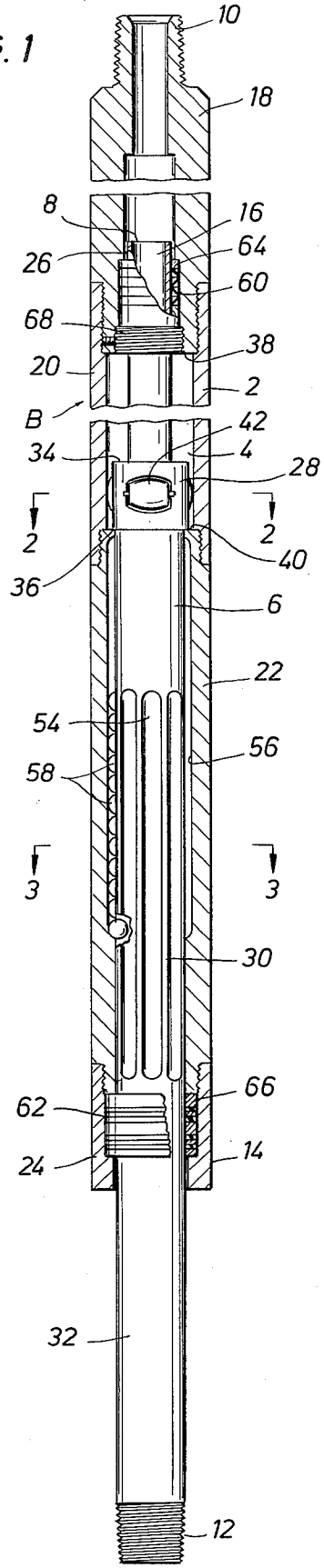


FIG. 1



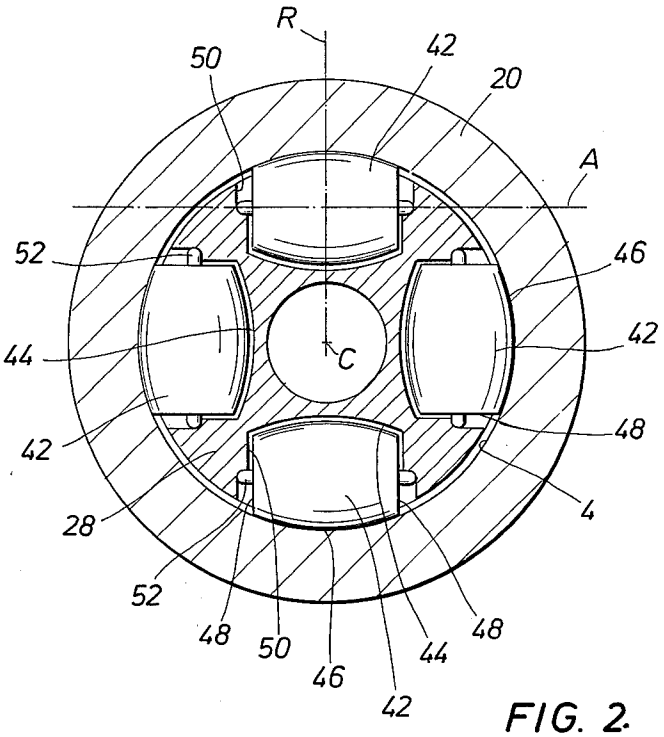


FIG. 2.

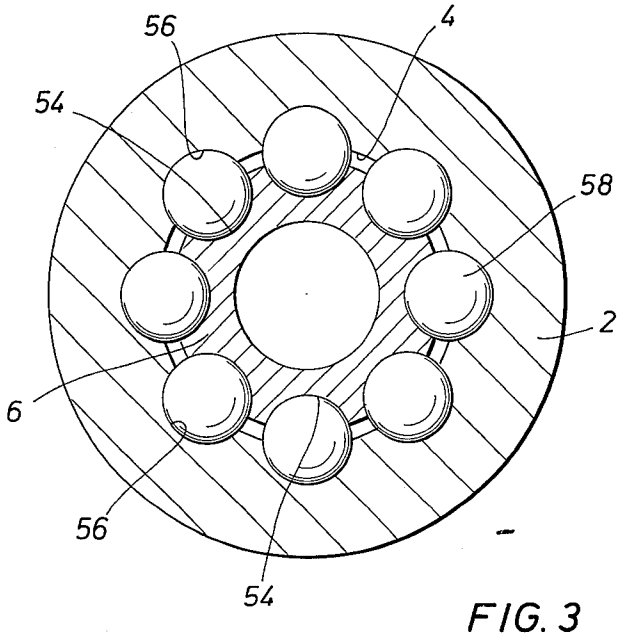


FIG. 3

BEARING STRUCTURE FOR TELESCOPING WELL TOOL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the drilling of oilwells, gaswells including mining and all drilling operations and the like and particularly to telescoping tools used in connection therewith. Such tools generally include an elongated outer member having a longitudinal bore therethrough and an elongated inner member telescopically mounted in this bore. The outermost end of each member is provided with conventional connecting means so that the tool can be disposed in a string of drill rod or pipe with one member connected to the upper portion of the string above the tool and the other member connected to the lower portion of the string beneath the tool. Limiting means are provided to limit the axial movement of one member with respect to the other in either direction; the distance it is permitted to move is known as the "stroke" of the tool. If the tool is intended to transmit torque, e.g. if it is used during drilling itself, the two members are splined so that relative axial movement between them is permitted while relative rotation is prevented.

One such type of telescoping tool is commonly referred to as a "bumper sub" because the limiting means is comprised of two sets of opposed shoulders one of which becomes engaged or "bumps" when the moving member reaches either end of its stroke. Bumper subs are often used to provide an upward and/or downward hammering action of relatively small magnitude or to allow a drill string to accommodate the rise and fall of a ship in offshore drilling.

A similar type of telescoping tool, known as a "jar," is provided with means for delivering upward and/or downward blows of greater magnitude to a piece of equipment stuck in the well.

Still another type of telescoping tool, often referred to as a shock or percussion tool is provided with resilient means which resist relative axial movement of the two members and provide a cushioning effect against shock.

There are other types of telescoping tools, e.g. some which combine some of the features of the tools discussed above.

2. Description of the Prior Art

Telescoping well tools are subjected to high radial forces which tend to misalign or deform the tools. Thus if the outer member, for example, is disposed uppermost in the string, its lower end must be made to fit tightly around the inner member, while the inner member must be guided or supported in the outer member by a bearing structure near its upper end.

In prior art devices, this bearing structure was usually of the friction type, see e.g. the present inventor's prior U.S. Pats. No. 3,345,832 and Re 27,745. The rolling or rotating type bearing was generally avoided. One possible explanation for this is that in some tools, particularly those with long strokes, it would be impractical to provide a long enough track or race for conventional rolling bearings to operate. Another reason is that the conventional rolling bearings provide only point contact with the members and thus would not have sufficient bearing area to accommodate the high radial loads to which well tools are subjected.

Another problem with prior art devices such as shown in applicant's prior patents is that at least one set of opposed limiting means was disposed on the outside of the tool and was thus subject to wear and abrasion by the mud to which it was exposed.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a telescoping well tool with an improved radial thrust bearing structure.

It is another object of the present invention to provide rotating radial thrust bearing elements in a telescoping well tool having axes of rotation which are fixed relative to one of the members of the tool.

Yet another object of the present invention is to provide a tool having two sets of limiting means both of which are disposed in a sealed lubricant chamber.

Still another object of the present invention is to provide rotating radial thrust bearing elements in a telescoping well tool whose sides have a longitudinal radius of curvature substantially the same as the circumferential radius of curvature of the bore of the outer member of the tool.

A tool according to the invention comprises two elongated members telescopically mounted for limited relative axial movement. The inner member is supported in the bore of the outer member by a plurality of rotating bearing elements disposed circumferentially symmetrically around the inner member so that they lie between and are engageable with the two members. Each of the bearing elements has its axis of rotation fixed with respect to one of the members and lying perpendicular to a radial line extending from the longitudinal axis of the inner member.

In a preferred embodiment, the bearing elements are barrel-shaped and are mounted on trunnions in suitable sockets in the inner member. Their sides, which extend outwardly from the sockets along substantially their entire lengths, have longitudinal radii of curvature which are substantially equal to the circumferential radius of curvature of the adjacent portion of inner surface of the outer member.

The tool preferably also includes ball bearing spline means for preventing relative rotation of the two members while permitting relative axial movement. Packings or seals are provided between the members to retain a lubricant around the bearing elements and spline, and the inner member may have a longitudinal passageway therethrough to allow drilling mud to be passed through the tool.

BRIEF DESCRIPTION OF THE DRAWINGS

The structure and operation of the invention as well as its objects and advantages will be more fully illustrated by the following detailed description and the drawings wherein:

FIG. 1 is a longitudinal view, partly in section and partly in elevation, of a tool according to the invention;

FIG. 2 is a transverse section along lines 2—2 of FIG. 1 showing the bearing structure; and

FIG. 3 is a transverse section along lines 3—3 of FIG. 1 showing the spline.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, the invention is shown as embodied in a bumper sub B, although it will

be readily appreciated that it can be applied as well as to other types of telescoping tools such as percussion tools and jars.

The bumper B comprises an elongated outer member 2 having a longitudinal bore 4 and an elongated inner member 6 telescopically mounted in the bore 4. Inner member 6 has a first end 8 mounted in the bore 4 axially inboard of first end 10 of member 2 and a second end 12 free of the bore 4 and axially outboard of the second end 14 of the outer member 2. As shown in the drawings, end 10 is the upper end of the tool, but it will be appreciated that the orientation of the tool could be changed without departing from the spirit of the invention. Ends 10 and 12 are provided with threaded pins or other suitable connecting means for connecting ends 10 and 12 to pieces of drill stem or the like.

Inner member 6 has a longitudinal passageway 16 therethrough to allow drilling mud to be passed through the tool. Each of the members 2 and 6 is comprised of a plurality of parts. Member 2 comprises, from top to bottom, an upper packer sub 18, a bearing sub 20, a spline sub 22, and a lower packer sub 24 all connected end to end by suitable threaded connections. Member 6 comprises, from top to bottom, a wash pipe 26, a hanger flange 28, a spline section 30, and a lower connection section 32, also connected together.

Hanger flange 28 is of greater outer diameter than the adjacent parts 26 and 30 so that it forms a pair of axially directed shoulders 34 and 36 whose surfaces face in opposite directions. Outer member 2 is provided with a pair of axially directed shoulders 38 and 40 on its inner surface. Shoulders 38 and 40 also have surfaces which face in opposite directions. One such pair of shoulders, in this case 34 and 36, face away from one another and lie between the shoulders of the other pair, in this case 38 and 40, which face toward one another. Shoulder 38 is opposed to and engageable with shoulder 34, and shoulder 40 is opposed to and engageable with shoulder 36. Shoulders 38 and 40 are spaced apart a greater distance than shoulders 34 and 36 so that limited relative movement between the two members 2 and 6 is permitted. The two members can telescopically contract until the shoulders 38 and 34, which form one set of limiting means, come into engagement; they can extend until shoulders 36 and 40, which form the other set of limiting means, come into engagement. The length of stroke of the tool is determined by the difference between the distance from shoulder 38 to shoulder 40 and the distance from shoulder 34 to shoulder 36. In a bumper sub, this stroke is usually relatively long, e.g. from 1 to several feet.

Mounted in the hanger flange 28 has a plurality of rotating bearing elements 42 which are circumferentially symmetrically disposed between hanger flange 28 of member 6 and bearing sub 20 of member 2. Each of the bearing elements 42 has an axis of rotation, e.g. A, which is in a plane perpendicular to the longitudinal axis of the inner member 6, i.e. the plane of cross section FIG. 2. Where the longitudinal axis of inner member 6 is represented by its point C in the plane of cross section, axis A is spaced from C, and part of the axis A lies between C and bearing sub 20. As shown, the bearing elements 42 are centered on radial lines in the plane of section, e.g. the roller whose axis is A is centered on radial line R where R is perpendicular to A.

The bearing elements 42 are mounted so that their axes of rotation are fixed with respect to one of the members 2 or 6. As shown they are mounted in sockets 44 in the hanger flange whose dimensions are large enough to permit the bearing elements 42 to rotate therein but small enough to keep their axes fixed relative to inner member 6. In the preferred form the bearing elements are barrel-shaped; their sides 46 are longitudinally curved and convex and their ends 48 are flat.

The sockets 44 have side walls 50 which lie adjacent the ends 48 of the bearing elements 42, and the bearing elements have trunnions 52 protruding from their ends 48 and rotatably mounted in the end walls 50. This mounting arrangement which keeps the bearing axes fixed with respect to inner member 6 does away with the need for an elongated bearing race or track in member 6. Such a race cannot usually be provided because of the limited longitudinal extent of space available on the inner member.

Each bearing element 42 must have a portion of its side 46 extending radially outwardly of the socket 44 to contact the inner surface of the bearing sub 20. In the preferred form each of the bearing elements 42 has a radius of longitudinal curvature which is substantially equivalent to the radius of circumferential curvature of the bore 4 along bearing sub 20 so that the portions which extend outwardly of the sockets are engageable with the bearing sub 20 along the entire lengths of their sides 46 (see FIG. 2).

This configuration provides more radial bearing area than conventional antifriction bearings which provide only point contact. This added area is needed in telescoping well tools which are subjected to high radial loads tending to bend or misalign the tool. The configuration does preclude a completely free rolling action of the bearing elements 42 against the bearing sub 20. For example if the portion of greatest diameter, near the center, of one of the bearing elements is rolling freely along the bearing sub, the portions near the ends will be slipping against it. However the disadvantage of this friction is relatively small compared to the advantages gained by the added contact area. The bearing arrangement provides greater ease of movement betwen the members 2 and 6 than was possible with the prior friction-type bearing, yet it allows for more radial bearing area than conventional rolling bearings which have not, for this reason, been thus used in the past. The spline means, to be described below, and the bottom of low packer sub 24, which fits snugly around lower connector section 32, provide additional radial bearing area.

In keeping with the greater ease of movement afforded by the above-described bearing structure, if the tool is to be splined, it is desirable to provide a type of spline which allows maximum ease of movement. Accordingly, a ball-bearing spline is preferably used with the radial bearing structure of the present invention. Such a spline comprises one or more longitudinally extending arcuate grooves 54 in the spline section 30 of inner member 2. An equal number of similar grooves 56 in the inner surface of member 2 are circumferentially aligned with grooves 54 to form opposed pairs. Between each pair of grooves 54, 56 are a plurality of ball bearings 58. This spline permits relative longitudinal movement of the members 2, 6 with great ease but prevents relative rotation thereof. Although the ball bearings, arcuate grooves form is preferred, it will be readily appreciated that grooves and rolling bearings of other configurations may be used (see the inventor's

prior U.S. Pats. No. 3,345,832 and Re 26,745 cited above).

In order to retain a lubricant around the bearing elements **42**, spline bearings **58**, and limiting means **34**, 36, 38, 40, annular seals **60** and **62** are provided between inner member **6** and outer member **2** to form a lubricant chamber. It will be appreciated that the particular arrangement of the shoulders **34, 36, 38** and **40**, by which all four shoulders are located within the bore **4** of outer member **2**, allows their inclusion in the lubricant chamber. This eliminates the problem of wear on the shoulders induced by drilling mud. The seals extend circumferentially about inner member **6** and may be retained by packing gland rings such as **64, 66** and **68**. Seal **60** is located in the upper packer sub **18** between the first ends **10, 8** of the members and the bearing elements **42**. Seal **62** is located in the lower packer sub **24** between the second ends **12, 14** of the members and the spline means **54, 56, 58**.

I claim:

1. A well tool for use within a hole, said tool comprising:

an elongated outer member having a longitudinal bore therethrough, and having a first end and a second end;

an elongated inner member telescopically mounted in the bore of said outer member, said outer member being axially movable relative to said inner member, said inner member having a first end located within the bore of said outer member axially inwardly of the first end of said outer member, and a second end located free of the bore of said outer member and axially outboard of the second end of said outer member;

means limiting axial movement of said outer member relative to said inner member in either direction;

a radial bearing for maintaining axial alignment of said inner and outer members, said bearing comprising a plurality of rotating bearing elements circumferentially disposed between and engageable with said inner and outer members, each of said bearing elements having an axis of rotation disposed in a plane normal to a longitudinal axis of said inner member and located in part between said axis and the inner wall of said outer member, the axes of said bearing elements being fixed with respect to one of said members; and

longitudinally extending spline means cooperative between said inner and outer members to permit relative axial movement between said members within the limits of said limiting means and prevent relative rotation between said members.

2. The tool of claim **1** wherein said spline means is comprised of a plurality of longitudinally extending grooves in the outer surface of said inner member between said bearing elements and said second ends of said members, an equal number of longitudinally extending grooves in the inner surface of said outer member between said bearing elements and said second ends of said members, each of the grooves in said outer member being circumferentially aligned with one of the grooves in said inner member to form a pair of grooves, and a plurality of rolling bearings disposed between each pair of grooves.

3. The tool according to claim **1** wherein said inner member has a plurality of sockets, each of said sockets being radially directed with respect to said inner member and having one of said bearing elements rotatably mounted therein, each of said bearing elements having a side portion which extends radially outwardly of the socket in which said bearing element is mounted and which is engageable with the inner surface of said outer member.

4. The tool according to claim **3** wherein each of said sockets has end walls adjacent the ends of the axis of the bearing element mounted therein and extending radially beyond the axis of said bearing element and wherein each of said bearing elements includes a pair of trunnions protruding from opposite ends along its axis and rotatably mounted in said end walls.

5. The tool according to claim **1** wherein said bearing elements are of roller type configuration and have longitudinally curved convex sides, the radius of longitudinal curvature of each of said bearing elements being substantially equivalent to the radius of circumferential curvature of the adjacent portion of said bore.

6. A well tool for use within a hole, said tool comprising:

an elongated outer member having a longitudinal bore therethrough, and having a first end and a second end;

an elongated inner member telescopically mounted in the bore of said outer member, said outer member being axially movable relative to said inner member, said inner member having a first end located within the bore of said outer member axially inwardly of the first end of said outer member, and a second end located free of the bore of said outer member and axially outboard of the second end of said outer member;

means limiting axial movement of said outer member relative to said inner member in either direction;

a radial bearing for maintaining axial alignment of said inner and outer members, said bearing comprising a plurality of rotating bearing elements circumferentially disposed between and engageable with said inner and outer members, each of said bearing elements having an axis of rotation disposed in a plane normal to a longitudinal axis of said inner member and located in part between said axis and the inner wall of said outer member, the axes of said bearing elements being fixed with respect to one of said members; and

wherein said inner member includes an annular flange disposed circumferentially therearound, said flange forming a pair of axially directed shoulders facing in opposite directions on said inner member, and wherein said outer member has a pair of axially directed shoulders formed in said bore, each of the shoulders on said outer member being opposed to and engageable with one of the shoulders on said inner member, and the distance between the shoulders on said outer member being greater than the distance between the shoulders on said inner member, whereby said shoulders comprise said limiting means, and wherein said bearing elements are mounted in said flange, and said axes of said bearing elements are fixed with respect to said flange.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. 3,884,051

DATED May 20, 1975

INVENTOR(S) : Clifford C. Bottoms

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the title page, after the inventor's name and residence, insert: --[73] Assignee: Dresser Industries, Inc., Dallas, Texas--.

In column 3, line 52, "has" should read --are--; line 59, after "tion" insert the word --in--.

In column 4, line 47, "low" should read --lower--; line 65, "bearings" should read --bearing--, and "grooves" should read --groove--.

Signed and Sealed this

eleventh Day of *November 1975*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks