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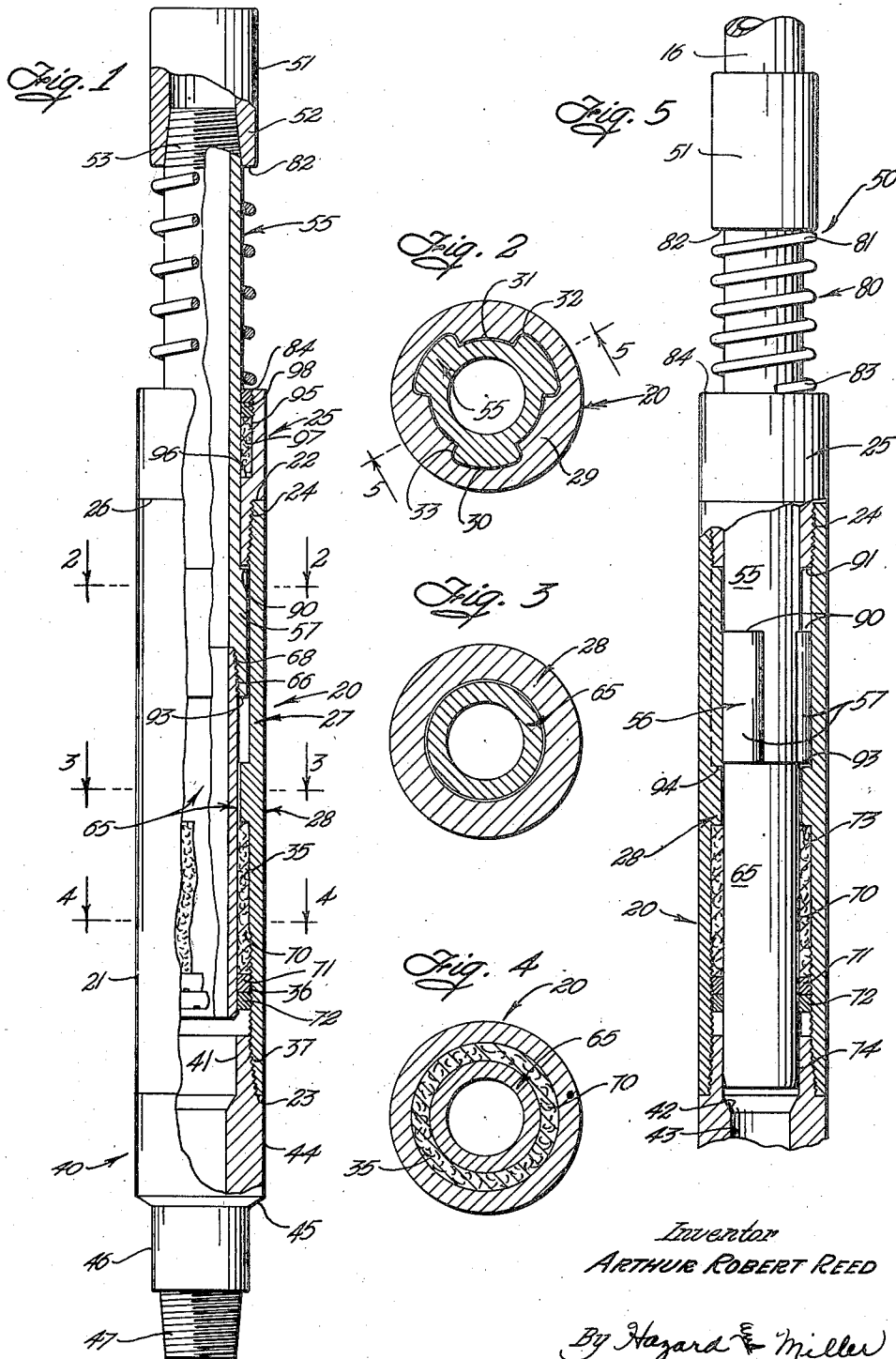
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DRILL STRING SHOCK ABSORBER

Filed Aug. 31, 1938

2 Sheets-Sheet 1



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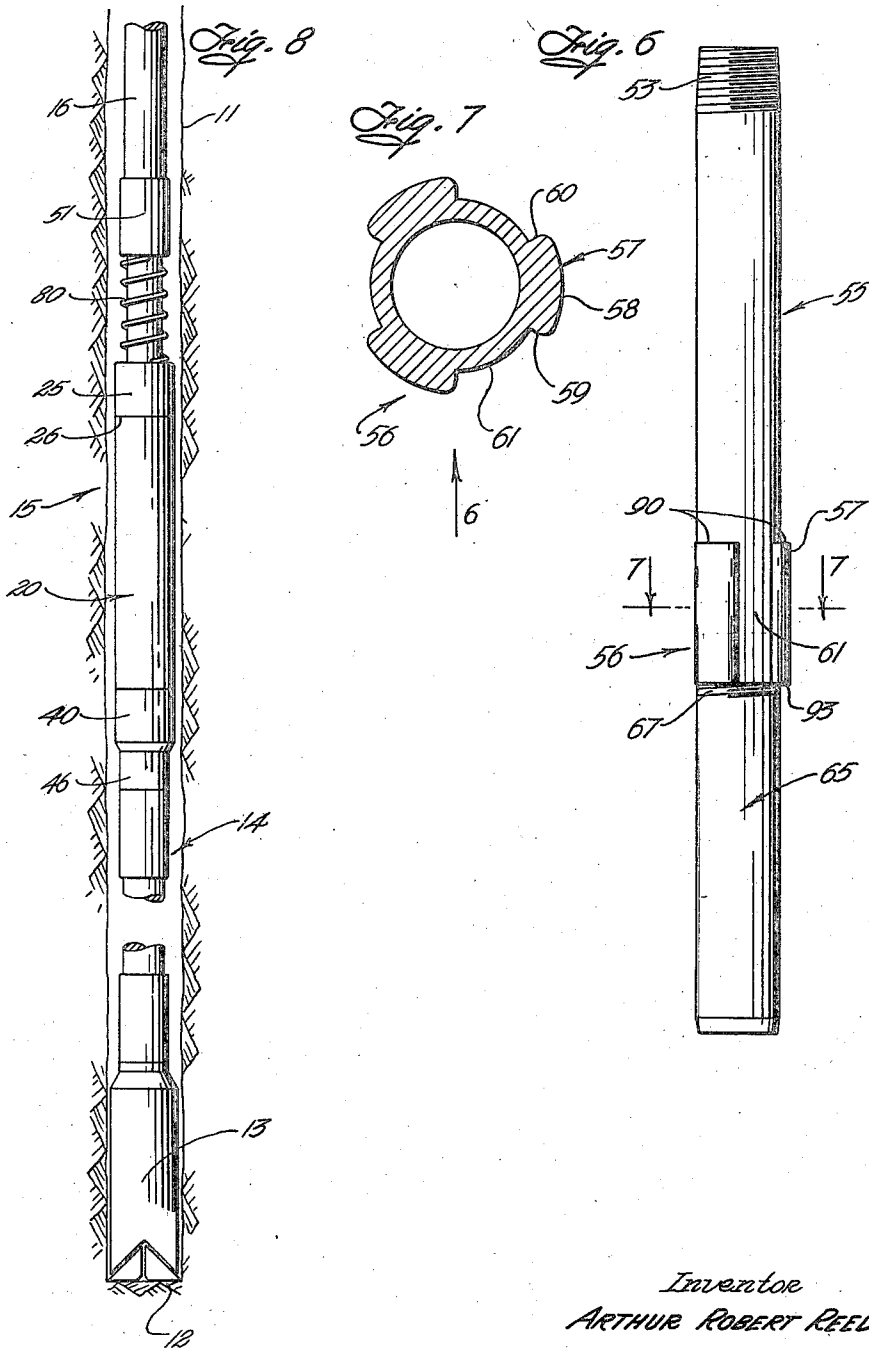
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## UNITED STATES PATENT OFFICE

2,240,519

## DRILL STRING SHOCK ABSORBER

Arthur Robert Reed, Taft, Calif.

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6 Claims. (Cl. 255—28)

My invention relates to a tool which is inserted and forms part of a string of drill pipe used in rotary drilling of the hydraulic type for deep earth boring, such as in boring oil wells.

In the present practice of boring oil wells and the like, it is quite customary in the rotary hydraulic type to employ what is termed hard rock bits. These are used with a comparatively light pressure on the bottom of the hole. Therefore, the major portion of the weight of a long string of drill pipes is supported from a rotary table and the weight of the bit is usually provided by a column of drill collars of sufficient height to provide the desired weight. Also, in the modern practice, the rotational speed of the drill string is very much higher than in former practice. Thus, even although the tool joints are threaded up as tightly as possible, in running the string of drill pipe, the drill bit, and other tools into the well nevertheless, in part, due to the light weight on the bottom of the hole coupled with the high speed of rotation a decided vibration is developed in the drill string which, among other things, tends to loosen the threaded joints and also produce crystallization of the drill pipe and other parts of the assembly.

An object and feature of my invention is a shock absorbing device which is attached at the lower end of the drill string and above the column of drill collars or the like which extend upwardly from the hard rock or similar bit. This shock absorber is provided with a spring giving a resilient downward thrust to the shock absorber tool and to the drill bit with the column of drill collars. This, therefore, relieves the string of drill pipe from the upward and downward vibration caused by the action of the bit on the bottom of the hole. With my invention the rotary drive is communicated through a mandrel, the upper end of which is attached to the lower end of the drill string and such mandrel has an interlocking engagement with the sleeve-like portion of the tool which sleeve is connected through the medium of the drill collars to the bit. The interlocking connection provides for a vertical sliding movement, and hence takes care of any vibration of a vertical type caused by the action of the bit.

A further characteristic of my invention is a construction of the shock absorber to convey the slushing fluid or slushing mud to the bit. This is accomplished by having the mandrel tubular, the interlocking head of the mandrel is at the bottom and to this is connected a wash pipe. The slushing mud is prevented from flowing upward-

ly between the wash pipe and the sleeve by packing and packing nuts to retain such packing in position. However, the wash pipe and sleeve develop a relatively upward and downward movement in locating the bit for operation. Then, due to the vibration of the bit in a vertical direction there is slight up and down movement of the sleeve with the packing relative to the wash pipe. As it is necessary to leave a space in the sleeve to accommodate the relative upward and downward movement of the interlocking head and such space must be filled with a liquid of some type it is desirable to fill this at the top of the well in assembling the tool with clear oil and provide sufficient clearance so that this oil may circulate upwardly and downwardly in reference to the interlocking head of the mandrel and driving lugs engaging therewith on the sleeve. Thus, this clear oil or the like prevents entrance of the slushing mud into the interior of the sleeve.

My invention is illustrated in connection with the accompanying drawings, in which:

Figure 1 is a side elevation partly broken away on a diameter line such as 5—5 of Fig. 2, to show the interior construction of the sleeve, mandrel, and wash pipe;

Fig. 2 is a transverse section on the line 2—2 of Fig. 1 in the direction of the arrows;

Fig. 3 is a transverse section on the line 3—3 of Fig. 1 in the direction of the arrows;

Fig. 4 is a transverse section on the line 4—4 of Fig. 1 in the direction of the arrows;

Fig. 5 is a part elevation and part diametrical section, the elevation being at the upper part of the tool and the section of the lower part of the sleeve on the line 5—5 of Fig. 2, the mandrel and wash pipe being shown in elevation;

Fig. 6 is an elevation of the mandrel and wash pipe taken in the direction of the arrow 6 of Fig. 7;

Fig. 7 is a transverse section on the line 7—7 of Fig. 6 through the driving head of the mandrel; and

Fig. 8 is a broken section through the lower part of a well bore illustrating my invention and its connection to a drill string and drill bit, the parts being broken away in horizontal portions to reduce the height.

Referring first to Fig. 8, the well bore is indicated by the numeral 11 having a bottom 12 on which the drill bit assembly 13 is indicated as operative. Above the bit assembly there is provided a column of drill collars or the like 14 to provide sufficient weight. The shock absorber

tool 15 extends from the drill collars to the string of drill pipe 16. It is of course obvious that the manner of assembly may be in any desired location in the drill string and also, that one or more of these shock absorber tools may be utilized in the same drilling equipment.

Referring first to the characteristics of the shock absorber tool and particularly to Figs. 1 through 5, a long and substantial sleeve 20 forms the main body of the tool. This is cylindrical on its outside surface 21 and terminates at the top at 22 and at the bottom at 23. There is a slightly tapered internal thread 24 at the top which is used to form a connection with a collar 25, this collar having an externally threaded portion thereby forming with the sleeve an annular joint 26 at the top 22 of the sleeve. Below the thread 24 there is an internally grooved section 27 of the sleeve extending downwardly to the horizontally positioned inwardly extending abutment section 28. The section 27 is formed with internal enlargement lugs 29 extending inwardly from the vertically grooved sections 30 which are segments of a cylinder. The inner surface of the lugs 29 indicated at 31 is also cylindrical being concentric with the axis of the sleeve. There are rounded curves 32 joining the vertical driving edges 33 where the lugs or grooves on the sleeve interlock with the head of the mandrel hereunder described in detail.

Below the abutment section 28 the sleeve has an internal cylinder 35 with an internally threaded section 36 and below this there is a tapered thread 37 to which is connected a coupling 40. This coupling has an upwardly extending threaded pin section 41 meshing with the threads 37, an internal bevel 42, and a cylindrical bore 43. The outside surface 44 is cylindrical and of the same diameter as the sleeve. An outside bevel 45 contracts the diameter to the lower cylindrical section 46 below which is a threaded pin 47 for connection to the column of drill collars and the like and where desired the drill bit assembly.

The driving mandrel assembly designated 50 has a coupling 51 connected to the lower end of the string of drill pipe. This is illustrated as provided with a box threaded end 52 in which is threaded the pin end 53 of the cylindrical mandrel 55. This mandrel has a sliding fit in the collar 25 and has the driving head 56, note particularly Figs. 6 and 7. This driving head has a series of projecting lugs 57 each lug has a segmental cylindrical surface 58 having a sliding fit in the vertical grooves 30 of the sleeve between the driving lugs 29. There are radial edges 59 with curved corners 60 similar to the edges 33 and 32 of the sleeve. The cylindrical sections 61 between the lugs is a continuation of the cylindrical portion of the upper part of the mandrel.

Extending below the mandrel there is a wash pipe 65. This has a threaded connection 66 with the lower portion of the driving head of the mandrel, the wash pipe being provided with external threads 67 and the lower portion of the driving head of the mandrel having tapered internal threads 68. The wash pipe is threaded tightly into this point. In order to prevent an entrance of slushing mud between the wash pipe and the lower part of the sleeve there is a packing 70 between the cylindrical portion 35 of the sleeve and the wash pipe. This packing is confined by externally threaded packing nuts 71 and 72 which are threaded to the internal

threads 36 of the sleeve. The wash pipe has a sliding fit on the inside of these packing nuts. The packing extends upwardly to the lower edges 73 of the abutment section 28 of the sleeve. The pin section 41 of coupling 40 has a sufficient internal diameter so that the lower end of the wash pipe, when in its lowermost position, may extend into this pin, this forming, in effect, a socket 74, note Fig. 5.

The resilient action and pressure is given by a strong compression spring 80 in upper end of which, 81, has a thrust bearing or action against the lower edge 82 of the tool joint or coupling 51. The lower end 83 of the spring bears on the upper edge 84 of the collar 25. In assembling, the wash pipe and mandrel may be inserted in the sleeve prior to coupling the collar 25 to such sleeve. The packing 70 may be made sufficiently tight by the packing nuts 71 and 72 and in the assembling clear oil may be filled into the space between the upper portion of the wash pipe and the sleeve above the annular abutment 28 and also the space between the mandrel and the grooves 30 of the sleeve above the mandrel driving head 56. These spaces vary in length, depending on whether the mandrel or wash pipe is in a raised or lowered position in reference to the sleeve. However, there is sufficient clearance of the lugs 57 of the mandrel head and the grooves 30 for this oil to flow upwardly and downwardly. Thus, there is no tendency of the slushing mud or the circulating liquid in the well to enter such spaces by flowing between the collar 25 and the outside surface of the mandrel. By this construction it will be seen that there is a relatively large-sized opening through the mandrel, the wash pipe, and the coupling 40 for the flow of the hydraulic fluid, that is the slushing mud used in rotary hydraulic drilling. The rotary drive is transmitted from the string of drill pipe to the mandrel and by means of the interengaging lugs 37 on the head 56 of the mandrel and the grooved section 27 of the sleeve, the sleeve is thus positively rotated and this conveys the rotational torque through the coupling or joint 40, and thence to the string of drill collars where these are used and to the drill assembly 13.

By this construction it will be seen that the bit assembly may be set on the bottom of the hole and the string of drill pipe lowered sufficiently so that there is a clearance between the upper edge 90 of the driving head of the mandrel and the lower edge 91 of the collar 25. The driving lugs 57 on the head 56 of the mandrel must be of considerable length to have a lug in driving mesh with the internal grooved section 27 of the sleeve, then any vertical vibrational movement communicated to the sleeve by the rotating bit is absorbed by the spring 80 and not transmitted to the string of drill pipe and thus relieving this drill string of being subjected to a vibrational action.

When the drill bit assembly 13 and 14 is being lowered into the well the sleeve assembly 20, the drill collars 14 and drill bit 13 is suspended by the lugs 57 of the driving head 56 of the mandrel by the lower edge 91 of the collar 25 resting on the upper edge 90 of the driving lugs 57. When the drill bit bears on the bottom of the well bore and thus supports the sleeve assembly 20, the drill string and mandrel may be lowered until the lower edges 93 of the driving lugs 57 rest on the upper edge 94 of the abutment section 28 of the sleeve 20.

In the operation of rotary drilling, as the drill pipe and mandrel are suspended from the rotary table the sleeve 20 may jump up and down the full length of the groove 30 of the grooved section 27 of the sleeve that is between the upper edge 94 of the abutment section 28 and the lower edge 91 of the collar 25. Such vertical jump or vibration of the sleeve 20 may develop a hammer blow of the upper edge 90 of mandrel lugs 57 and the lower edge 91 of collar 25 but this is counteracted by the stiff spring 80.

My construction of drill string shock absorber is operative with bits either rolling or dragging on the bottom of the hole bored by such bit and under the high speed of rotation of the present drilling operations, when these bits pass over loose or chipped rocks, a vibrational action is developed. The pulsations of the modern high pressure mud pumps also create very strong vibrations, the two actions develop a vertical jumping of the drill stem. In the ordinary constructions with a rigid connection, these vibrations and vertical jumps destroy the structure and material in the drill strings, sometimes kink the drill pipe and drill collars and also loosens the threading of the collars and tool joints. This action also in the ordinary procedure at times puts an excessive weight on the drill bits causing an unnecessary amount of wear. With my construction therefore it will be seen that the vibrations especially the vertical pulsations, are taken care of by the telescopic action of the mandrel in the long sleeve and the upward jumps or pulsations being resisted by the compression spring, therefore in my construction as there is less wear and tear on the drilling assembly, there is less danger of breakage and hence elimination of a considerable number of fishing jobs. It will be seen therefore that my invention not only comprehends the tool as a shock absorber, but a method of drilling in which the compensation is made for the vertical vibrations and these are caused to develop a useful function in acting on the bit.

It is advisable to provide the collar 25 with a packing. This may be done by having an enlarged bore 95 terminating in the shoulder 96. Within the space between such bore and the mandrel 55, I employ a suitable packing 97 held in place by a nut and lock nut 98 threaded in the upper end of the bore 95.

Various changes may be made in the details of the construction without departing from the spirit or scope of the invention as defined by the appended claims.

I claim:

1. In a device as described in which a string of rotatable tubular drill pipe is connected to a drill bit to rotate such bit and communicate slushing fluid to the bit combined with a shock absorber assembly including a tubular mandrel connected to the lower part of the drill string, a long tubular sleeve having a connection to the bit, the mandrel extending into and having a sliding motion in the sleeve, a collar threaded to the upper end of the sleeve having a sliding fit on a cylindrical portion of the mandrel, the sleeve having a plurality of vertical internal grooves extending downwardly from the collar with an abutment section at the bottom of each groove, the mandrel having a driving head with a plurality of projecting lugs, each fitting in a groove of the sleeve, the grooves being of sufficient length to provide relative reciprocating motion of the lugs in the grooves, the lower face

of the lugs being adapted to contact the abutment section of the sleeve on an upward jump of the sleeve in a drilling operation, the said collar at the upper end of the sleeve having a lower end forming a closure for each groove and adapted to restrain the relative downward motion of the sleeve relative to the projecting lugs of the mandrel and a spring encircling the mandrel and bearing against a connecting means to the drill string and to the top of the collar.

2. In a device as described in which a string of rotatable tubular pipe is connected to a drill bit to rotate such bit and supply slushing fluid to the bit combined with a shock absorber assembly including a tubular mandrel directly connected to the lower part of the drill string, such mandrel having a driving head with a plurality of projecting lugs, a long tubular sleeve having a connecting means to the bit, the mandrel extending into and having a sliding motion in the sleeve, such sleeve having a lower abutment section and a plurality of longitudinal grooves thereabove, the lugs of the driving head of the mandrel being fitted in and sliding in the said grooves on vertical reciprocation, a stop means connected to the sleeve at the upper end of the grooves to limit the upward movement of the mandrel relative to the sleeve, a spring interacting between a thrust means connected to the upper end of the mandrel and a complementary thrust means at the upper end of the sleeve.

3. In a device as described and claimed in claim 2, there being sufficient clearance between the lugs on the mandrel and the grooves of the sleeve to permit flow of liquid in the grooves between the upper and lower end of the lugs on the relative reciprocating motion of the sleeve and the mandrel.

4. In a device as described and claimed in claim 2, there being sufficient clearance between the lugs on the mandrel and the grooves of the sleeve to permit flow of liquid in the grooves between the upper and lower end of the lugs on the relative reciprocating motion of the sleeve and the mandrel, the mandrel having a wash pipe extending downwardly below the driving head, there being a space between the sleeve and the wash pipe below the abutment section of the sleeve with a packing therein, a collar connected to the upper portion of the sleeve and having an enlarged bore with a packing therein engaging the mandrel, the packing contacting the mandrel and the wash pipe being adapted to prevent flow of slushing fluid longitudinally of the mandrel and the wash pipe.

5. In a device as described and claimed in claim 2, the mandrel having a wash pipe connected thereto below the driving head, a packing between the sleeve and the wash pipe, part of the connection of the sleeve to the bit including a coupling secured to the sleeve and having a bore of sufficient diameter and length to receive the lower end of wash pipe when such pipe and the mandrel are in a lowered position relative to the sleeve.

6. In a device as described in which a string of rotatable tubular pipe is connected to a drill bit to rotate such bit and supply slushing fluid to the bit combined with a shock absorber assembly including a tubular mandrel cylindrical on its outside surface except for a driving head at the lower end and such head having radially extending lugs, a wash pipe secured to the lower end of the driving head and extending downwardly, a sleeve having a collar detachably connected

thereto at its upper end, such collar having a cylindrical inside surface forming a sliding fit with the cylindrical section of the mandrel, the sleeve having a cylindrical inside surface with a clearance for the mandrel except for a plurality of vertical grooves, there being an abutment section at the lower end of the grooves, the lugs of the mandrel having a sliding fit in such grooves, the upper edge of the driving head being adapted to engage the lower edge of the collar for suspension of the sleeve in lowering the tools into the well and the lower edge of the driving head being adapted to contact the upper edge of the abutment section on an upward reaction of the sleeve relative to the mandrel in drilling, there being an annular space between the lower por-

tion of the wash pipe and the portion of a sleeve below the abutment section with a packing therein and packing nuts directly connected to the inside portion of the sleeve adjacent its lower end, a spring surrounding the mandrel and bearing against the means connecting the mandrel to the drill pipe and reacting against the said collar, there being a liquid confined in the sleeve in the portion having the vertical grooves, there being a clearance for the transfer of such liquid past the lugs of the driving head in the relative up and down movement of the sleeve and the mandrel, the said wash pipe having a working fit on the packing nuts and the packing below the abutment section.

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