

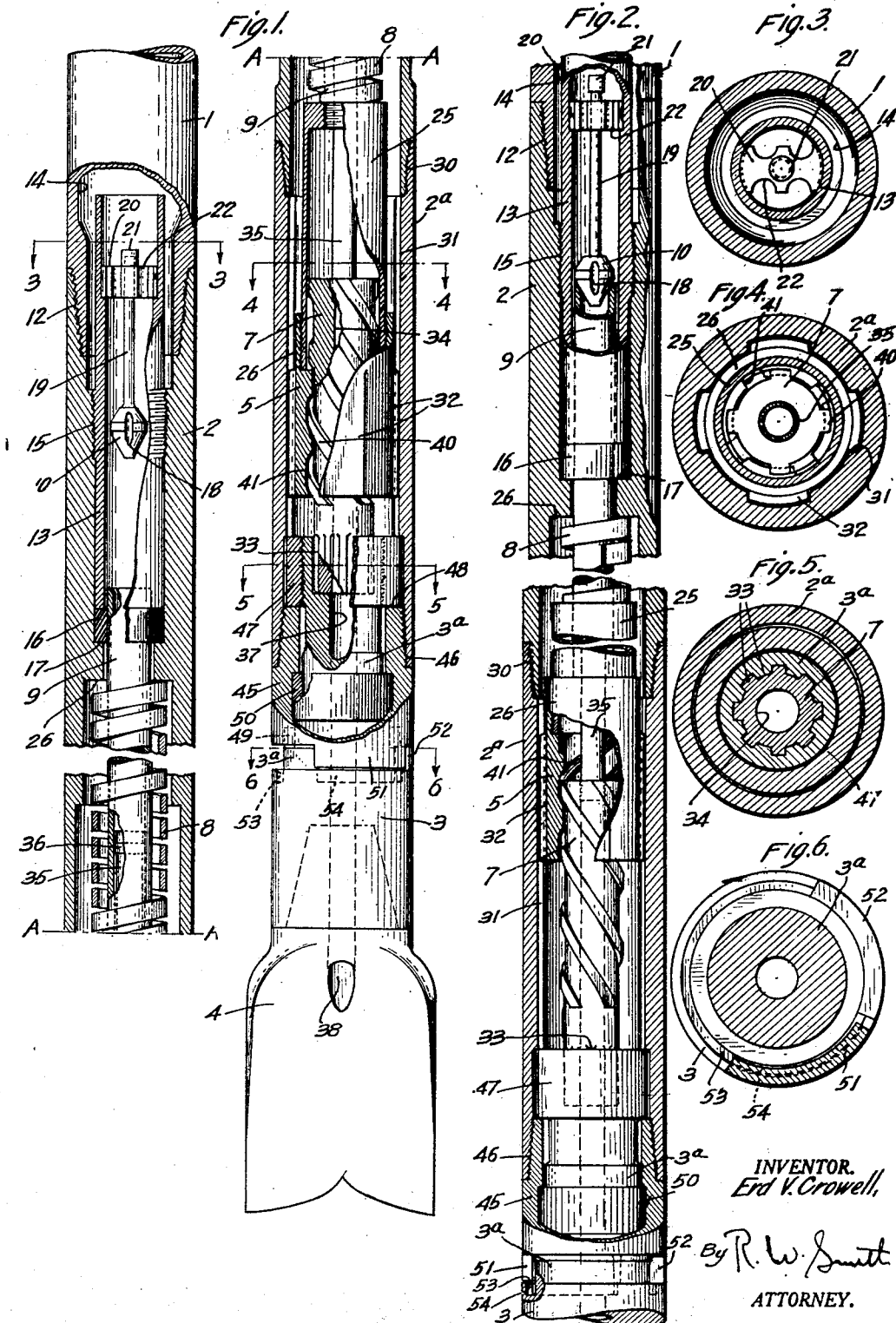
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DRILL STEM

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## UNITED STATES PATENT OFFICE

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## DRILL STEM

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This invention is a rotary drill stem for drill bits used in drilling oil wells and the like, and it is the object of the invention to provide for normal positive rotation of the drill bit by a string of drill pipe, while permitting yielding of the rotary driving connection for relieving torsional strain when the torque of the drill string reaches a predetermined maximum which has been calculated in accordance with a desired safety factor.

It is a further object of the invention to not only control the maximum torque of the drill string but also obstruct circulation when the predetermined maximum is reached, so as to indicate such condition by the reduction in flow of the circulating medium and thereby provide a safety device for both regulating and indicating excessive torque.

More particularly the invention provides a threaded engagement between the drill pipe and the bit, with tensioning means normally preventing relative axial movement at the threaded engagement and thus holding the parts against relative rotation for maintaining a positive rotary drive, and the tensioning means adapted to yield responsive to a predetermined maximum torsional strain at the threaded engagement so as to permit relative threaded movement of the parts resulting in their relative rotation causing lag of the bit with relation to the drill pipe, with the pitch of the threaded engagement calculated with relation to the tensioning means so as to hold the parts against their relative threaded movement and thus maintain the positive rotary drive until the torque reaches the maximum which has been determined as the limit of safety.

It is a further particular object of the invention to provide the drill stem with a normally open valve permitting usual circulation of a fluid as long as the positive rotary drive is maintained, but adapted to at least partially shut-off circulation when there is

relative threaded movement between the drill pipe and the bit as a result of excessive torsional strain, in order to indicate by the resulting partial stoppage of circulation that the predetermined maximum torque has been reached.

Further objects of the invention will be readily understood from the following description of the accompanying drawings, in which:

Fig. 1 is a front elevation of the drill stem partly in axial section and transversely severed at the line A—A, showing the normal positive rotary drive for the bit.

Fig. 2 is a fragmentary axial section through the drill stem, showing the bit lagging with relation to the drill pipe in accordance with excessive torque.

Figs. 3, 4, 5 and 6 are transverse sections on the correspondingly indicated lines of Fig. 1.

The drill stem is adapted for suspension from a usual string of rotary drill pipe 1, and preferably comprises a tubular body 2 having an extension 2<sup>a</sup> adapted to receive a bearing projection 3<sup>a</sup> of a collar 3 from which a usual drill bit 4 is suspended. A sleeve 5 is axially slidable in the extension 2<sup>a</sup> but turns therewith so that it is rotated by the string of drill pipe 1, and a threaded engagement is provided between this rotating sleeve and a mandrel 7 with which the collar 3 and the drill bit 4 are adapted to turn. A spring 8 normally holds the rotating sleeve retracted against threaded elevation relative to mandrel 7 as shown in Fig. 1, so that the threaded engagement turns the mandrel with the rotating sleeve in order to provide a positive rotary drive for the drill bit 4; but when the torque of the drill string reaches a predetermined maximum the spring 8 is adapted to yield so as to permit threaded movement of rotating sleeve 5 upwardly along mandrel 7 as shown in Fig. 2, thereby causing rotary lag of the mandrel with relation to the sleeve 5 resulting in cor-

responding yielding of the rotary driving connection for the drill bit.

Circulation through the drill string is preferably by way of a pipe 9 which is adapted for axial movement with sleeve 5, and a valve 10 may be suspended in body 2 so that during normal threaded retraction of the sleeve 5 on mandrel 7 for maintaining the positive rotary drive, the valve 10 is spaced from the open end of pipe 9 as shown in Fig. 1 in order to permit unobstructed circulation; while threaded elevation of sleeve 5 on the mandrel as a result of the torque of the drill string overcoming the tension of spring 8, will correspondingly elevate pipe 9 relative to valve 10 as shown in Fig. 2 so that the valve seats in the open end of the pipe and thus at least partially obstructs circulation for indicating that the positive rotary drive for the drill bit has yielded responsive to a predetermined maximum torque.

As an instance of the aforementioned arrangement of parts, the body 2 may be suspended from drill pipe 1 by a usual threaded connection 12, and a guide pipe 13 open at its upper end to the bore 14 of pipe 1 is preferably suspended in body 2 by a threaded connection 15. The pipe 9 is adapted for telescopic reception in guide pipe 13, with packing 16 between pipe 9 and the bore of body 2 preferably compressed by the guide pipe against a shoulder 17 in the bore of body 2 so as to insure all of the circulating medium flowing downwardly through pipe 13 and thence through pipe 9.

The valve 10 which cooperates with the open end of pipe 9 is shown as a usual tapering valve, preferably having by-passes 18 for permitting some flow of the circulating medium past the valve even when the valve is seated for shutting-off the major portion of the flow; and the valve is preferably suspended from a stem 19 which may slidably project through a spider 20 mounted in pipe 13, with downward movement of the valve stem limited by its head 21 engaging the spider which is shown as cut-away to form suitable passages 22 for free flow of the circulating fluid.

The pipe 9 may be arranged for axial movement with sleeve 5 by threading the lower end of the pipe into the closed upper end of a tube 25 which may be in turn threaded into a coupling collar 26 at the upper end of sleeve 5; and the spring 8, which is preferably a relatively heavy coil spring, preferably surrounds pipe 9 and abuts at its respective ends against the closed upper end of tube 25 and against a shoulder 26 in the bore of body 2.

The extension 2<sup>a</sup> of tubular body 2 is preferably suspended from the body by a usual threaded connection 30, and its bore is provided with grooves or keyways 31 adapted to engage corresponding longitudinal lugs

32 on the outer surface of sleeve 5 for rotating the sleeve with the body while permitting relative axial sliding of the sleeve.

The bearing projection 3<sup>a</sup> of collar 3 preferably extends upwardly into the lower end of body extension 2<sup>a</sup>, and the mandrel 7 projects upwardly from the bearing projection and is fixed against rotation relative thereto, preferably by keying the lower end of the mandrel for reception in correspondingly grooved counterbore in the end of the bearing projection as is shown at 33. The mandrel is shown as having an open bore 34, with a pipe 35 preferably projecting upwardly from said open bore and telescoping in pipe 9, and the pipe 35 may be provided with a packing ring 36 engaging the bore of pipe 9 for insuring all of the circulating medium flowing downwardly through the bore of the mandrel. The collar 3 and its bearing projection 3<sup>a</sup> is provided with a bore 37 communicating with the bore of the mandrel and opening into the usual circulating bore 38 of drill bit 4 for circulating a fluid in usual manner during the drilling operation.

The threaded engagement between rotating sleeve 5 and the mandrel 7 preferably comprises threads 40 of extremely coarse pitch on the exterior surface of the mandrel engaging corresponding threads 41 in the bore of sleeve 5; and the tension of spring 8 is such with relation to the pitch of threads 40—41 as to normally hold the rotating sleeve retracted on the mandrel against threaded elevation relative thereto so that the mandrel is positively rotated with the sleeve as shown in Fig. 1, but the spring is adapted to yield responsive to a predetermined maximum torsional strain at the threaded engagement 40—41 so as to permit threaded elevation of the rotating sleeve relative to the mandrel and thus cause corresponding rotary lag of the mandrel with relation to the rotating sleeve as shown in Fig. 2. This rotary lag of the mandrel results in corresponding rotary lag of drill bit 4 relative to the string of rotary drill pipe 1, since the sleeve 5 is rotated by the extension 2<sup>a</sup> of the tubular body 2 which is in turn rotated by drill pipe 1, while the mandrel 7 is fixed for rotation with the bearing projection 3<sup>a</sup> of the collar 3 from which the drill bit 4 is suspended; and consequently by providing any predetermined relationship between the tension of spring 8 and the pitch of threads 40—41, the drill bit 4 will be rotated with the drill pipe 1 as long as the torque of the drill string does not exceed the predetermined maximum, but torque beyond said predetermined safety factor will cause the bit to lag relative to the rotating drill pipe in order to relieve the excessive torque.

The bearing projection 3<sup>a</sup> of collar 3 which supports the drill bit is preferably journaled in a bearing sleeve 45 which may be fixed to the lower end of body extension 2<sup>a</sup> by means

of a usual threaded connection 46, and a collar 47 is preferably threaded onto the upper end of the bearing projection 3<sup>a</sup> and rotatably seats on a shoulder 48 formed by the upper end of bearing sleeve 45 so as to prevent axial displacement of collar 3 while permitting its rotation relative to the string of drill pipe for producing the desired rotary lag of the bit when the predetermined maximum torque is reached. A thrust bearing comprising an annulus 49 may be provided between the bearing projection 3<sup>a</sup> and the bearing sleeve 45, and packing shown at 50 is preferably also provided between these relatively rotating parts. The packing 50 in conjunction with the packing 16 and 36 thus packs-off the bore for the circulating medium which extends through the drill stem, so that the threaded engagement 40—41 is shut-off from said circulating medium both above and below said threaded engagement, and the possibility of mud or the like clogging the threads is thus avoided and a suitable lubricant sealed against escape by the packing may be provided at the threaded engagement.

Arcuate abutments 51—52 preferably project axially from the proximate ends of bearing sleeve 45 and collar 3, and are adapted for circumferential abutment to preferably limit the relative lag of drill bit 4 to approximately one-half a revolution as will be understood by a comparison of Figs. 1 and 2; and an annular groove 53 is preferably provided in the end of collar 3 for reception of an axially projecting tongue 54 on the abutment 51 so as to maintain concentric alinement of the abutments during relative rotation of bearing sleeve 45 and collar 3.

In operation the parts are normally in the position shown in Fig. 1, with spring 8 holding the sleeve 5 in axially depressed position relative to mandrel 7 and against threaded elevation on the mandrel, so that the valve 10 is spaced from the end of pipe 9 for free circulation through the drill stem, and the arcuate abutment 51 of bearing sleeve 45 is in advance of the cooperating abutment 52 of collar 3. The tension of spring 8 thus holds the drill bit against rotary lag relative to the string of drill pipe as long as the torque of the drill string does not exceed a predetermined maximum; but when the torque exceeds the predetermined safety factor the torsional strain at threads 40—41 overcomes the tension of spring 8 and permits threaded elevation of sleeve 5 relative to mandrel 7. Rotation of drill pipe 1 is thus continued with the drill bit lagging behind to the limit of movement permitted by the abutment of the cooperating elements 51—52, and at the same time pipe 9 is elevated by the relative axial movement of sleeve 5 so that the open upper end of the pipe is engaged by valve 10 for cutting off the major portion of the flow of the circulating medium. This retarding of

circulation advises the operator that the torque of the drill string has reached the predetermined maximum, and at the same time the torque is relieved by the lagging of the drill bit relative to the rotating drill pipe.

I have thus provided extremely simple but practical means for regulating the torque of a drill string by a driving connection which is adapted to permit rotary lagging of the drill bit when the torque reaches a predetermined maximum, and said yielding of the rotary driving connection is also adapted to at least partially shut-off circulation for indicating that the torque has reached the predetermined limit of safety.

I claim:

1. A drill stem comprising a body adapted by a string of drill pipe, a section fixed against axial displacement relative to the body and adapted to rotate a drill bit, and a normally non-yielding rotary driving connection between the body and said section adapted to rotatably yield in accordance with a predetermined torque of the drill stem so as to permit rotary lagging of the drill bit with relation to the string of drill pipe.

2. A drill stem comprising relatively rotatable sections, one of which is adapted for rotation by a string of drill pipe and the other of which is adapted to rotate a drill bit, a normally non-yielding rotary driving connection between said sections adapted to rotatably yield in accordance with a predetermined torque of the drill stem so as to permit rotary lagging of the drill bit with relation to the string of drill pipe, and means for indicating said yielding of the rotary driving connection.

3. A drill stem having a circulating bore and comprising relatively rotatable sections, one of which is adapted for rotation by a string of drill pipe and the other of which is adapted to rotate a drill bit, a normally non-yielding rotary driving connection between said sections adapted to rotatably yield in accordance with a predetermined torque of the drill stem so as to permit rotary lagging of the drill bit with relation to the string of drill pipe, and means actuated by said yielding of the rotary driving connection for retarding circulation through the said bore.

4. A drill stem having a circulating bore and comprising a body adapted for rotation by a string of drill pipe, a section fixed against axial displacement relative to the body and adapted to rotate a drill bit, a normally non-yielding rotary driving connection between the body and said section adapted to rotatably yield in accordance with a predetermined torque of the drill stem so as to permit rotary lagging of the drill bit with relation to the string of drill pipe, and fluid tight packing for packing-off the rotary driving connection from the circulating bore.

5. A drill stem having a circulating bore

and comprising relatively rotatable sections, one of which is adapted for rotation by a string of drill pipe and the other of which is adapted to rotate a drill bit, a normally non-yielding rotary driving connection between said sections adapted to rotatably yield in accordance with a predetermined torque of the drill stem, means actuated by said yielding of the rotary driving connection for retarding circulation through the said bore, and means for packing-off the rotary driving connection from the bore.

6. A drill stem comprising a body adapted for rotation by a string of drill pipe, a section fixed against axial displacement relative to the body and adapted to rotate a drill bit, a normally non-yielding rotary driving connection between the body and said section adapted to rotatably yield in accordance with a predetermined torque of the drill stem so as to permit rotary lagging of the bit with relation to the string of drill pipe, and means for limiting said relative lag of the bit.

7. A drill stem comprising relative rotatable sections, one of which is adapted for rotation by a string of drill pipe and the other of which is adapted to rotate a drill bit, a normally non-yielding rotary driving connection between said sections adapted to rotatably yield in accordance with a predetermined torque of the drill stem so as to permit rotary lagging of the bit with relation to the string of drill pipe, cooperating abutment elements circumferentially fixed with relation to the respective sections and adapted for circumferential abutment for limiting said relative lag of the bit, and an axially extending annular tongue and groove engagement between the abutment elements for maintaining their concentric alinement.

8. A drill stem comprising relatively rotatable sections, a body adapted for rotation by a string of drill pipe and engaging one of the sections for rotating the same, the other of said sections being adapted for rotation but fixed against axial displacement relative to the body and adapted to rotate a drill bit, and a normally non-yielding rotary driving connection between said sections adapted to rotatably yield in accordance with a predetermined torque of the drill stem so as to permit rotary lagging of the drill bit with relation to the string of drill pipe.

9. A drill stem comprising relatively rotatable sections having a circulating bore, a body adapted for rotation by a string of drill pipe and engaging one of the sections for rotating the same, the other of said sections being adapted for rotation but fixed against axial displacement relative to the body and adapted to rotate a drill bit, a normally non-yielding rotary driving connection between said sections adapted to rotatably yield in accordance with a predetermined torque of the drill stem so as to permit

rotary lagging of the drill bit with relation to the string of drill pipe, and packing between the body and the circulating bore of the sections for packing-off the rotary driving connection.

10. A drill stem comprising relatively rotatable sections, a body adapted for rotation by a string of drill pipe and engaging one of the sections for rotating the same, the other of said sections being adapted for rotation but fixed against axial displacement relative to the body and adapted to rotate a drill bit, a normally non-yielding rotary driving connection between said sections adapted to rotatably yield in accordance with a predetermined torque of the drill stem so as to permit rotary lagging of said other section with relation to the body, and cooperating abutment elements fixed relative to the body and said other section and adapted for circumferential abutment for limiting the relative lag of said other section.

11. A drill stem comprising relatively rotatable sections, a body adapted for rotation by a string of drill pipe and engaging one of the sections for rotating the same while permitting axial movement of said section relative to the body, said section constituting a drive section, the other of said sections being fixed against axial displacement relative to the body and adapted to rotate a drill bit, said section constituting a driven section, a threaded engagement between the sections, and means for normally tensioning the drive section against axial movement relative to the body so as to hold the sections against relative threaded movement and thus maintain a positive rotary driving connection between the sections, the said tensioning means being adapted to yield in accordance with a predetermined torque of the drill stem in order to permit axial movement of the drive section relative to the body for relative threaded movement between the sections causing yielding of the rotary driving connection and lagging of the bit with relation to the string of drill pipe.

12. A drill stem comprising relatively rotatable sections having a circulating bore, a body adapted for rotation by a string of drill pipe and engaging one of the sections for rotating the same while permitting axial movement of said section relative to the body, said section constituting a drive section, the other of said sections being fixed against axial displacement relative to the body and adapted to rotate a drill bit, said section constituting a driven section, means for normally tensioning the drive section against axial movement relative to the body, a driving connection between the sections held against yielding by said non-movement of the drive section relative to the body, the

said tensioning means being adapted to yield in accordance with a predetermined torque of the drill stem in order to permit axial movement of the drive section relative to the body, said movement of the drive section causing rotary yielding of the driving connection and lagging of the drill bit with relation to the drill pipe, and a valve mounted in the body and normally spaced from the circulating bore of the drive section so as to permit unobstructed circulation but arranged whereby axial movement of the drive section relative to the body in response to yielding of the tensioning means is adapted to seat the valve in the circulating bore of the drive section for obstructing circulation.

13. A drill stem comprising relatively rotatable sections having a circulating bore, a body adapted for rotation by a string of drill pipe and engaging one of the sections for rotating the same while permitting axial movement of said section relative to the body, said section constituting a drive section, the other of said sections being fixed against axial displacement relative to the body and adapted to rotate a drill bit, said section constituting a driven section, means for normally tensioning the drive section against axial movement relative to the body, a driving connection between the sections held against yielding by said non-movement of the drive section relative to the body, the said tensioning means being adapted to yield in accordance with a predetermined torque of the drill stem in order to permit axial movement of the drive section relative to the body, said movement of the drive section causing rotary yielding of the driving connection and lagging of the drill bit with relation to the drill pipe, a pipe projecting upwardly from the bore of the drive section, and packing between said pipe and the body.

14. A drill stem comprising relatively rotatable sections having a circulating bore, a body adapted for rotation by a string of drill pipe and engaging one of the sections for rotating the same while permitting axial movement of said section relative to the body, said section constituting a drive section, the other of said sections being fixed against axial displacement relative to the body and adapted to rotate a drill bit, said section constituting a driven section, means for normally tensioning the drive section against axial movement relative to the body, a driving connection between the sections held against yielding by said non-movement of the drive section relative to the body, the said tensioning means being adapted to yield in accordance with a predetermined torque of the drill stem in order to permit axial movement of the drive section relative to the body, said movement of the drive section causing rotary yielding of the driving connection and lagging of the

drill bit with relation to the drill pipe, a pipe projecting upwardly from the bore of the drive section, a pipe projecting upwardly from the bore of the driven section and telescoping in the first mentioned pipe, and packing between said pipes.

15. A drill stem comprising relatively rotatable sections having a circulating bore, a body adapted for rotation by a string of drill pipe and engaging one of the sections for rotating the same while permitting axial movement of said section relative to the body, said section constituting a drive section, the other of said sections being adapted for rotation but fixed against axial displacement relative to the body and adapted to rotate a drill bit, a normally non-yielding rotary driving connection between said sections adapted to rotatably yield in accordance with a predetermined torque of the drill stem so as to permit rotary lagging of the drill bit with relation to the string of drill pipe, the rotary driving connection being arranged whereby its yielding will axially shift the drive section relative to the body, and a valve mounted in the body and normally spaced from the circulating bore of the drive section so as to permit unobstructed circulation but arranged whereby said axial shifting of the drive section relative to the body is adapted to seat the valve in said circulating bore for obstructing circulation.

16. A drill stem comprising relatively rotatable sections having a circulating bore, a body adapted for rotation by a string of drill pipe and engaging one of the sections for rotating the same, the other of said sections being adapted for rotation but fixed against axial displacement relative to the body and adapted to rotate a drill bit, a normally non-yielding rotary driving connection between said sections adapted to rotatably yield in accordance with a predetermined torque of the drill stem so as to permit rotary lagging of the drill bit with relation to the string of drill pipe, and packing between the body and said sections axially beyond the rotary driving connection.

17. A drill stem comprising relative rotatable sections, one of which is adapted for rotation by a string of drill pipe and the other of which is adapted to rotate a drill bit, a normally yielding rotary driving connection between said sections adapted to rotatably yield in accordance with a predetermined torque of the drill stem so as to permit rotary lagging of the bit with relation to the string of drill pipe, cooperating abutment elements circumferentially fixed with relation to the respective sections and adapted for circumferential abutment for limiting said relative lag of the bit.

18. A drill stem comprising a body adapted for rotation by a string of drill pipe, a section fixed against axial displacement relative

to the body and adapted to rotate a drill bit,  
the body and said section having normally  
communicating circulating bores, fluid tight  
packing means between the body and said  
5 section, and a normally non-yielding rotary  
driving connection between the body and said  
section adapted to rotatably yield in accord-  
ance with a predetermined torque of the drill  
stem so as to permit rotary lagging of the  
10 drill bit with relation to the string of drill  
pipe.

In testimony whereof he has affixed his  
signature.

ERD V. CROWELL.

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**CERTIFICATE OF CORRECTION.**

**Patent No. 1,817,067.**

**Granted August 4, 1931, to**

**ERD V. CROWELL.**

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, line 82, claim 1, after "adapted" insert for rotation; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 29th day of September, A. D. 1931.

(Seal)

**M. J. Moore,**  
**Acting Commissioner of Patents.**