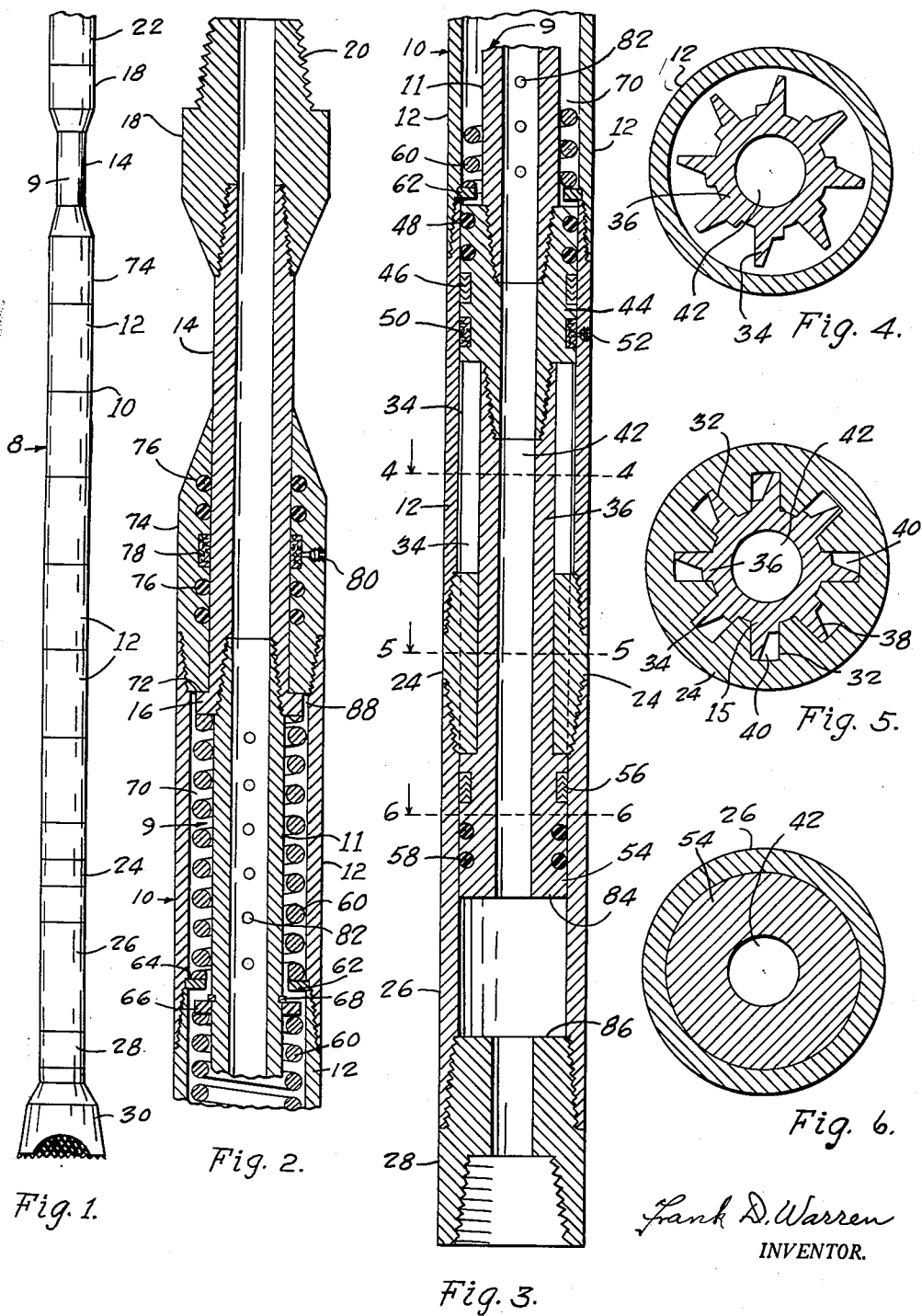


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RESILIENT DRILLING TOOL

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RESILIENT DRILLING TOOL
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This invention relates generally to improvements in the art of drilling oil and gas wells, and more particularly, to a resilient tool to be interposed in the drilling string of a rotary type drilling system. This application is a continuation-in-part of my co-pending application Serial No. 600,990, filed July 30, 1956, now abandoned, and entitled "Multiple Spring Shock Absorber."

As it is well known in the art, a rotary type drilling system comprises a large number of joints of drill pipe interconnected in tandem relation and having a drill bit secured on the other end of the lowermost joint, or on the end of a series of drill collars which are in turn secured on the lower end of the lowest joint of drill pipe. The drill pipe and bit comprise what is commonly referred to as the drill or drilling string. The drilling string is rotated by suitable surface equipment to turn the drill bit and facilitate the downward movement of the drill string to form a well bore. As the drilling operation progresses, a drilling fluid is normally circulated downwardly through the drill string and then upwardly through the annulus between the drill string and the walls of the well bore to remove earth cuttings provided by operation of the drill bit.

In many rotary drilling operations, and particularly when a diamond type core bit is being used, the drill bit tends to vibrate as it moves over a formation to provide shocks and vibrations in the drill string. These shocks and vibrations are amplified by the rotating drill string, such that shock waves tend to travel up and down the drill string and hammer the drill bit against the formation being drilled. In many cases the drill string literally dances on the bit. These shocks imposed on the drill bit soon blunt the sharp points of the teeth of the drill bit, or break the teeth off. In either event, the drilling operation is reduced in efficiency, and the drill bit requires rather frequent replacement. As it is well known in the art, the time and expense required in replacing a drill bit is substantial and materially affects the overall cost of drilling an oil or gas well. In addition to damage to the drill bit, the vibration of the drill string creates stresses and strains in the joints of drill pipe and provides an unduly high rate of crystallization of the metal in the joints of drill pipe.

Several prior attempts have been made to reduce the vibration and shock imposed on a drill bit in a rotary drilling operation. Heretofore, however, none of these prior devices have been widely accepted in the oil industry. In the main, such prior devices utilize a pair of telescoping and splined tubular sections, with one of the sections connected to the upper portion of the drill string and the other section connected to the lower portion of the drill string to provide relative vertical movement of the two sections and yet transmit torque from the upper to the lower portion of the drill string. For resiliency, these prior devices have relied upon a single spring constantly urging the two sections of the tool in opposite directions in an effort to eliminate the transfer of vibrations from one portion of the drill string to another portion of the drill string. A single shock absorbing spring has been found to be ineffective, since a spring having the required characteristics is either so bulky as not to be useable in a drill string of practical diameter, or the spring is so stiff that it does not effectively dampen vibrations.

The present invention contemplates a novel resilient tool comprising a pair of tubular housings or pipes tele-

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scoped together and provided with cooperating splines to transmit torque from one housing to the other. A plurality of helical springs are anchored in the annulus between the two telescoped housings to constantly urge the housings in opposite directions and effectively dampen any vibration of a drill string in which the tool is interposed. The separate springs are anchored in the two housing sections in such a manner that the springs may be assembled one at a time to minimize the time and work involved in assembling the tool. The present invention also contemplates a novel spline construction to retain lubricant in the splines at all times and to prevent the entrance of dirt or other foreign matter into the splines which would accelerate wear of the tool.

5 An important object of this invention is to reduce the number of times drill bits must be changed during a rotary drilling operation.

Another and more specific object of this invention is to effectively dampen out vibrations of a rotary drilling string.

A further object of this invention is to provide a resilient tool for interpositioning in the drill string of a rotary drilling system which may be easily assembled by hand in the field.

25 Another object of this invention is to provide a resilient tool for use in a rotary drilling string having a plurality of cushioning springs wherein the outer diameter of the tool is substantially equal to the outer diameter of the drill string and which will not restrict the flow of drilling fluid during a rotary drilling operation.

A still further object of this invention is to provide a resilient tool for use in a rotary drilling string which is simple in construction, may be economically manufactured and which will have a long service life.

35 Other objects and advantages of the invention will be evident from the following detailed description, when read in conjunction with the accompanying drawings which illustrate my invention.

In the drawings:

40 FIGURE 1 is an elevational view of a resilient tool constructed in accordance with this invention and shown interposed in a rotary drill string.

FIGURE 2 is a vertical sectional view through the upper portion of the tool shown in FIG. 1.

45 FIGURE 3 is a vertical sectional view through the lower portion of the tool shown in FIG. 1.

FIGURE 4 is a transverse sectional view as taken along lines 4-4 of FIG. 3.

FIGURE 5 is a transverse sectional view as taken 50 along lines 5-5 of FIG. 3.

FIGURE 6 is a transverse sectional view as taken along lines 6-6 of FIG. 3.

Referring to the drawings in detail, reference character 8 generally designates a tool constructed in accordance with this invention and which generally comprises an inner tubular housing 9 and an outer tubular housing 10 telescoped together. The inner housing 9 principally comprises a pipe 11 and the outer housing 10 principally comprises a plurality of pipe joints 12 interconnected in tandem relation. A tubular extension 14 is threadedly secured on the upper end of the inner pipe 11 and is provided with an outwardly extending circumferential flange 16 on the lower end thereof for purposes which will be hereinafter set forth. A tubular head member 18 is secured on the upper end of the extension 14 and is provided with suitable threads 20 on the upper end thereof for connection with a joint of drill pipe 22 or a drill collar (not shown) forming a portion of the drill string. It will thus be seen that the inner pipe 11 is rigidly coupled to the upper portion of a rotary drill string. The lower joint 12 of the outer housing 10 is provided with a coupling 24 used in securing another tubular section

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26 on the lower end of the outer housing 10. A suitable connector 28 is threaded to the lower end of the tubular extension 26 of the outer housing 10 and is suitably adapted for connection with a drill bit 30 as illustrated in FIG. 1, such that the outer housing 10 is rigidly coupled to the drill bit 30.

The coupling 24 secured to the lowest pipe joint 12 of the outer housing 10 is provided with a plurality of circumferentially spaced grooves 32 (FIGS. 3 and 5) extending vertically along the inner periphery thereof to receive the lugs or splines 34 formed around the outer periphery of a member 36 secured to the lower end of the inner pipe 11. It will be observed in FIG. 5 that the trailing edges 38 of the lugs or splines 34 of the member 36 are cut-away, and the grooves 32 in the coupling member 24 are substantially rectangular in cross-section to form a plurality of passageways 40 extending through the spline members 24 and 36 for the passage of lubrication, as will be described. The leading edges or faces of the splines 24 are squared-off to contact the respective sides of the grooves 32 and provide rotation of the outer housing 10 upon rotation of the inner housing 9 in a clockwise direction.

The member 36 has a bore 42 extending lengthwise therethrough, and the upper end of the member 36 is threadedly connected to a head 44 which is in turn threadedly connected to the lower end of the inner pipe 11. Suitable packing rings 46 and O-rings 48 are secured in the outer periphery of the upper head 44 to provide a sliding seal of the head 44 in the lowest joint or section 12 of the outer housing 10. Also, suitable lubrication packing 50 is secured below the sealing rings 46 and 48 and is provided with a lubrication fitting 52 to prevent the head 44 from becoming frozen in the lower pipe section 12. A similar head 54 is formed on the lower end of the member 36 and is provided with suitable packing rings 56 and O-rings 58 to slidingly seal the head in the tubular extension 26 formed on the lower end of the outer housing 10. A supply of suitable lubricant (not shown) is disposed in the lower pipe section 12, the coupling member 24, and the tubular extension 26 between the head members 44 and 54 to constantly lubricate the cooperating splines 34 and grooves 32. The head members 44 and 54 prevent the entrance of dirt and other foreign matter into the splined members, and the lubricant will flow through the coupling 24 by means of the passageways 40, as previously described, upon relative lengthwise movement of the inner housing 9 and the outer housing 10.

A plurality of helical springs 60 are telescoped over the inner housing 9 and inside of the outer housing 10, with one of the springs 60 being disposed in each of the pipe sections 12, except the lowermost pipe section 12. The upper end of the upper spring 60 (FIG. 2) is anchored against the flange 16 formed on the lower end of the tubular extension 14, and the lower end of the upper spring 60 is anchored against a ring 62 secured between the upper end of the adjacent lower pipe section 12 and a shoulder 64 formed in the inner periphery of the upper pipe section 12. The lower end of each of the lower springs 60 is anchored against a similar ring 62 secured between adjacent pipe sections 12 in the same manner as the uppermost spring 60. The upper end of each of the lower springs 60 is anchored against a ring 66 which in turn is prevented from upward movement by a cleat or locking ring 68 secured in a complimentary circumferential groove in the outer periphery of the inner pipe 11. Each of the springs 60 is anchored in the annulus 70 between the inner and outer housings under compression when the flange 16 on the tubular extension 14 is in contact with the lower end or shoulder 72 of a tubular head member 74 secured on the upper end of the outer housing 10. In other words, the springs 60 are anchored between the respective rings under compression when the housings 9 and 10 are telescoped apart the greatest distance.

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In assembling the springs 60, the upper pipe section 12 is threaded onto the lower end of the head 74 and then the upper spring 60 is telescoped over the inner pipe 11 into contact with the flange 16. The uppermost ring 62 is then positioned on the next lower adjacent pipe section 12 and this last mentioned pipe section 12 is threaded into the uppermost pipe section 12 until the respective ring 62 is in contact with the respective shoulder 64, at which time the uppermost spring 60 will be placed under compression and suitably anchored between the flange 16 and the uppermost ring 62. The uppermost cleat 68 and ring 66 are then assembled as shown in FIG. 2, and the next lower spring 60 is telescoped over the inner pipe 11 into contact with this ring 66. The next lower ring 62 is then placed on the upper end of the next lower pipe section 12 and the respective pipe sections 12 are threaded together in the manner illustrated in FIG. 3 to place the respective spring 60 under compression. The remaining springs 60 are assembled individually in the same manner until the desired number of springs 60 are provided. In an average drilling tool, ten of these springs 60 will be utilized, although any desired number may be used, depending principally on the depth of the well to be drilled.

The head 74 provided on the upper end of the outer housing 10 has an inner diameter of a size to provide a sliding fit thereof on the extension 14 at the upper end of the inner housing 9. A plurality of O-rings 76 are secured around the inner periphery of the head 74 and suitable lubrication packing 78 is provided in the head 74 around the tubular extension 14 to facilitate the telescoping movement of the head 74 on the member 14. A suitable lubrication fitting 80 is utilized to supply lubricant to the packing 78.

In operation of the present tool, the tool is assembled as shown in FIGS. 2 and 3, with the springs 60 being individually installed as previously described. Then the upper head 18 is connected to the lowermost joint of drill pipe 22 and the lower connector 28 is secured to the drill bit 30 in the manner illustrated in FIG. 1. The drill string is then lowered in the well bore with the tool 8 assembled as shown in FIG. 1 until the drill bit 30 reaches the bottom of the well bore. At this time the upper portion of the drill string is lowered on down to lower the inner housing 9 within the outer housing 10 and partially compress the springs 60 until the desired amount of weight is imposed on the drill bit 30. In many drilling operations from 30,000 to 40,000 pounds are usually imposed on the drill bit. It will be observed that the weight of the drill string is transmitted through the springs 60 and the cooperating rings 62 and 66 to the outer housing 10 on down to the drill bit 30.

Rotation of the drill string is transmitted through the splines 34 and cooperating grooves 32 in the coupling member 24 to rotate the drill bit 30 simultaneously with rotation of the drill string and provide a drilling operation. Simultaneously with rotation of the drill string, drilling fluid is pumped downwardly through the drill string and then through the inner housing 9 into the tubular extension 26 secured on the lower end of the outer housing 10. It will be observed that this drilling fluid is blocked off from the female spline member 24 and splines 34 by the lower head member 54. The drill fluid is pumped on downwardly through the lower connector 28 and the drill bit 30 to pick up cuttings made by the drill bit 30.

As the drilling operation proceeds, the drill bit 30 will tend to vibrate by movement thereof over the formation being drilled, and the drill string above the tool 8 will tend to vibrate by virtue of its rotation and inherent rubbing at various points against the walls of the well bore being formed. All of these vibrations are dampened by the various springs 60, such that vibrations will not be transferred through the tool 8. As a result, the drill string and the drill bit will not tend to oscillate as in drilling systems wherein the drill bit is connected directly

to the lower joint of drill pipe or connected to the lower joint of drill pipe through the medium of rigid drill collars.

As the springs 60 absorb and dampen out vibrations of the drill bit 30 and the drill string, the housings 9 and 10 will tend to reciprocate with respect to one another to various degrees. During this reciprocation of the housings 9 and 10, the drilling fluid flowing downwardly through the inner pipe 11 will flow in and out of apertures 82 formed through the walls of the inner pipe 11 above the upper head 44, such that the springs 60 will be free to retract and expand upon the imposition of various forces on the housings 9 and 10. In other words, none of the drilling fluid will be trapped in the annulus 70 between the upper head 44 and the head 74 in the outer housing 10 to interfere with compression and expansion of the springs 60.

The present tool may also be used in the nature of a jar to loosen the drill bit 30 in the event the bit becomes stuck in the well bore being drilled. When the drill string is lowered to a sufficient degree, the lower end 84 (FIG. 3) of the lower head 54 contacts the upper face 86 of the lower connector 28 to provide a sudden thrust on the drill bit 30. It should be noted in this connection that the lengths of the various elements of the tool 8 are such that the end 84 of the head 54 will contact the face 86 of the connector 28 prior to a complete collapse of the springs 60, such that the springs 60 will not be damaged and the rings 62 and 66 will not be sheared off when the tool 8 is used as a jar. An upward thrust may be imposed on the drill bit 30 by suddenly raising the drill string until the flange 16 of the extension 14 on the inner housing 9 contacts the lower face 72 of the head member 74. The springs 60 will facilitate the upward movement of the drill string and increase the amount of shock imposed on the drill bit 30 when the flange 16 contacts the face 72 of the head 74. It will also be noted in FIG. 2 that the flange 16 has an outer diameter less than the inner diameter of the upper pipe section 12 to provide an annulus 88 and prevent trapping of drilling fluid above the flange 16 during upward movement of the inner housing 9.

Another important feature of the present invention is the construction of the splines 34 and cooperating grooves 32. The splines 34 extend all the way between the heads 44 and 54, such that the outer housing 10 will be rotated upon clockwise rotation of the inner housing 9, regardless of the telescoped position of the tool 8. Thus, any desired amount of weight may be imposed through the springs 60 onto the drill bit 30. Normally, the springs 60 will be designed to be compressed substantially half-way during a normal drilling operation. However, if a greater or lesser weight is desired on the drill bit 30, the drill string may be lowered or raised a short distance to increase or decrease the compression of the springs 60, and the outer housing 10 will still be rotated by rotation of the inner housing 9.

From the foregoing it will be apparent that the present invention provides a novel resilient tool for use in a rotary drilling string, such that all vibrations generated in the drill string or by operation of the drill bit will be effectively dampened and the drill string will not tend to oscillate and damage the drill bit. Furthermore, vibration of the drill string will be reduced to decrease the rate of crystallization of the drill pipe and materially increase the service life of the complete drill string. The use of multiple springs in the present tool facilitates the assembly of the tool, such that the tool may be assembled manually in the field in the event repairs or cleaning operations are required. Each of the springs may be compressed individually and secured in the tool prior to assembly of the next lower spring to reduce the overall work required in assembling the tool, and yet provide any desired amount of spring action. The tool will remain operative in all telescoped positions and the springs

will be free to contract and expand in all positions of the tool. It will also be apparent that the present tool is simple in construction, may be economically manufactured and will have a long service life.

Changes may be made in the combination and arrangement of parts or elements as heretofore set forth in the specification and shown in the drawings, it being understood that changes may be made in the precise embodiment disclosed without departing from the spirit and scope of the invention as defined in the following claims.

I claim:

1. A shock-absorbing tool for interpositioning in a rotary drilling string, comprising a first tubular housing adapted at its upper end for connection with the drill string, a second tubular housing telescoped over the first housing and adapted at its lower end for connection with the drill string, said housings having cooperating shoulders limiting the downward movement of the second housing on the first housing, cooperating splines on said housings to provide rotation of the second housing and the drilling string therebelow upon rotation of the first housing by the upper portion of the drilling string, said second housing including a plurality of threadedly connected sections, a plurality of vertically spaced helical springs telescoped over the first housing within the second housing, lower anchoring means for anchoring the lower end of each of said springs to a separate section of the second housing, and upper anchoring means for anchoring the upper end of each of said springs to a portion of the first housing, said upper anchoring means being spaced from said lower anchoring means by a distance less than the length of said spring in its uncompressed state when said cooperating shoulders are in contact whereby said springs are maintained under compression at all times despite relative movement between said tubular housings.

2. A tool as defined in claim 1 characterized further in that the first housing has a plurality of apertures therein adjacent each spring placing the bore of said first tubular housing in communication with the annulus between said housings to avoid entrapment of drilling fluid between said first housing and said second housing.

3. A shock-absorbing tool for interpositioning between the lower end of a rotary drill string and a drill bit, comprising a first elongated tubular housing adapted at its upper end for connection with the lower end of the drill string; a second, larger diameter tubular housing telescoped over the first housing and adapted at its lower end for connection with the drill bit; a tubular head on the upper end of the second housing forming a downwardly facing shoulder around the inner periphery of the second housing; a flange on the first housing of a size to engage said downwardly facing shoulder and limit the downward movement of the second housing on the first housing; said second housing including a plurality of sections threadedly interconnected in tandem relation, with an internal downwardly facing circumferential shoulder formed in the lower end portion of each section, except the last two sections, in proximity with the upper end of the next lower section when said sections are threadedly connected; a ring anchored between each of the last-mentioned shoulders and the upper end of the next lower section; a ring anchored on the first housing in upwardly spaced relation to each of the first-mentioned rings; a helical spring telescoped over the first housing between each ring on the first housing and the lower adjacent ring in the second housing; said rings and flange being spaced from each other by distances less than the length of said helical springs in their uncompressed state when said first-mentioned shoulder and said flange are in contact whereby said springs are maintained under compression at all times despite relative movement between said tubular housings; a female spline member interposed between the lower two sections of the second housing; and male splines on the first housing mating

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with said female spline member to provide rotation of the second housing upon rotation of the first housing by the drill string.

4. A tool as defined in claim 3 characterized further in that the first housing has a plurality of apertures therein opposite each of said springs placing the bore of said first tubular housing in communication with the annulus between said housings to avoid entrapment of drilling fluid between said first housing and said second housing.

5. A tool as defined in claim 1 characterized further in that said lower anchoring means comprises a first ring at the lower end of each spring, each of said first rings being secured between the upper end of a section of the

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second housing and a downwardly facing shoulder on the adjacent upper section of the second housing; and said upper anchoring means comprises a second ring of smaller diameter than said first ring at the upper end of each spring, and a cleat embedded in a complementary groove in the outer periphery of the first housing above each of said second rings to limit the upward movement of said second rings.

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