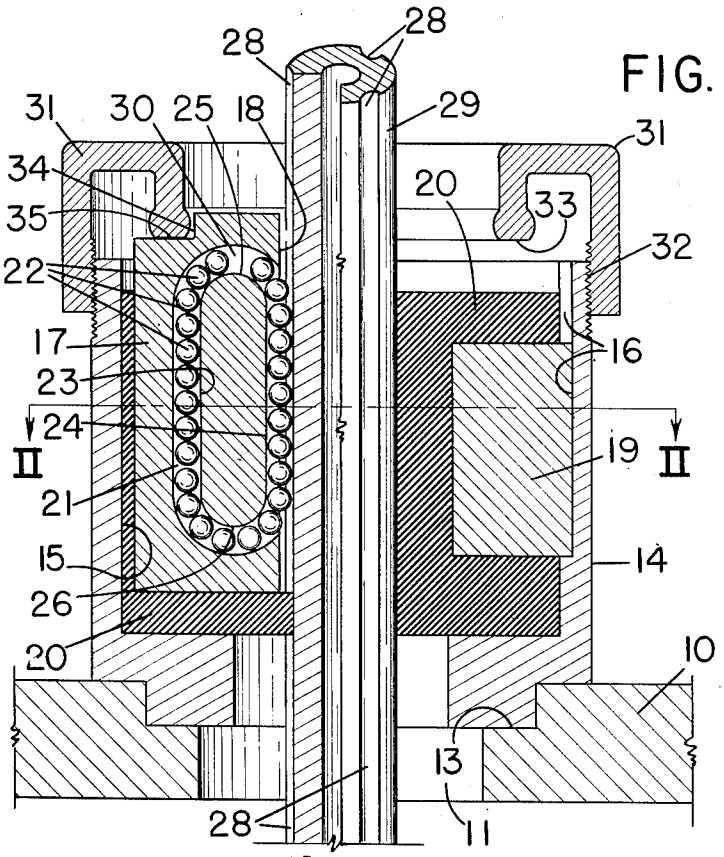
Dec. 2, 1952 A. L. STONE 2,620,163

KELLY BUSHING

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FIG. 1.



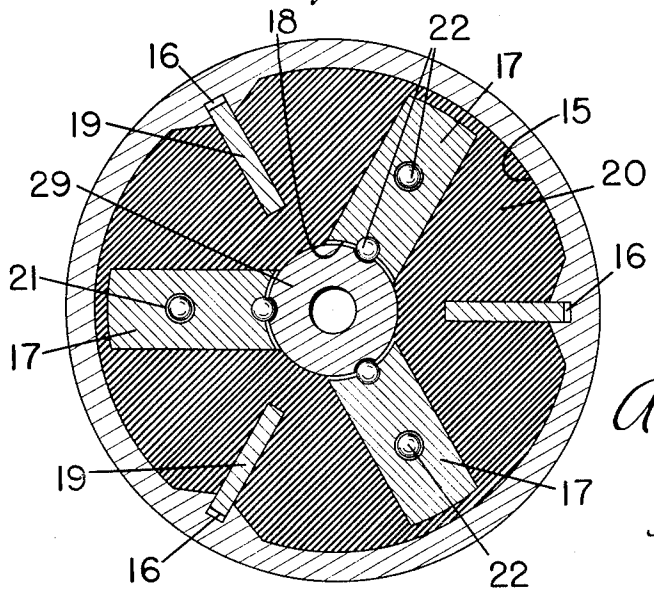


FIG. 2.

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BY

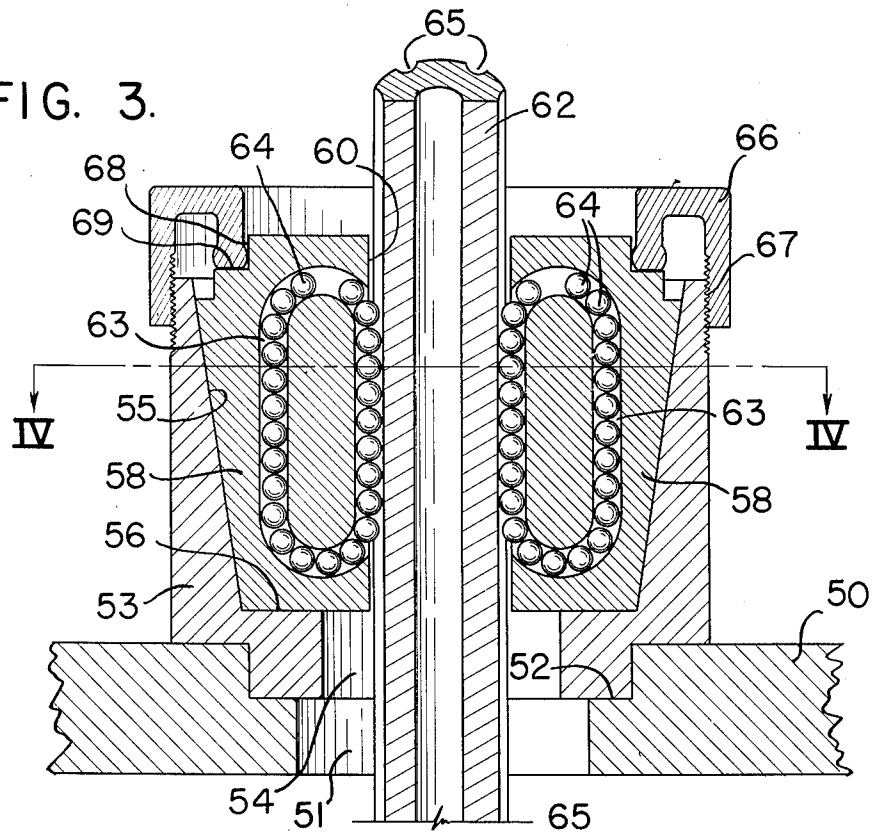
Melvin F. Fincke
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Dec. 2, 1952 A. L. STONE 2,620,163

KELLY BUSHING

Filed Dec. 22, 1948 3 Sheets-Sheet 2

FIG. 3.



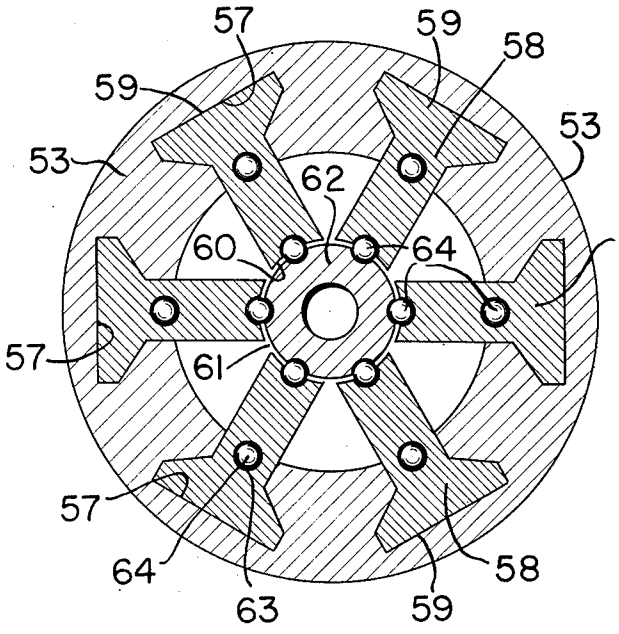


FIG. 4.

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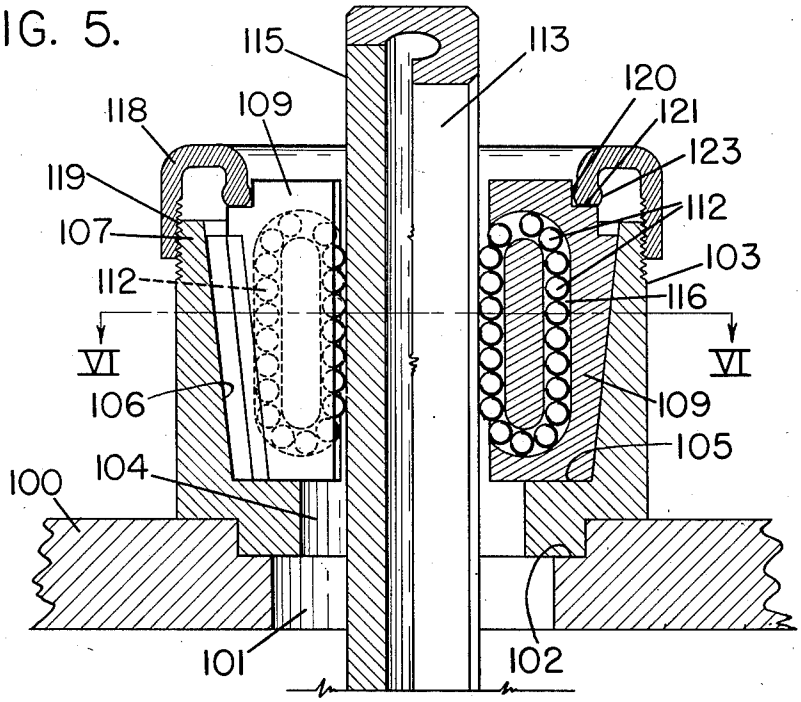
ATTORNEY.

Dec. 2, 1952 A. L. STONE 2,620,163

KELLY BUSHING

Filed Dec. 22, 1948 3 Sheets-Sheet 3

FIG. 5.



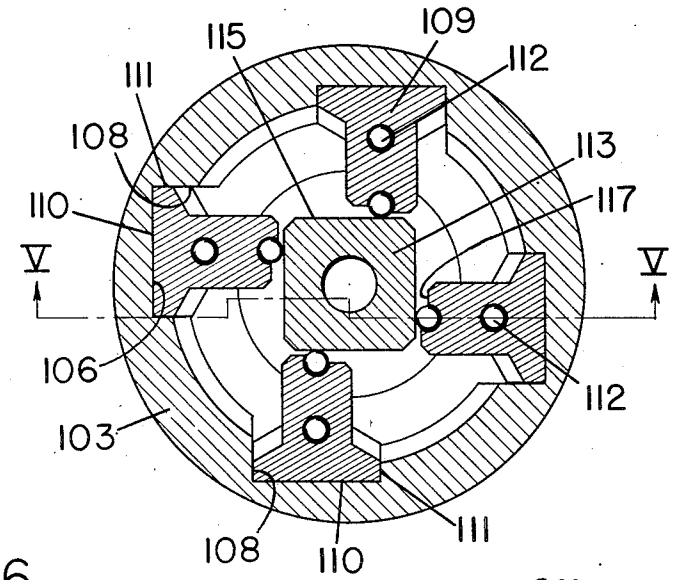


FIG. 6.

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Patented Dec. 2, 1952

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UNITED STATES PATENT OFFICE

2,620,163

KELLY BUSHING

Albert L. Stone, Redondo Beach, Calif., assignor, by mesne assignments, to Standard Oil Development Company, Elizabeth, N. J., a corporation of Delaware

Application December 22, 1948, Serial No. 66,772

1 Claim. (Cl. 255—23)

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This invention relates to rotary drilling apparatus and more particularly to a drive bushing for a Kelly rod.

In the drilling of oil wells by the rotary drilling method, it is common practice to employ a suspended string of drill pipe at the lower end of which a drill bit is positioned and at the upper end of which a drill string driving mechanism, such as a Kelly bar, is attached. The Kelly bar is usually square or polygonal in cross section, although it may be circular in cross section and provided with longitudinally extending flutes or grooves. The Kelly bar passes through a Kelly bar bushing mounted in the rotary table which is adapted to be rotated. The Kelly bar is rotated by the Kelly bar bushing on rotation of the rotary table and is adapted to move longitudinally through the said bushing. When rotating the drill stem by the aforementioned means, torques of high magnitude are imposed on the Kelly bar by the bushing and, consequently, large amounts of friction ar set up between the Kelly bar and the bushing. Frictional resistance to the longitudinal movement of the Kelly bar through the bushing is greatly aggravated by conditions which are often encountered in actual drilling operations such as misalignment of the Kelly bar with the axis of the borehole or a slight bend in the Kelly bar. As a matter of fact, an overall bend of as little as $\frac{1}{8}$ of an inch may produce such great resistance to the longitudinal movement of the kelly through the bushing as to prohibit its passage therethrough.

Various expedients have been provided for reducing the resistance of the Kelly bar bushing to longitudinal movement of the kelly therethrough. For example, Kelly rods are sometimes constructed to provide considerable looseness between the Kelly rod and the bushing so as to reduce the aforementioned frictional resistance. Unfortunately, this very looseness produces other undesirable consequences such as back lash of the kelly and excessive wear of the kelly and the bushing due to battering of the Kelly bar against the bushing caused by resistance of bit rotation under power of the rotary blade. This battering not only causes wear but also may deform the Kelly bar.

Still other efforts directed toward reducing the resistance of the Kelly bar bushing to longitudinal movement of the kelly therethrough have involved the provision of rollers in the bushing itself. These rollers are rotatably mounted on axles and are positioned in the central passage of the bushing so that each roller may rotate

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on its axle with its outer surface in line contact with a surface of the polygonal Kelly bar. Normally a sufficient number of rollers are provided so that each surface of the Kelly bar is in contact with at least one roller. When such bushings are new, they offer little resistance to longitudinal movement of the Kelly bar but as the rollers and their axles become worn, the line contact between the outer surface of the rollers and the surface of the Kelly bar tends to become a point contact, the point of contact tending to shift more and more toward the leading edge of the surface contacted by the roller and toward an edge of the roller. This tendency, once it has started, continues at an accelerated pace inasmuch as the torque exerted on the Kelly bar by the rollers is applied over a continually diminishing area of contact. A point may be reached when the Kelly bar is so seriously deformed and the rollers and their axles so badly worn that longitudinal movement of the Kelly bar through the bushing is effectively prohibited.

It is the principal object of the present invention to provide a Kelly bar bushing which will permit rotative movement to be imparted to the kelly and which will also permit the kelly to move longitudinally therethrough while being rotated even when the kelly is misaligned with the borehole or when the kelly is bent. Another object of the present invention is to provide a Kelly bar bushing in which the forces tending to rotate the Kelly bar are evenly distributed along the bar and which offers a minimum of resistance to the longitudinal movement of the kelly therethrough while the kelly is rotated. A further object is to provide a Kelly bar bushing carrying anti-friction elements which will provide a constant area of contact with the Kelly bar and which will not tend to cause appreciable deformation of the kelly.

The present invention contemplates the use of either a Kelly bar of circular cross section having longitudinally extending grooves on its outer surface or a conventional polygonal Kelly bar. In conjunction with such a Kelly bar, my invention contemplates the provision of a Kelly bar bushing adapted to seat within the rotary table of a drilling rig, and through which the Kelly bar may be moved longitudinally the entire length of the Kelly bar, said bushing being adapted to carry balls disposed in an endless raceway so that at least a portion of the balls in each raceway contacts the Kelly bar. Each of the endless raceways are so arranged that their axes lie in a plane parallel to the axis of the central passage

of the bushing. This arrangement permits the rotative movement of the rotary table to be transmitted through the balls to the Kelly bar while permitting the kelly to move longitudinally through the bushing in contact with the balls.

A preferred form of my invention contemplates that the balls will be disposed in a mass of deformable material, such as rubber, so as to permit the bushing to absorb the misalignment forces in drilling operations, such for example, as misalignment produced by off-center suspension of the Kelly bar or misalignment due to a bent Kelly bar. The deformable material employed is preferably so arranged as to be in tension rather than in compression so that the bushing will automatically return to its proper alignment with the axis of the bore-hole after the forces tending to misalign the bushing elements cease to operate thereon.

The present invention is more fully illustrated in the accompanying drawings in which:

Fig. 1 is a vertical section through a drill rotating mechanism equipped with a round grooved kelly and a drive bushing embodying the features of the present invention;

Fig. 2 is a section through the drive bushing and kelly taken on the line II—II of Fig. 1;

Fig. 3 is a vertical section of a modified form of the Kelly drive bushing of my invention;

Fig. 4 is a section through the drive bushing and kelly taken on the line IV—IV of Fig. 3;

Fig. 5 is a vertical section of a modified form of the drive bushing of the present invention adapted to be employed with a Kelly rod having polygonal cross section; and

Fig. 6 is a section through the drive bushing and kelly taken on the line VI—VI of Fig. 5.

Referring to the drawing, and more particularly to Figs. 1 and 2, 10 indicates a portion of a typical rotary table having the usual central opening 11. The upper portion of central opening 11 is polygonal in cross section, preferably square, and defines seat 13 for receiving a Kelly bar bushing. Numeral 14 designates the body or housing of the Kelly bar bushing with which the present invention is concerned. The outer vertical surface of housing 14 is normally cylindrical for a major portion of its height while the lower end thereof is conventionally polygonal in cross section, normally square, and adapted to fit slidably in central opening 11 and to rest on shoulder 13. Housing 14 defines a central passage 15 substantially circular in cross section defining spaced keyways 16 opening into said passageway. Disposed in central passage 15 and spaced away from keyways 16 are a plurality of raceway housing members 17. Each of raceway housing members 17 defines an arcuate surface 18 substantially equidistant from the center of opening 15, members 17 being so arranged that surfaces 18 thereof cooperate to define a substantially cylindrical central passage having its axis substantially coincident with the axis of central opening 15. Keys 19 are adapted to fit slidably into keyways 16 and project inwardly from the inner surface of housing 14 toward the center of central opening 15.

Each raceway housing member 17 defines a raceway 21 which carries disposed therein circulating balls 22. Raceway 21 is disposed in raceway housing member 17 in such manner that the balls 22 in circulating therein travel in a plane which passes through the longitudinal axis of the central passage formed by surfaces 18 of raceway housing members 17. Raceway 21 consists of substantially parallel linear sections 23 and 24 and substantially circular upper section 25 and substantially circular lower section 26, all of said sections being in communication to form one continuous raceway of uniform diameter. Section 24 of raceway 21 for at least a portion of its length forms an open slot in surface 18 of such width that circulating balls 22 are held within raceway 21 while at least a portion of the balls circulating in said portion of the raceway extends slightly beyond arcuate surfaces 18 to project into the central passage formed by surfaces 18. The portion of balls 22 extending into this central passage engages with the longitudinally extending grooves 28 carried by the outer surface of Kelly bar 29. In Fig. 1 seven balls 22 are shown in engagement with grooves 28 of Kelly bar 29. Preferably, raceway 21 contains sufficient balls 22 to occupy all of the space defined by raceway 21 except for a small space, as at 30, in section 25 of the raceway. The purpose of providing a free space in raceway 21 is to permit the free rotation of balls 22 in travelling the path defined by raceway 21. With this arrangement each of balls 22 is in contact with two adjacent balls except when negotiating the space in section 25 indicated by numeral 30, in which case the two balls at the top of the race, that is, the two balls on each side of space 30, are in contact with only one other ball. The provision of space 30 minimizes the tendency of balls 22 to jam in their circulation within race 21 when Kelly bar 29 is moved longitudinally through the bushing assembly while being rotated.

Raceway housing members 17 and keys 19 are bonded together in driving relation by means of a deformable bonding material 20 such as natural or synthetic rubber. The bonding of raceway members 17 and keys 19 may be accomplished by placing raceway housing members 17 and keys 19 in proper relation in a mold having an inner surface shaped similarly to the inner surface of housing 14 and filling the space in the mold between members 17 and keys 19 with deformable bonding material. The deformable bonding material may be then vulcanized to the surfaces of members 17 and keys 19. In accomplishing the molding operation raceway housing members 17 may be arranged equidistant from the center of a central opening by arranging said members radially around a mandrel having a diameter somewhat smaller than the diameter of the kelly to be fitted by the completed assembly. The difference in diameter between the mandrel and the kelly to be fitted will be determined by the amount of pre-loading desired between balls 22 and kelly 29 when the completed bushing is mounted on the kelly.

It will be understood from Fig. 2 and from the previous description that the molding operation is conducted in such a manner that deformable material 20 will be positioned between the outer edges of raceway housing members 17 and housing 14. The deformable material located in this space will be in compression and consequently the completed assembly will be able to withstand very large misalignment loads. It will be further understood, however, that the aforedescribed molding operation may be so conducted that no deformable material 20 is present between the outer edge of ball raceway housing members 17 and housing 14, reliance in absorbing misalignment loads being placed entirely upon the extensive bond between deformable material 20 and raceway housing members 17 and between

deformable material 20 and keys 19. When the mold is made in this last mentioned manner, the mass of deformable material 20 between keys 19 and raceway housing members 17 is in tension and shear, rather than in compression, thus providing a maximum of shock absorption.

While Figs. 1 and 2 show three raceway housing members 17 and three longitudinally extending grooves 28 in kelly 29, it will be understood that a grooved round kelly having a larger number of longitudinally extending grooves 28 may be employed with a bushing assembly having only three raceway housing members 17. In any event, raceway housing members 17 are arranged in housing 14 and deformable material 20 so that the balls 22 carried by members 17 operatively engage in three of grooves 28. It will be further understood that a larger number than three raceway housing members 17 may be employed. For example, it might be desirable to employ as many as six such members 17 with a grooved kelly 29 having at least six longitudinally extending grooves 28. Preferably, of course, raceway housing members 17 are radially spaced within housing 14 and in any event must be spaced so that the balls 22 carried by members 17 will engage with longitudinally extending grooves 28 of Kelly bar 29. It will be further understood that as few as two raceway housing members 17 may be employed although I prefer to employ at least three such members.

It will also be noted from Figs. 1 and 2 and from the previous description that deformable material 20 may be molded in such a way as to contact the outer surfaces of kelly 29. It should be mentioned that deformable material 20 may instead be molded so that it does not contact the outer surfaces of kelly 29, although I prefer that it contact the kelly. Contact between deformable material 20 and the outer surface of kelly 29 below housing members 17 affords a number of advantages, among which are the wiping effect which such contact provides. When contact is afforded, drilling fluid is wiped off the kelly as it passes upwardly through the kelly drive bushing described, thereby reducing the amount of fluid which might possibly interfere with the circulation of balls 22 in raceways 21 and also reducing the wear of balls 22 and kelly 29.

While Fig. 1 shows raceway 21 to be oval in form and further shows seven balls 22 in contact with Kelly grooves 28, it will be understood that the raceway carried by raceway housing members 17 may be circular in form and that raceway 21 may be so arranged that a larger or smaller number than seven balls 22 are continuously in contact with Kelly grooves 28. The number of balls 22 carried by raceway 21 will be determined by the amount of force which the balls will be required to transmit and by the size of the balls employed. When it is expected that low torques will be encountered, raceway 21 may be so arranged that only one ball 22 is in contact with Kelly groove 28 at any instant of time, although I prefer to arrange raceway 21 so that at least two balls 22 are continuously in contact with Kelly grooves 28. Where it is expected that very high torques will be encountered, raceway 21 should be so arranged that a larger number of balls are continuously in contact with Kelly groove 28.

Having described the component parts of the embodiment of my invention shown in Figs. 1 and 2 and the relation of these parts to each other, its mode of operation will now be briefly described. The molded assembly comprising housing member 17, keys 19 and deformable material 20 may be formed into the completed assembly in the following manner. A cone having a base whose diameter is approximately the same as the diameter of the lower end of the kelly may be placed on the lower end of the kelly with its base abutting against the lower end of the kelly and the molded assembly forced over the cone until balls 22 carried by raceway housing members 17 drop into Kelly bar grooves 28. Housing 14 may then be slipped over the molded assembly and the molded assembly held in place in housing 14 by means of hold-down ring 31 which is adapted to be engaged with housing 14 as by means of threads 32. The downwardly projecting upper end 33 of ring 31 abuts against surfaces 34 and 35 formed by an upper, outer portion of raceway housing members 17, thus preventing the molded assembly including raceway housing members 17 from moving from their intended positions in housing 14. Kelly bar 29, together with the Kelly bar bushing of my invention mounted thereon, is then hoisted by suitable means, as by the drilling line of a drilling rig, and placed over the axis of the well. The Kelly bar and the Kelly bar bushing are then lowered until housing 14 is seated on shoulder 13 of rotary table 10. The Kelly bar and bushing are now in operative relation with respect to rotary table 10. Rotation of rotary table 10 produces corresponding rotation of the bushing of my invention. This rotative force is transmitted through deformable material 20 to balls 22 and, in turn, to Kelly bar 29. When Kelly bar 29 is moved longitudinally through the Kelly bar bushing of my invention, balls 22 circulate in raceway 21. It will be obvious that inasmuch as balls 22 are free to circulate in raceway 21, the Kelly bar bushing of my inventon offers very little frictional resistance to the longitudinal passage of Kelly bar 29 through the said bushing while imparting rotative motion thereto.

Figs. 3 and 4 show another embodiment of the Kelly bar bushing of my invention. Referring to Figs. 3 and 4, 50 indicates a portion of a typical rotary table having the usual central opening 51. The upper portion of central opening 51 is polygonal in cross section, normally square, and defines a seat 52 for receiving a Kelly bar bushing. Numeral 53 designates the body or housing of the Kelly bar bushing with which the present invention is concerned. The outer vertical surface of housing 53 may be cylindrical for a major portion of its height while the lower end thereof may be polygonal in cross section, preferably square, and adapted to fit slidably in central opening 51 and to rest on shoulder 52. Housing 53 defines a central passage 54 and an inwardly extending shoulder 56 at the lower end thereof. Housing 53 also defines in its inner surface a plurality of radially spaced keyways 57 opening into central passage 54, surface 55 forming keyway 57 being tapered downwardly and inwardly. A plurality of raceway housing members 58 defining outwardly extending keys 59 are disposed in central passage 54 with keys 59 engaged in keyways 57. With raceway housing members so disposed the inner surfaces 60 of said members define a central passage 61 through which a Kelly bar 62 may be passed longitudinally. The axis of central passage 61 is substantially coincident with the axis of the central passage defined by housing 53.

Each raceway housing member 58 defines a

raceway 63 which carries disposed therein circulating balls 64. Raceway 63 is disposed in raceway housing member 58 in such manner that the balls 64 in circulating therein travel in a plane which passes through the longitudinal axis of the central passage formed by the inner surfaces 60 of raceway housing members 58. Raceway 63 is positioned in raceway housing members 58 so that at least for a portion of its length it forms an open slot in the inner surface 60 of the member, the slot being of such arrangement that balls 64 are held within raceway 63 while at least a portion of the balls circulating past the slot in raceway 63 extends slightly beyond the inner surface 60 of raceway housing members 58 to project into the central passage 61 formed by the said surfaces. The portion of the balls 64 extending into central passage 61 engages with the longitudinally extending grooves 65 of Kelly bar 62. Raceway housing members 58 are held against upward movement with respect to housing 53 by means of hold-down ring 66 which is adapted to be mechanically connected to housing 53, as by means of threads 67, ring 66 having a downwardly projecting portion which abuts against surfaces 68 and 69 of raceway housing members 58.

Having fully described the component parts of the embodiment of my invention shown in Figs. 3 and 4 and the relationship of these parts to each other, the mode of operation and use of this embodiment will now be briefly described. In assembling the Kelly drive bushing of my invention for use in rotating a grooved kelly, housing 53 may be placed in its conventional position in rotary table 50, that is, it may be seated on shoulder 52 of rotary table 50. Kelly bar 62 is then lowered into central opening 54 of housing 53 and suspended in said opening. Raceway housing members 58 are then individually lowered into central opening 54 of housing 53 with keys 59 in engagement with keyways 57. At the same time that keys 59 are engaged in keyways 57, that portion of balls 64 which projects through the slot formed by raceway 63 and the inner surface 60 of raceway housing member 58 is engaged with a longitudinally extending groove 65 of kelly 62. This operation is repeated with respect to each raceway housing member 58 until all of these members have been inserted. It will be understood that as few as two raceway housing members may be suitably employed for driving a grooved kelly. It will be further understood that these members must be positioned in housing 53 so that balls 64 carried by each of members 58 will engage with one longitudinally extending groove 65. Of course, Kelly bar 62 must be equipped with at least as many grooves 65 as the number of members 58 disposed in housing 53. After all of raceway housing members 58 have been inserted in housing 53, the said members are secured against upward movement in the said housing by hold-down ring 66.

While the Kelly bar bushing of my invention has heretofore been described and shown when used in conjunction with a longitudinally grooved Kelly bar of circular cross section, it will be understood that the Kelly bar bushing of my invention may be modified so as to be suitable for use in conjunction with Kelly bars having a polygonal cross section. Accordingly, an embodiment of my invention is shown in Figs. 5 and 6 which is adapted to be employed with a kelly having a polygonal cross section. While the drawing shows, for the sake of simplicity, a square kelly, it will be apparent that the Kelly bar bushing of my invention may be suitably modified so as to be used with any Kelly bar having any polygonal cross section.

Referring now to Figs. 5 and 6, 100 indicates a portion of a typical rotary table having the usual central opening 101. The upper portion of central opening 101 is polygonal in cross section, normally square, and defines a seat 102 for receiving a Kelly bar bushing. Numeral 103 designates the body or housing of the Kelly bar bushing with which the present invention is concerned. The outer vertical surface of housing 103 is normally cylindrical for a major portion of its height while the lower end thereof is conventionally polygonal in cross section, normally square, and adapted to fit slidably into central opening 101 and to rest on shoulder 102. Housing 103 defines a central passage 104 and inwardly extending shoulder 105 at the lower end thereof. Inner surface of housing 103 defines a plurality of circumferentially spaced recesses 108 with surface 106 of recess 108 tapering downwardly and inwardly from the upper end 107 of housing 103 to inwardly extending shoulder 105. A raceway housing member 109, defining a raceway 116 carrying balls 112, is disposed in each of recesses 108 and extends into central passage 104. Outer surface 110 and side surfaces 111 of each of raceway housing members 109 are arranged to fit slidably in recess 108. Raceway housing members 109 are so arranged with respect to each other and with respect to the axis of central opening 104 that the circulating balls 112 carried by each of raceway housing members 109 contact a longitudinal surface of polygonal Kelly bar 113. Fig. 6 of the drawing shows that raceway housing members 109 are disposed within housing 103 in such manner that the plane passing through the circulating ball race 116 is substantially perpendicular to a surface 115 of Kelly bar 113 when Kelly bar 113 is disposed in central opening 104.

Raceway 116 is disposed in raceway housing member 109 in such manner that balls 112 in circulating in the said raceway travel in a vertical plane. Raceway 116 for a portion of its extent forms an open slot in surface 117, the said slot being of such width that circulating balls 112 are held within raceway 116 while at least a portion of balls 112 in circulating in said portion of raceway 116 project beyond surface 117. This slot is of such length that at least a portion of balls 112 circulating in raceway 116 past the said slot contact Kelly bar 113. In Fig. 6 seven balls 112 are shown as extending into central passage 104 and in engagement with a longitudinally extending surface 115 of kelly 113 near the leading edge of said surface.

Raceway housing members 109 are held against upward movement with respect to housing 103 by means of hold-down ring 118 which is adapted to be mechanically connected to housing 103 by means of threads 119, ring 118 having a downwardly projecting portion 123 which abuts against surfaces 120 and 121 of raceway housing member 109.

While raceway housing members 109 are shown in Fig. 6 as being disposed within housing 103 in such manner that balls 112 contact the leading edge of a longitudinally extending surface 115 of kelly 113, it will be understood that raceway housing members 109 may be disposed within housing 103 in such manner that balls 112 contact a longitudinal surface of kelly 113 at a point other than the leading edges of the said surface.

I prefer, however, that raceway housing members 109 be so arranged within housing 103 that balls 112 contact the leading edge of a surface of kelly 113. It will also be noted from Fig. 6 that inner surface 117 of raceway housing member 109 may be so arranged that the portion of surface 117 adjacent the trailing edge of a longitudinally extending surface 115 of kelly 113 does not project as far toward the center of central opening 104 as that portion of surface 117 adjacent the leading edge of the said surface. This arrangement reduces the possibility of Kelly bar 113 contacting any portion of raceway housing member 109 other than balls 112.

When it is desired to employ the Kelly bar bushing of the embodiment shown in Figs. 5 and 6 for rotating a polygonal kelly, housing 103 is placed in operative position in rotary table 100 with its lower end abutting on shoulder 102. Kelly bar 113 is then suspended within housing 103 with its longitudinal axis aproximately in the center of central opening 104. Each of raceway housing members 109 is then individually inserted in housing 103 with surfaces 110 and 111 thereof positioned in recess 108 and with balls 112 in contact with a longitudinally extending surface of kelly 113 as shown. After all of raceway housing members 109 have been inserted, they are held in position against upward movement with respect to housing 103 by means of hold-down ring 118.

Having described only typical preferred forms of my invention, I do not wish to be limited or restricted to the specific details herein set forth but wish to reserve to myself any variations or modifications that may appear to those skilled in the art or fall within the scope of the following claim.

Having fully described my invention, what I claim as new and useful and desire to secure by Letters Patent is:

A driving member adapted to rotate an elongated driven member while permitting longitudinal movement of said elongated driven member therethrough comprising, in combination, a housing adapted to be rotated defining a central annulus and carrying keys projecting inwardly into said annulus, a plurality of raceway housing members radially disposed within said annulus and radially spaced from said keys and said housing, each said raceway housing member defining an inner surface and having an endless raceway therein, deformable material vulcanized to said raceway housing members and said keys bonding said members and said keys together in driving relation, the inner surfaces of said raceway housing members cooperating to define a central passage within said central annulus, said raceway housing members being radially yieldable with respect to the axis of said central passage, each of the raceways in said raceway housing members lying in a plane passing through said central passage and parallel to the axis of said central passage, each raceway opening for at least a portion of its extent into said central passage through said inner surface and balls disposed in each of said raceways for travel therein, the inner surface of said raceway housing members being so formed as to prevent the escape of the balls from said raceway, said balls partially projecting into said central passage when travelling past that portion of the raceway opening into said central passage and engaging with the elongated driven member, whereby rotation of the housing imparts corresponding rotation to the elongated driven member while permitting unlimited longitudinal movement of said elongated driven member through said central pasage.

ALBERT L. STONE.

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