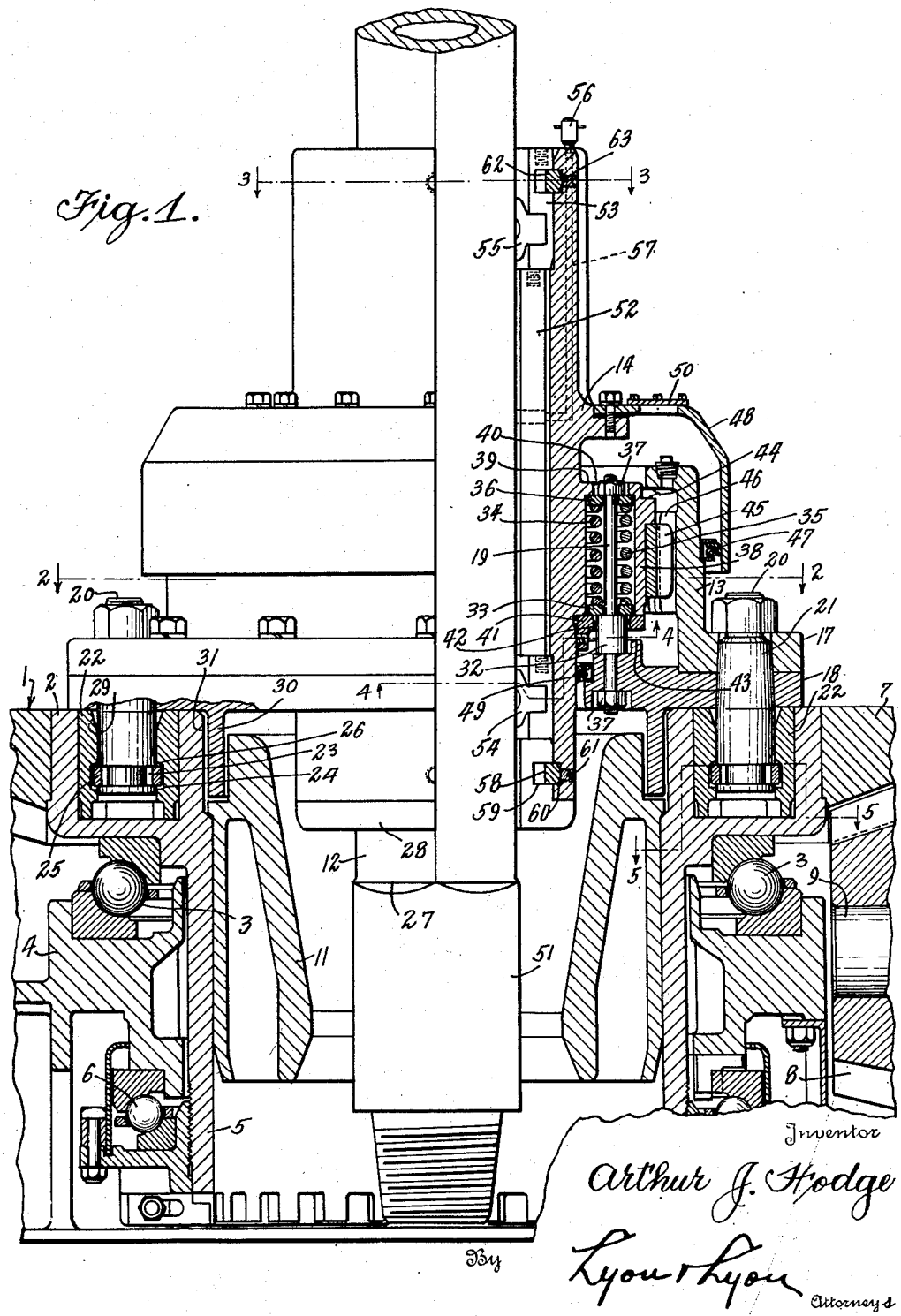
Oct. 14, 1941. A. J. HODGE 2,259,224

DRILL STEM DRIVE DEVICE

Filed Jan. 22, 1940 4 Sheets-Sheet 1

Fig. 1.



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DRILL STEM DRIVE DEVICE

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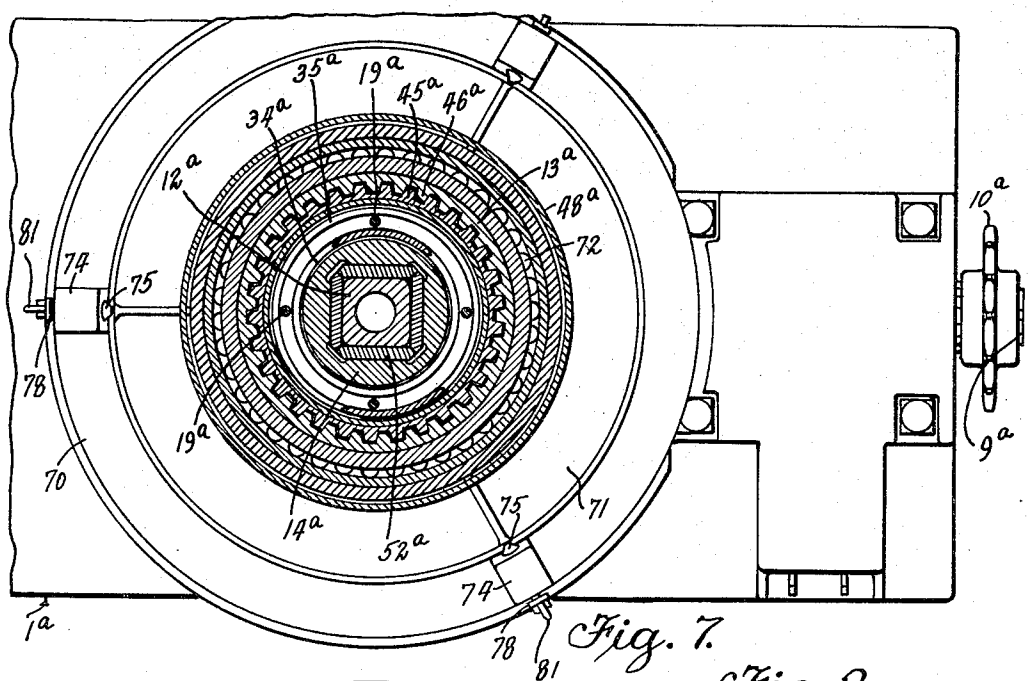

Fig. 7.

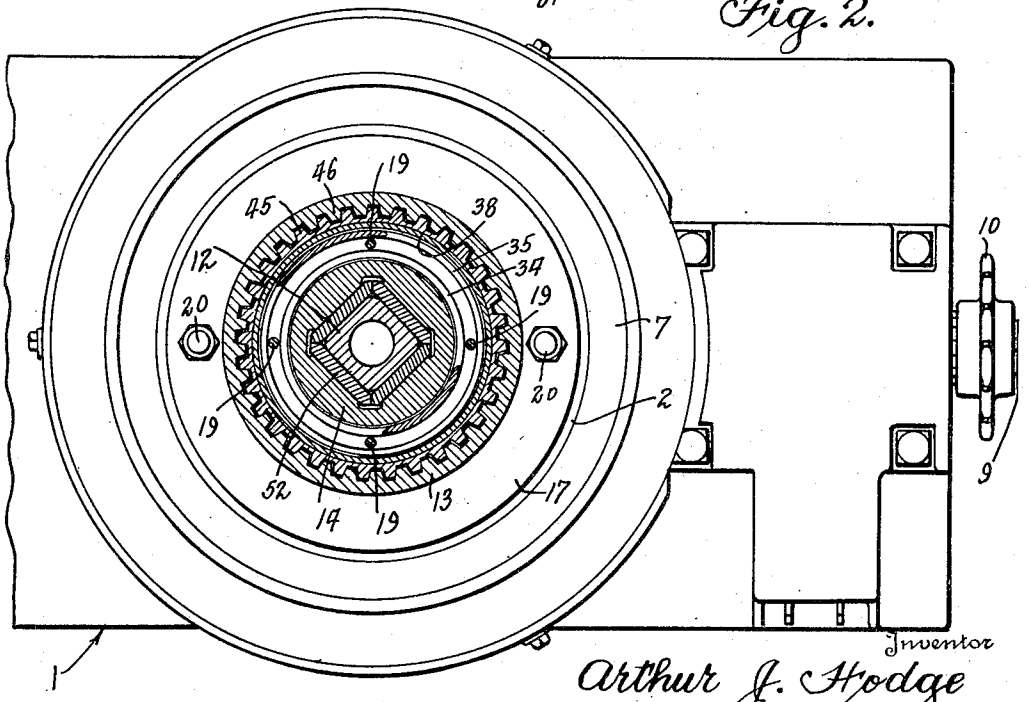

Fig. 2.

Inventor

Arthur J. Hodge

By Lyon & Lyon

Attorneys

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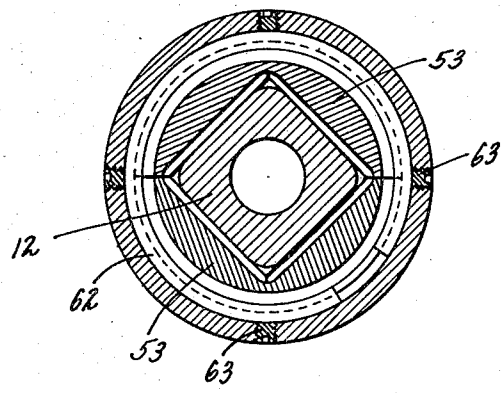
Fig. 3.



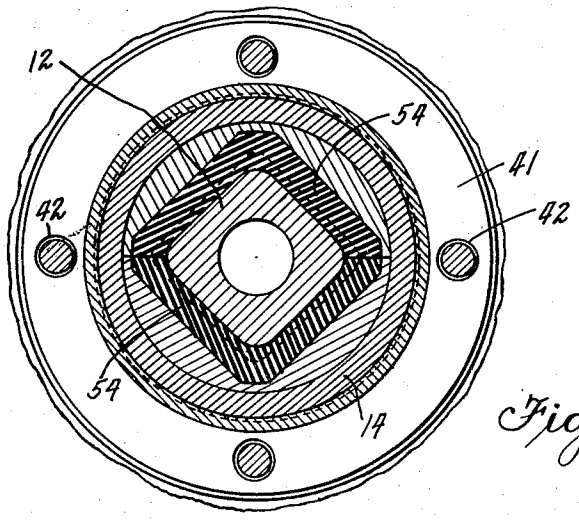


Fig. 4.

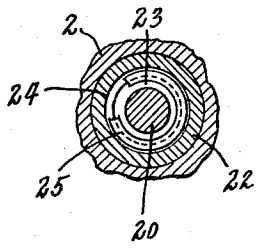


Fig. 5.

Inventor

Arthur J. Hodge

By Lyon & Lyon

Attorneys

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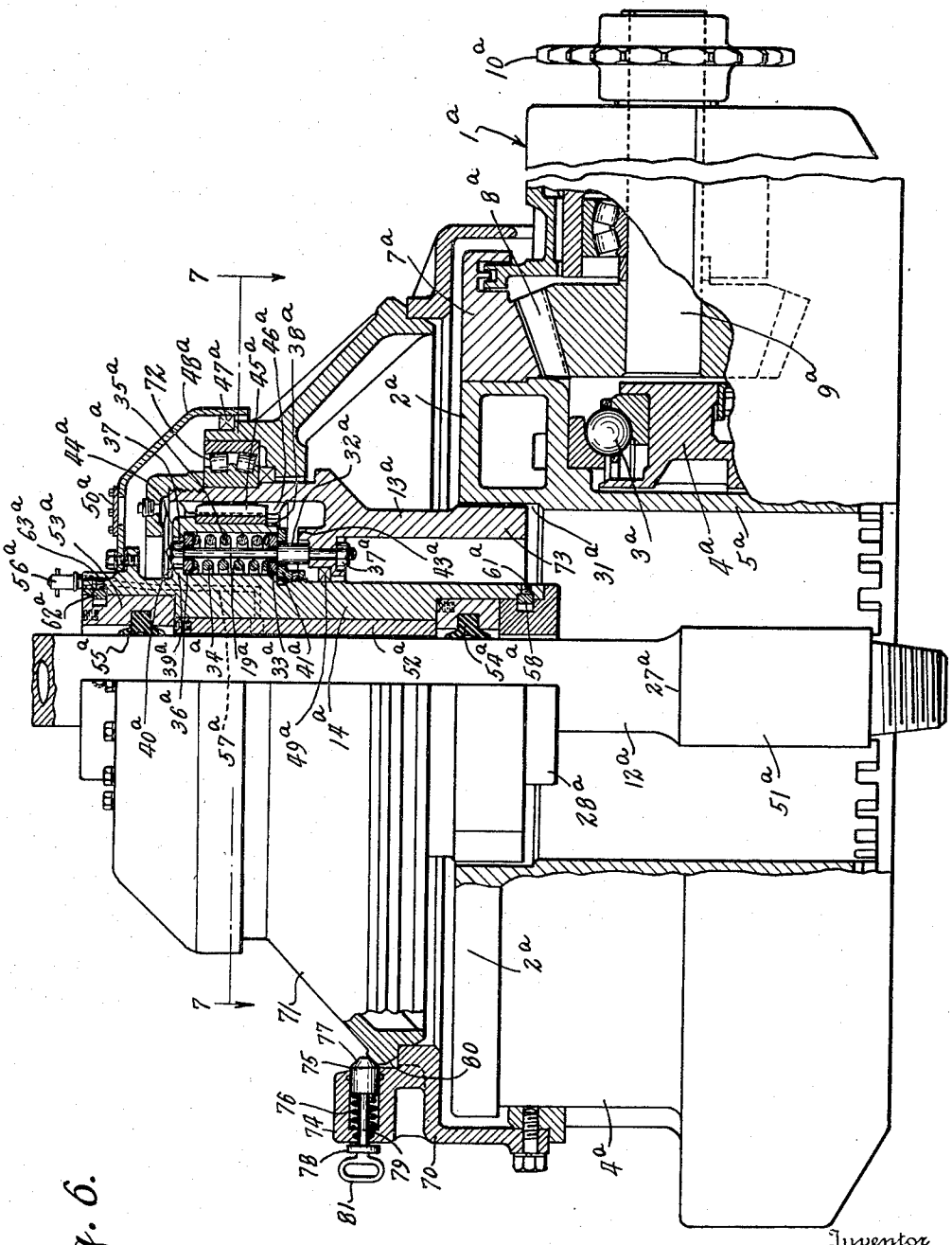

Fig. 6.

Inventor

Arthur J. Hodge

By Lyon & Lyon

Attorneys

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UNITED STATES PATENT OFFICE

2,259,224

DRILL STEM DRIVE DEVICE

Arthur J. Hodge, Lomita, Calif., assignor to The National Supply Company, Pittsburgh, Pa., a corporation of Pennsylvania

Application January 22, 1940, Serial No. 314,971

13 Claims. (Cl. 255—23)

This invention relates to rotary drilling apparatus of the type employed in the drilling of wells and is more particularly directed to an improvement in such apparatus, particularly in the devices utilized for driving the drill stem from the rotary machine.

In the rotary drilling of wells, the drill stem is secured to the drill pipe which carries the drilling bit at its lower end. The rotary motion is transmitted to the drilling bit from the drill stem through the drill pipe and from the driven rotary machine located in the drilling derrick at the surface of the ground.

During actual drilling operations, with the exception of the relatively small weight imposed upon the bit, the entire weight of the drill stem pipe and drilling bit is supported by a wire line reeved between a crown block, traveling block and a hoist.

It has been found that during actual drilling operations that the drill stem oscillates vertically through the rotary machine and the driving element interposed between the rotary machine and the drill stem. The resilient nature of the wire line and the flexibility of the drill pipe are undoubtedly contributing causes of this vertical oscillatory motion. This vertical oscillation or reciprocation of the drill stem through the driving connection from the rotary machine has a very destructive effect upon this driving element or drive bushing, as it is termed.

It has also been found that the drive bushings reciprocate with the drill stem resulting in destructive wear of their driving surfaces to such an extent that the driving connection between the driving bushings and the rotary table is destroyed or lessened in its driving efficiency. Accordingly, it is an object of this invention to provide a drill stem drive device in which provision is made to prevent relative reciprocation of the drive bushing and the rotary table.

Another object of this invention is to provide a drill stem drive device in which provision is made to permit the driving member to reciprocate with the drill stem and independently of the driving connection from the rotary table to the drill stem drive device.

Another object of this invention is to provide a drill stem drive device in which there is incorporated a preloaded spring arranged to oppose reciprocating movement of the driving device in either direction.

Another object of this invention is to provide a drill stem drive device in which there is incorporated a splined driving connection between the relatively movable parts.

Another object of this invention is to provide a drill stem drive device which is capable of universal swiveling movement permitting the drill stem to hang slightly out of plumb without imposing undue load upon the bearings of the rotary table and which permits the drill stem to feed through the driving connection without hanging up.

Another object of this invention is to provide a drill stem drive device provided with means for aligning the same with the rotary table prior to final engagement of the driving elements between the drive device and the rotary table.

Other objects and advantages of this invention it is believed will be apparent from the hereinafter contained description of the preferred embodiment thereof as illustrated in the accompanying drawings.

In the drawings:

Figure 1 is a side elevation mainly in vertical midsection of a drill stem drive device embodying my invention illustrating the same as mounted in a fragment of a rotary machine, also shown substantially in vertical midsection.

Figure 2 is a sectional view taken on the line 2—2 of Figure 1.

Figure 3 is a sectional view taken on the line 3—3 of Figure 1.

Figure 4 is a sectional view taken on the line 4—4 of Figure 1.

Figure 5 is a sectional view taken on the line 5—5 of Figure 1.

Figure 6 is an elevation partly in vertical midsection of another modified form of drill stem drive device embodying my invention.

Figure 7 is a sectional view taken substantially on the line 7—7 of Figure 6.

In the embodiment of my invention as illustrated in Figures 1 to 5, inclusive, the rotary machine is indicated at 1 as including a table 2 mounted upon bearings 3 carried by a base 4. The table 2 has a depending annular skirt 5 which carries an upthrust bearing 6 which serves to prevent upward movement of the table 2 relative to the base 4. The table 2 carries a ring gear 7 adapted to mesh with a pinion 8 mounted upon a pinion shaft 9. The pinion shaft 9 is driven by a sprocket 10. Mounted within the skirt 5 is a master bushing 11 through which the usual drill stem 12 is extended.

The drive device of my invention is adapted to form a driving connection between the table 2 and the drill stem 12. As the rotary table 2

is driven, the drill stem is driven through this drive device. The drive device consists of a body 13 which constitutes a driving member and a driven member 14 which is connected in driving relation with the driving member 13 through the medium of a spline connection 45, 46.

The body 13 is supported in this embodiment of my invention upon the table 2 through the medium of a supporting flange 17. Interposed between the flange 17 and the table 2 is a supporting disc 18 which supports the driven member 14. The driven member 14 is supported on the disc 18 by means of a plurality of springs carried on bolts 19 which extend upwardly from, and are secured to, the disc 18. The driving member 13 and the disc 18 are releasably connected in driving relation with the rotary table 2 by means of the driving pins 20. The driving pins 20 are tapered at their upper portion as indicated at 21 and the tapered shoulder thus provided receives correspondingly tapered bores of the flange 17 and the disc 18 in order to secure these members together. The drive pins 20 below the disc 18 are received within bushings 22 pressed into driving recesses formed in the rotary table 2.

The driving bushings are normally carried in the driving recesses formed in the table 2 and are releasably connected with the drive pins 20. In order to accomplish this releasable connection, there is provided corresponding grooves 23 and 24 on the driving pins 20 and bushings 22 between which there is fitted a snap ring 25. The upper extremity of the groove 24 is tapered as indicated at 26 sufficiently to compress the snap ring 25 when the driving device of my invention is raised from the rotary table by the raising of the drill stem 12 with the striking of the shoulder 27 against the lower end abutment member 28. The upper end of the bore of the drive bushings 22 is chamfered as indicated at 29 to permit easy entry of the snap ring 25 into the bore of the drive bushings 22.

The snap rings exert a sufficient holding pressure between the drive pins 20 and the bushings 22 so that the normal oscillating movement of the drill stem 12 is insufficient to displace the drive pins 20 from the bores of the bushings 22.

In order to locate the drive device of my invention to the rotary table 2 so that the drive pins 20 will align with the bores of the bushings 22, there is provided an aligning flange 30 extending downward from the supporting disc 18 corresponding in non-circular configuration with the non-circular opening 31 of the rotary table 2.

The flange 30 extends below the lower ends of the drive pins 20 so that when the driving device of my invention is lowered into position for connection with the rotary table 2, the lower end of the flange 30 may be dropped into the opening 31 of the rotary table. This action automatically aligns the drive pins 20 with the openings in the bushings 22 so that further lowering movement of the driving device drops the drive pins 20 into driving position. The fit between the bushings 22 and the drive pins 20 is considerably tighter than the relatively loose fit between the flange 30 and the opening 31 so that the drive pins normally carry all the driving load without assistance from the flange 30.

Means are provided for supporting the driven member or sleeve 14 upon the disc 18 so as to permit of limited vertical oscillation with the drill stem 12. This means as herein illustrated includes the supporting bolts 19 having supporting shoulders 32 upon which supporting washers 33 are positioned. Supported upon the washers 33 are the annular compression springs 34 and 35. The opposite ends of these springs 34 and 35 engage similar washers 36 carried by the bolts 19. Nuts 37 are threaded upon the bolts 19 to confine the springs 34 and 35 between the washers 33 and 36. By means of the nuts 37 the springs 34 and 35 are "preloaded" to provide an initial resistance to the oscillation of the driver or sleeve 14.

The driver 14 is formed to provide an annular housing 38 to house the springs 34 and 35. The upper end 39 of this housing rests upon the upper washers 36. Circular openings 40 are provided in this upper wall 39 of sufficient size to provide clearance around the nuts 37. At the lower end the driver 14 is engaged with the washer 33 by means of a removable stop flange 41 which is removably threaded upon the driver. This stop flange is also provided with openings 42 for the enlarged sections of the bolts 19 and of a sufficient size to provide for clearance around these enlarged sections. The construction as thus described permits of limited oscillatory motion or vibration with the driver 14 with reference to the driven member 13.

In this assembly, downward movement of the driver member 14 is resiliently opposed by the springs 34 and 35 as the end wall 39 moves the washer 36 downward upon the bolts 19. Downward movement is limited by the stop flange 41 striking the stop shoulder 43. Similarly upward movement of the member 14 is resiliently opposed by the springs 34 and 35 as the flange 41 moves the washer 33 along the bolts 19. Upward movement is limited by engagement of the shoulders 44.

Means are provided for connecting the members 13 and 14 in driven and driving relation, which means are illustrated as including the complementary splines 45 and 46 having the external and internal teeth respectively carried by the members 13 and 14. The teeth of the spline 46 are longer than the teeth of the spline 45 in order that a full driving contact may be maintained when the driver 14 moves up and down from its neutral position.

Relationship of the support for the member 14 and the driving connection between the members 13 and 14 is such as to permit of a limited universal movement between these members as may be required to accommodate the misalignment of the drill stem 12 with the opening through the rotary table 2. Thus the arrangement is such that the driver 14 may have universal swiveling movement about a point on its axis. This ability of the driver 14 to so move allows the drill stem 12 to hang slightly out of vertical in any direction without increasing the load on the table bearings 3 and thereby contributes to easy feeding of the drill stem 12 longitudinally through the driver 14. In order to permit of this movement, the shape and clearance between the splined teeth 31 and 32 are such as to permit this swiveling movement without interference.

As illustrated in Figure 2, the splined teeth are formed with clearance both radially and between their driving faces. The springs 34 and 35 and the spline elements 45 and 46, together with the annular seal 47, provided between the cover member 48 and the member 13 are all mounted concentrically so that each may be bisected by a horizontal plane containing the center

of swiveling movement of the driver 14 and therefore the radial displacement of the various parts incident to tilting of the driver 14 is maintained at a minimum. The lower seal 49 between the disc 18 and the driver 14 is a yieldable sealing element designed to accommodate the relative radial displacement occurring at this position.

The cover 48 is secured to the driver 14 and overlaps the upwardly extending portion of the member 14 in order to provide an enclosure operative in connection with the seals 47 and 49 to maintain lubricant within and to prevent the admission of foreign matter into driving connection provided by the teeth of the splines 45 and 46 and for the proper operation of the reciprocating connection provided between the member 14 and the disc 18.

In order to admit lubricant into the interior of this enclosure, the cover 48 is provided with a removable cap 50 through which lubricant may be admitted. The lubricant is maintained in contact with the teeth of the splines 45 and 46 by the centrifugal action resulting from the rotation of the rotary table 2.

In order to permit the drill stem 12 to be inserted longitudinally through the driver 14, the same is preferably made of a sufficiently large bore to accommodate collars 51 of the drill stem 12. There is then provided on the interior bore of the driver 14 a split driver liner 52 which is of configuration corresponding to the configuration of the drill stem 12. This split liner is removably held in position by means of the upper and lower split abutment rings 53 and 28.

Positioned within the interior of the driver 14 are resilient sealing means 54 and 55 likewise of split construction to exclude foreign matter from, and to confine lubricant within, the bore of the driver 14. This lubricant is admitted by means of a suitable pressure fitting 56 operating in conjunction with the lubricant passage 57 formed in the driver 14. The split abutment element 28 at the lower end of the bore of the driver 14 is maintained against displacement by means of a snap ring 58. The snap ring 58 is a split spring ring and is adapted to be positioned within the corresponding grooves 59 and 60 of the abutment member 28 and driver 14, respectively. A set screw 61 is provided for contracting this split ring when it is desired to release the abutment member 28 from the member 14. A similar snap ring 62 is provided at the upper end of the driver 14 for releasably connecting the abutment ring 53. This split ring is interposed between corresponding grooves and is adapted to be contracted by means of a set screw 63 when it is desired to remove the abutment ring 53.

Referring to the modified form of my invention illustrated in Figures 6 and 7, similar parts are indicated by the same numeral with the addition of an exponent "*a*" thereto.

The principal distinction between these forms of my invention is that in the forms illustrated in Figures 6 and 7, the drive device is supported upon the base 4*a* of the rotary machine independently of the table 2*a*. The drill stem 12*a* is therefore guided in alignment with respect to the opening through the stationary base 4*a* and the table bearings 3*a* are relieved of the guiding function. In this form of my invention an annular ring 70 is secured to the base 4*a* and overlaps a portion of the table 2*a*. A frusto-conical supporting structure 71 rests upon, and is supported by, the ring 70 and carries a self-aligning roller bearing 72 near its upper end. The guiding device is supported on this roller bearing 72, the bearing 72 being interposed between the body 13*a* and the frusto-conical supporting member 71. The body 13*a* has a depending portion 73 which is adapted to fit within the non-circular opening 31*a* in the table 2*a* forming a driving connection.

The driver 14*a* is supported upon and driven from the upper end of the body 13*a* in the same manner as that described in detail in connection with the previously described modification of this invention.

Carried by the ring 70 is a latch means for retaining the frusto-conical element 71 in position. These latch elements consist of latch plungers 75 mounted in cylinders 74. Springs 76 are interposed between the cylinders 74 and the plungers 75 in order to yieldably urge the plungers 75 into latching position. Each plunger has a frusto-conical latching section 77 adapted to engage a corresponding surface on the member 71. The degree of taper of the frusto-conical section 77 is such that the supporting structure 71 is held against displacement due to reciprocation of the driver 14*a*. On the other hand, this degree of taper is such as to permit displacement of the supporting structure 71 under the relatively greater force acting when the shoulder 27*a* engages the abutment piece 28*a* of the driver 14*a*.

A stop 78 on the plunger rod 79 prevents overtravel of the plunger 75 when the supporting structure 71 is removed. When the supporting structure 71 is returned to operative position, the beveled surface 80 automatically pushes the plunger 75 back into the cylinders 74 so that the supporting structure 71 may rest upon the annular ring 70.

Handles 81 are provided on the piston rod 79 in case manual manipulation of the plunger 75 is found necessary or desirable for any reason.

Having fully described my invention, it is to be understood that I do not wish to be limited to the details herein set forth, but my invention is of the full scope of the appended claims.

I claim:

1. A device for rotating a drill stem, comprising in combination a driver member through which the drill stem may have axial movement when drilling, said driver member encircling a portion of the drill stem and adapted to transmit rotary movement thereto, a body member encircling a portion of said driver member, means whereby said body member may be rotated, resilient means adapted to support said driver member on said body member, cooperating drive splines on said members adapted to form a non-rotatable driving connection whereby the body member may rotate the driver member, said drive splines being parallel to the axis of the drill stem and adapted to accommodate axial reciprocation of the driver member.

2. A device for rotating a drill stem, comprising in combination a driver member through which the drill stem may have axial movement when drilling, said driver member encircling a portion of the drill stem and adapted to transmit rotary movement thereto, a body member encircling a portion of said driver member, means whereby said body member may be rotated, cooperating drive elements on said members adapted to form a non-rotatable driving connection whereby the body member may rotate the driver member, said drive elements being adapted to accommodate relative axial movement of the members, means for supporting the driver member on the body member, said means including a spring

operatively interposed between said members and acting to resist relative movement of the members in either direction.

3. A device for rotating a drill stem, comprising in combination a sleeve member having a non-circular opening axially therethrough forming a slidable but non-rotatable connection with the drill stem, a body member encircling a portion of said sleeve member, means whereby said body member may be rotated, drive means including interengaging teeth on said members whereby the body member may rotate the sleeve member, said interengaging teeth being parallel with the axis of rotation, and said drive means being adapted to permit limited axial reciprocation of the sleeve member relative to the body member.

4. A device for rotating a drill stem, comprising in combination a sleeve member having a non-circular opening axially therethrough forming a slidable but non-rotatable connection with the drill stem, a body member encircling a portion of said sleeve member, means whereby said body member may be rotated, resilient means adapted to support said sleeve member on said body member, drive means including interengaging teeth on said members whereby the body member may rotate the sleeve member, said drive means being adapted to permit limited axial reciprocation of the sleeve member relative to the body member.

5. In a device of the class described, the combination of a driver member adapted to rotate a drill stem, a body member encircling a portion of the driver member, cooperating spline elements on said members adapted to form a driving connection whereby the body member may rotate the driver member, said spline elements being adapted to accommodate relative movement of the members axially of said spline elements, resilient means operatively interposed between said members and adapted to resist relative movement of the members in either direction, said means including a compression spring confined between end elements which are separated by a distance less than the normal free length of the spring.

6. In a device for rotating a drill stem, the combination of a driver through which the drill stem may have axial movement, said driver encircling a portion of the drill stem and adapted to transmit rotary motion thereto, a body, a spline driving connection between said driver and body comprising a series of external teeth on the driver meshing with a series of internal teeth on the body, said spline driving connection being adapted to permit axial reciprocation of the driver within certain limits relative to the body, resilient means interposed between said body and driver and adapted to oppose movement of the driver in either direction, said resilient means including a compression spring confined between end elements which are separated by a distance less than the normal free length of the spring, the central plane of said spline connection lying intermediate the planes of said end elements.

7. A rotary machine for rotating a drill stem, having a base and a table rotatably mounted on the base, in combination with a driver member through which the drill stem may have axial movement, said driver member encircling a portion of the drill stem and adapted to transmit rotary motion thereto, means driven by the table adapted to rotate said drive member, means for supporting said driver member independently of the table, said supporting means being adapted to permit universal swiveling movement within certain limits of the driver member relative to said table.

8. A rotary machine for rotating a drill stem, having a base and a table rotatably mounted on the base, in combination with a driver member through which the drill stem may have axial movement, said driver member encircling a portion of the drill stem and adapted to transmit rotary motion thereto, a body member associated with the driver member, means carried on said base adapted to support said body member, cooperating parts forming a driving connection between the table and the body member, interengaging drive elements on said members whereby the body member may rotate the driver member, said drive elements being adapted to permit the driver member to have universal swiveling movement within certain limits relative to said body member.

9. A rotary machine for rotating a drill stem, having a base and a table rotatably mounted on the base, in combination with a driver member through which the drill stem may have axial movement, said driver member encircling a portion of the drill stem and adapted to transmit rotary motion thereto, a body member associated with the driver member, means independent of the table adapted to support said body member, cooperating parts forming a driving connection between the table and the body member, interengaging drive elements on said members whereby the body member may rotate the driver member, said drive elements being adapted to permit the driver member to have universal swiveling movement within certain limits relative to said body member.

10. In a device for rotating a drill stem, the combination of a driver member through which the drill stem may have axial movement when drilling, said driver member encircling a portion of the drill stem and adapted to transmit rotary motion thereto, a body member associated with said driver member, means forming a driving connection between said members and adapted to permit both relative axial movement and relative universal swiveling movement of said members, and resilient means acting to maintain said members at a position between the extreme end positions of their relative axial movement.

11. In a device for rotating a drill stem, the combination of a driver member through which the drill stem may have axial movement, said driver member encircling a portion of the drill stem and adapted to transmit rotary motion thereto, a body member associated with said driver member, cooperating drive elements forming a positive driving connection between said members and adapted to permit both relative axial movement and relative universal swiveling movement of said members, and resilient means acting to oppose both of said movements permitted by said driving connection.

12. In a device for rotating a drill stem, the combination of a driver through which the drill stem may have axial movement, said driver encircling a portion of the drill stem and adapted to transmit rotary motion thereto, a body adapted to support said driver, a spline driving connection between said body and driver comprising a series of external teeth on the driver meshing with a series of internal teeth on the body, the shape of said teeth and the clearance between them being such as to permit both axial movement and universal swiveling movement of the driver relative to the body.

13. In a device for rotating a drill stem, the combination of a driver through which the drill stem may have axial movement, said driver encircling a portion of the drill stem and adapted to transmit rotary motion thereto, a body adapted to support said driver, a spline driving connection between said driver and body comprising a series of external teeth on the driver meshing with a series of internal teeth on the body, the shape of said teeth and the clearance between them being such as to permit both axial movement and universal swiveling movement of the driver relative to the body, and resilient means acting to oppose both of said movements permitted by said driving connection, said resilient means including a compression spring confined between end elements which are separated by a distance less than the normal free length of the spring.

ARTHUR J. HODGE.