Sept. 16, 1952 L. FAGG 2,610,827

ROTARY SWIVEL

Filed July 16, 1948 2 SHEETS--SHEET 1

Fig. 1.

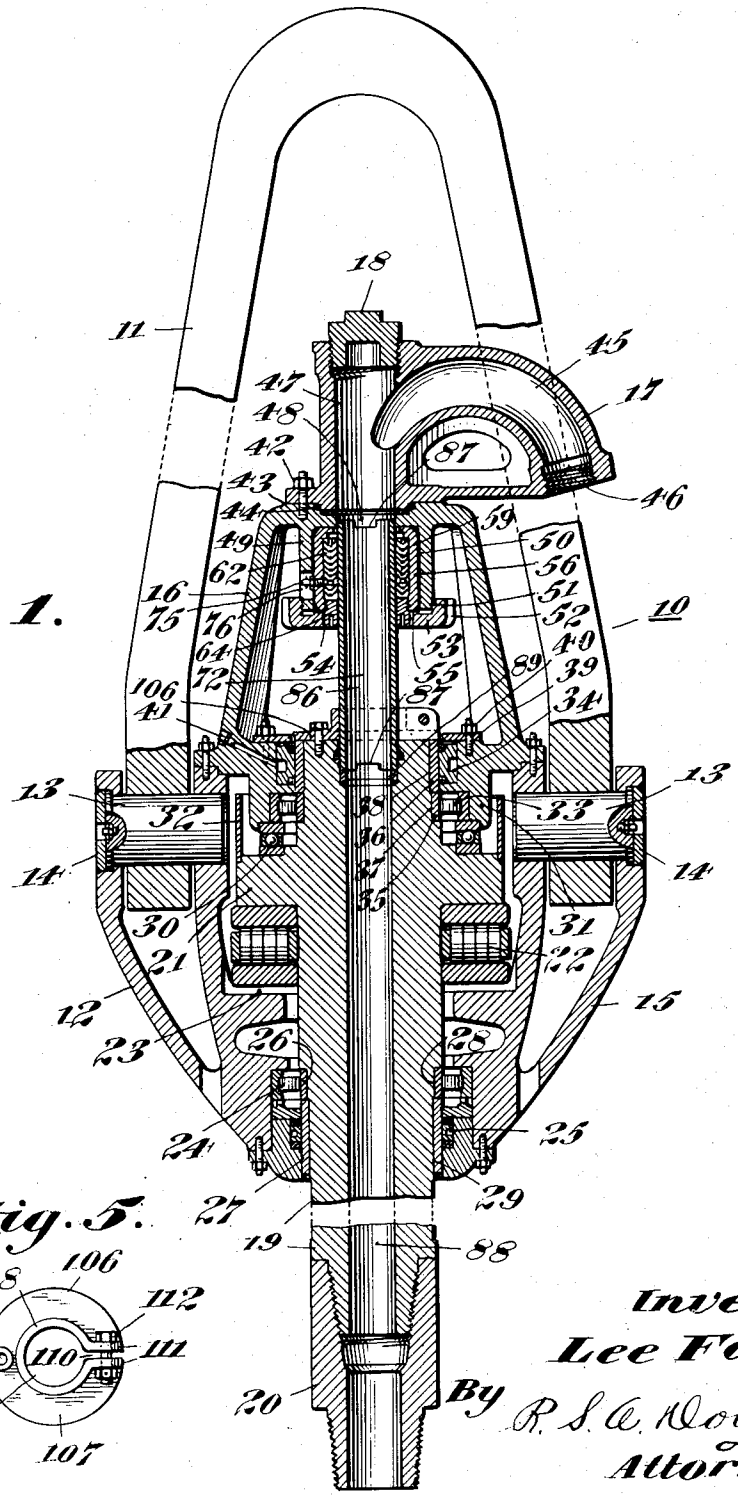



Fig. 5.



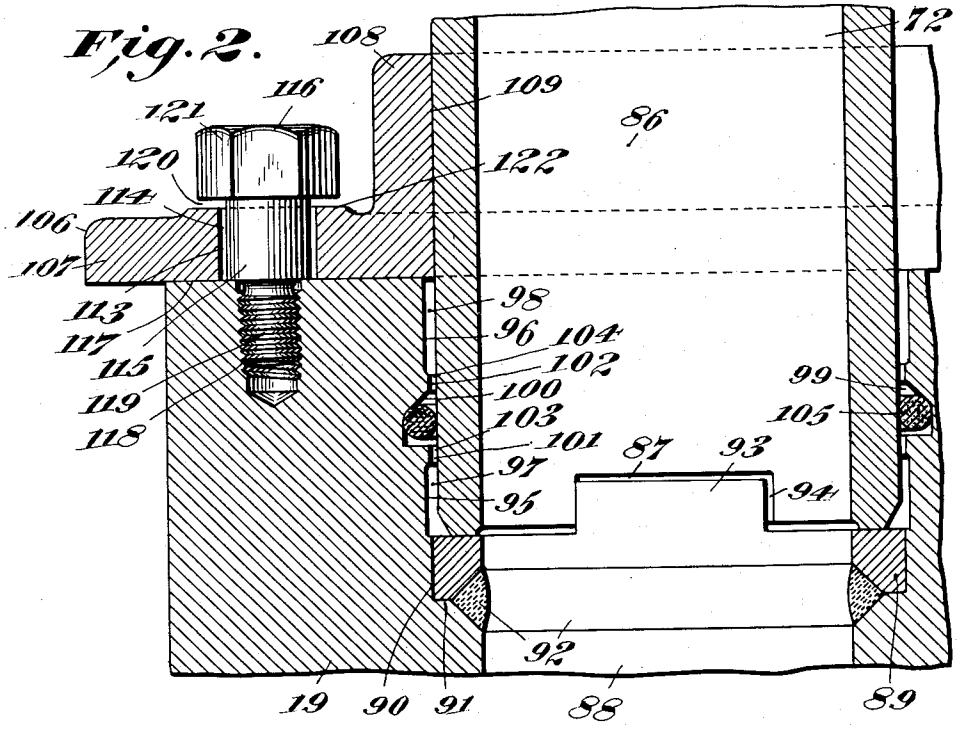

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Fig. 2.



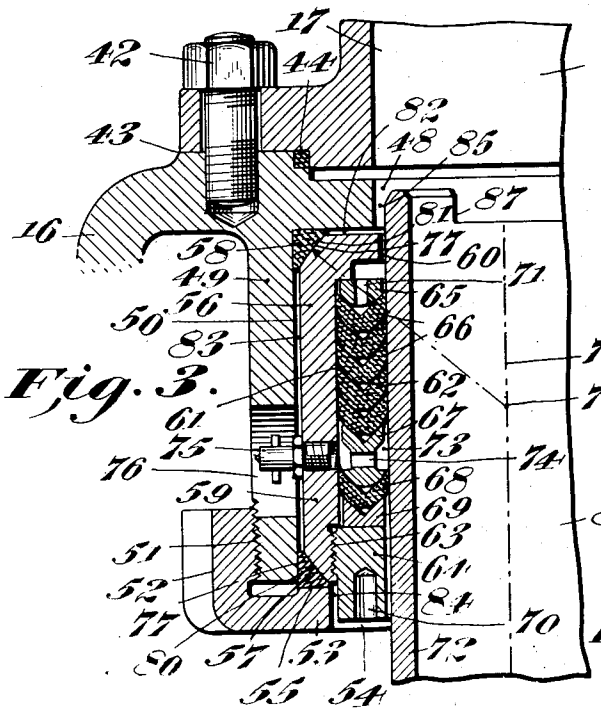
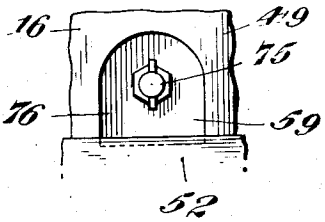




Fig. 3.

Fig. 4.




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# UNITED STATES PATENT OFFICE

2,610,827

## ROTARY SWIVEL

Lee Fagg, Corsicana, Tex., assignor, by mesne assignments, to Bethlehem Supply Company, a corporation of Delaware

Application July 16, 1948, Serial No. 38,990

10 Claims. (Cl. 255—25)

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This invention relates to rotary hydraulic swivels of the type employed in the drilling of wells, and is more particularly directed to an improvement in the wash pipe and in its packings provided to form a fluid-tight pipe connection between the stationary gooseneck of the swivel and the rotatable drilling stem supported by the said swivel.

The modern oil field rotary swivel is a massive and sturdy mechanism designed to provide a body means for operatively and rotatably suspending the hollow drill stem in the well while being drilled. It also comprises the conduit means for pumping the circulating drilling fluid through the stationary swivel body and into the rotatable hollow drill stem operably supported thereby. As usually constructed the upper part of the swivel body comprises a gooseneck operably integral therewith and having a flow passage therethrough. The outer end of the gooseneck flow passage is adapted to receive an armored hose connected to the delivery outlet of the mud pumps. The inner end of the gooseneck flow passage is adapted for a fluid-tight connection with the wash pipe. The function of the wash pipe is to complete the fluid-tight flow passage from the stationary inner end of the gooseneck flow passage to the upper end of the rotatable hollow drill stem.

The rotary swivel when in operation is suspended between the fixed crown block of the derrick and the fixed point of entry of the well into the earth. The crown block supports sheaves over which the plural turns of the elevating cable are looped to manipulate a hoist block with sheaves and a hook therebelow. The hook engages a massive bail trunnioned in the upper body of the swivel. By these means the swivel with its supported drill stem may be raised and lowered in the well.

The drill stem is the direct means whereby a hole is driven in the earth. It is normally comprised of jointed hollow sections operable as an integral pipe unit from its top to its bottom section. The top section of the drill stem comprises the swivel rotary spindle, followed by a grief stem, and this by sections of drill pipe, and finally at its lower or bottom end is the drill bit. The drill bit is provided with holes through which the circulating drilling fluid is projected toward the cutting edges of the bit for the purpose of flushing the detritus away from the bottom of the hole in a well known manner.

The swivel rotary spindle usually is mounted as a part of the swivel assembly but in operation

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it is an operable integral unit of the drill stem and rotates therewith. The spindle is hollow for the passage of the circulating fluid, and is suitably mounted on suitable bearings to take the vertical load of the supported drill stem with a minimum of friction, and is also provided with other suitable bearings to take the transverse thrusts of the drill stem developed in operation. The lower end of the spindle extends below the body of the swivel and is normally machined for a threaded connection to a grief stem or kelly joint. The grief stem is the first joint of the drill stem below the swivel and is usually square in cross section. The square portion of the grief stem has a slidable engagement through the center of the rotary driving table and is rotated thereby. The jointed drill stem transmits the torque delivered to the grief stem by the power driven rotary table down through the drill stem to the drill bit at the lower end thereof.

The length of the drill stem is greatly out of proportion to its diameter and the drill stem is therefor capable of considerable elastic deformation between the rotary table at the surface and the bit at the bottom of the hole. The amount of twisting and torsional strain varies with the resistance offered to the progress of the bit through opposing rock and deflection in the drill stem takes place. The drill stem due to torsional strain developed when in operation takes a corkscrewy position in the well and contacts with the walls of the well, and revolving with rapid variations in stress causes whipping against the walls of the well which set up vibration and transverse stresses that are transmitted to the surface of the well throughout the length of the drill stem. Furthermore, certain conditions may exist above the earth that cause further variable transverse stresses, such as a crown block not accurately located. Also within the structure of the swivel itself are inherent limitations of manufacture and assembly which result in workable transverse clearances, which clearances by accumulation may result in a condition when in operation whereby the actual axis of rotation of the drill stem within the rotary swivel assumes a gyratory movement about its theoretical vertical axis. It is now apparent that when such a condition exists a special problem arises for making a fluid-tight operable pipe connection between the stationary inner end of the gooseneck and the upper end of the rotatable drill stem. The known prior art discloses some rather ineffectual attempts to satisfy this problem.

It is therefore the primary object of my inven-

tion to construct a hydraulic swivel comprising a wash pipe assembly having a fluid-tight universal joint connection with the stationary gooseneck thereof and with the rotatable drill stem supported by said swivel.

It is a further object of my invention in its preferred form to construct a hydraulic swivel comprising a wash pipe assembly having a fluid-tight universal joint connection with the stationary gooseneck thereof and with the rotatable drill stem supported therein, whereby the wash pipe per se is rotatable with respect to the said stationary gooseneck and is flexibly affixed with the said rotatable drill stem but is relatively non-rotatable therewith.

It is a further object of my invention to provide in a hydraulic swivel a wash pipe assembly having a fluid-tight universal joint connection at each end thereof, whereby gyratory movement of either end of the axis of the wash pipe is operably provided for with respect to its opposite end.

Further objects and advantages will be apparent from the following description wherein details of design and operation will be given in full with reference to the accompanying drawings illustrating the preferred embodiment of my invention, and wherein similar reference numerals designate similar parts throughout the several views.

Figure 1 is a vertical sectional elevation of a hydraulic rotary swivel incorporating the preferred form of my invention, as shown in enlarged detail in Figures 2 to 5, inclusive.

Fig. 2 is an enlarged fragmental sectional view showing the preferred embodiment of my invention as applied to the drill stem end of the wash pipe assembly,

Fig. 3 is an enlarged fragmental sectional view showing the preferred embodiment of my invention as applied to the gooseneck end of the wash pipe assembly,

Fig. 4 is an enlarged fragmental front elevation detail view showing the clearance opening in the swivel body for the stuffing-box lubricator, and,

Fig. 5 is a detail plan view of the split clamping and retaining ring.

Referring now to the drawings, and more particularly to Fig. 1, the numeral 10 designates the complete ensemble of a hydraulic rotary swivel embodying the preferred form of my invention. The swivel 10 comprises a bail 11 by which it is suspended when in operation from the hook of a derrick hoisting block (not shown). The bail 11 is pivotally mounted in the body housing 12 by means of the trunnions 13 secured in the body housing by means of the securing discs 14 welded thereto. The body housing 12 comprises the bowl 15, the bonnet 16, the gooseneck 17, and the gooseneck cap 18.

The body housing 12 rotatably supports the swivel rotary spindle 19 which, as hereinbefore described, forms the top section of the hollow drill stem. The lower elements of the drill stem (not shown) are normally attached to the spindle 19 by means of the hollow tool joint 20. The spindle 19 has an outstanding flange 21 whereby the load on the stem is transmitted through the main bearings 22 to the abutment, or shelf 23, in the housing 12. A bottom radial bearing 24 is provided in the base of the bowl 15 for the spindle 19 together with a packing assembly 25, the latter being designed to prevent leakage of lubricant and to exclude foreign matter from the interior of the housing 12. In order to permit replacement for wear without damaging the



spindle 19, lower wear rings 26 and 27 are positioned on the lower support surfaces 28 and 29 of the spindle 19, whereby replacement of the wear rings may be made without replacement of the spindle 19 itself.

Upward thrust of the drill stem is taken by the hold-down bearing 30 mounted between the lower face of the skirt 31 of the bonnet 16 and the upper face of the flange 21 of the spindle 19. In order to provide a supply of lubricant for the bearings 30 and 33 an upstanding ring 32 is carried by the flange 21 of the spindle 19 and projects to an elevation above that of the top radial bearing 33.

The top radial bearing 33 is provided in a recess in the skirt 31 of the bonnet 16 for the spindle 19, together with a packing assembly 34, the latter being designed to prevent leakage of lubricant and to exclude foreign matter from the interior of the housing 12. Upper wear rings 35 and 36 are positioned on the upper support surfaces 37 and 38 of the spindle 19, being similar in design and purpose to the lower wear rings 26 and 27. The packing assembly 34 is held in position by the plate 39 attached to the bonnet 16 by fastening devices 40. In order to introduce lubricant into the packing assembly 34 a lubricant fitting 41 is provided in the bonnet 16 leading to the packing assembly 34.

We come now to those features of the hydraulic swivel to which my improvement is particularly directed—i. e. the structure of the wash pipe and its fluid-tight connections between the stationary swivel housing and the rotatable swivel spindle. For the purposes of clear delineation of and understanding of the structure of my improvement the enlarged fragmental Figures 2 to 5, inclusive, are to be considered for details thereof, while the Figure 1 indicates diagrammatically their embodiment within the swivel.

Referring now to Figures 1, 3 and 4 the gooseneck 17 is joined to the upper end of the bonnet 16 by means of fastening devices 42, and the joint 43 therebetween is sealed by a suitable packing 44. The gooseneck 17 is provided with a curved flow passage 45 having an inlet end 46 adapted to receive the discharge end of a drilling fluid hose (not shown) communicating with the discharge of the mud pump (not shown). The curved flow passage 45 becomes one with a straight vertical portion 47 thereof above the joint 43. The upper end of the straight vertical portion 47 of the flow passage is normally closed by a suitable threaded plug 18 while the downward or outlet end thereof communicates with a matching flow passage 48 in the top of the bonnet 16 within the confines of the packing 44. Surrounding the flow passage 48 and depending from the top of the bonnet 16 and preferably integral therewith is the skirt 49 having an enlarged counterbore 50 machined therein axially in line with the flow passage 48. The lower end of the skirt 49 forms an annular flange threaded externally at 51 to engage a threaded clamp cap 52. The cap 52 has an inwardly extending annular flange 53 having a central opening 54 suitably smaller in diameter than the counterbore 50 to provide a clamping abutment 55 to act as a retaining means for the wash pipe stuffing box assembly 56 in conjunction with its bearing ring 57 and its sealing ring 58 (hereinafter more fully described).

The wash pipe stuffing box assembly 56 is a unit comprising a self-adjusting stuffing box 59 which is suitably recessed at its top end with a

communicating stepped opening 60, and intermediate its ends with an enlarged counterbore 61 to carry suitable packing means 62, and at its lower end with a threaded opening 63 for a threaded retaining gland 64. The packing means 62 may be any suitable commercial packings, but I prefer a known type such as is illustrated in Fig. 3 comprising a top support ring 65, followed by a plurality of cup-section fabricated packing rings 66, a lantern ring 67, below which is another packing ring 68 similar to the rings 66, and a lower support ring 69 in contact with and supported by the gland 64. The gland 64 is provided with spanner wrench openings 70. The top support ring 65 is provided with a series of vertical openings 71 through which pressure fluid from the stepped opening 60 is operably effective against the topmost packing ring 66 which transmits said pressure to each succeeding ring whereby the upturned lips thereof are pressed outwardly in sealing contact against their respective opposed surfaces of the counterbore 61 and of the outer surface of the wash pipe 72 (to be further described hereinafter). In operation the drilling fluid tends to infiltrate abrasive particles into the packings 66 and these tend to cause excessive wear on the outer surface of the wash pipe—to minimize this wear the lantern ring 67 is channelled on its outer and inner surfaces as at 73 and a series of openings 74 communicate the channels one with the other, whereby lubricant forced into the channels from a communicating lubricant fitting 75, provided in the stuffing box 59, works itself upward, thereby tending to displace outwardly the abrasive particles. For permitting assembly of the fitting 75 and to give it operating clearance an opening 76 is provided in the skirt 49 of the bonnet 16. The fitting 75 when in place in the opening 76 also acts as a key means to prevent excessive rotation of the stuffing box 59 from its assembled position in the counterbore 61.

In order that the stuffing box assembly 56 may adjust itself automatically to possible axial gyratory movement of the wash pipe when in operation it is necessary that the stuffing box assembly unit be specifically adapted for such movement. I prefer to do this by making the mounting of the stuffing box assembly 56 within the skirt 49 of the bonnet 16 that of a universal joint of the ball-and-socket type. This is done by machining the end corners of the stuffing box 59 as convex surfaces of spherical revolution 77 about the spherical center 78 lying on its axis 79. These surfaces 77 of the stuffing box 59 engage suitably adapted concave surfaces 80 and 81 of the bearing ring 57 and of the sealing ring 58 respectively. Furthermore, it is necessary that proper clearances be provided to permit the stuffing box assembly 56 to have suitable limited gyratory movement about its theoretical normal vertical axis—this I do by providing clearances between the respective opposed surfaces of the counterbore 50 and of the stuffing box 59 as at 82 at the top, and at 83 diametrically, and between the gland 64 and the cap 52 at 84 at the bottom. The flow passage 48 in the top of the bonnet 16 is also given sufficient clearance as at 85 to avoid contact with the wash pipe 72.

When in operation pressure of the drilling fluid against the effective pressure exposed areas of the stuffing box assembly 56 tends to slidably seat the lower corner surface 77 forcibly against the bearing ring 57, and for this reason I prefer to make the bearing ring 57 of suitable pressure resisting bearing material. At the same time the pressure of the drilling fluid in the clearance space 82 is exerted against the sealing ring 58 and tends to compress the ring and to force its surface 81 into an elastic sealing and holding contact with the convex upper corner surface 77 of the stuffing box 56. For this latter reason I prefer to make the sealing ring 58 of a suitable elastic material such as rubber or the like whereby its sealing action is maintained during relatively oscillatory movement of the surface 77. Furthermore, since the wash pipe 72 when in operation rotates with respect to the stuffing box packings means 62 I prefer to have suitable working clearances between the outside diameter of the wash pipe 72 and the respective inside diameters of the rings 65, 67, and 69; of the gland 64; and of the stepped opening 60 in the stuffing box 59 as indicated in Fig. 3.

It is now apparent that I have provided a detachable fluid-tight universal joint connection between the rotatable wash pipe 72 and the stationary swivel housing 12. This connection comprises a relatively rotatable fluid tight engagement of a stuffing box assembly 56 about the said wash pipe, and a relatively non-rotatable fluid tight ball-and-socket engagement of the said stuffing box assembly with the said swivel housing, whereby operable means are provided for possible simultaneous rotary and gyratory motion of the said wash pipe with respect to the said stationary housing body.

Referring now to Figures 1, 2, and 5 the wash pipe 72 is a cylindrical pipe preferably made of high grade wear resisting metal with a polished exterior surface and has the flow passage 86 extending throughout its length. It is provided at each end with symmetrically shaped notches 87 diametrically opposed at each side thereof by means of which the wash pipe may be driven in rotation from either end thereof with and by the swivel spindle 19. The double end drive provision permits of turning the wash pipe end-for-end for economy purposes when the wear of one end becomes excessive. As shown in the enlarged view of Fig. 2 the upper end of the hollow spindle 19 has its end-to-end flow passage 88 enlarged to provide a recess to receive the lower end of the wash pipe 72 and its associated drive bushing 89. The lower end of the said recess is counterbored as at 90 with an abutment 91 to receive the said drive bushing 89. Both the drive bushing 89 and the abutment 91 have their opposed inner corners bevelled in order to provide space for weld metal 92 by which the bushing 89 is attached to the spindle 19. The drive bushing 89 is provided with two diametrically opposed lugs 93 on its upper surface which engage the adjacent notches 87 in the wash pipe 72 when in assembled position. The width of the lugs 93 is made of less width than that of the notches 87 in the wash pipe 72 in order to provide a suitable operating clearance as shown at 94, whereby the wash pipe 72 may be slightly tilted out of line from that of the axis of the spindle 19. Above the counterbore 90 the recess is slightly enlarged in diameter as at surfaces 95 and 96, in order to provide suitable operating clearances 97 and 98 for the wash pipe 72 when tilting or gyrating during operation. Midway in the depth of the recess a trapezoidal groove 99 is provided having an angular abutment 100 sloping toward the top of the recess. The boundary surfaces 101 and 102 of the groove 99 have substantially the same inside diameter as that

of the counterbore 90 to permit assembly of the drive bushing 89 and at the same time reduce the clearances 103 and 104 between the outer diameter of the wash pipe 72 and the opposing surfaces 101 and 102 respectively. This is practical since any tilting or gyratory movement of the wash pipe will tend to be centered about the center of the annular sealing ring 105 seated in the groove 99 and therefor the clearances 103 and 104 need not be so great as those of 97 and 98 which are further away from the plane of the sealing ring 105. Furthermore the smaller clearances of 103 and 104 give added protection to the sealing ring 105. The sealing ring 105 is preferably made of a suitable elastic sealing material such as rubber, or the like. In operation drilling fluid under pressure passing through the drill stem will allow leakage past the lower end of the wash pipe 72 through the clearance spaces 94, 97, and 103, and into the trapezoidal groove 99 beneath the sealing ring 105, and will press the latter into sealing engagement against the outer surface of the wash pipe 72 and the surface of the angular abutment 100 of the groove 99. Due to the elastic nature of the sealing ring 105 this sealing engagement will be effectively maintained during slight oscillatory or gyratory movements of the wash pipe 72.

In order to prevent the wash pipe 72 from withdrawing upwardly from its driven relationship with the drive bushing 89, and at the same time permit it to tilt or gyrate at an angle with respect to the axis of the spindle 19, the split clamping and retaining ring 106 is provided. As shown in Figures 2 and 5 the ring 106 is annular in shape having the flat circumferential flange 107 and a vertical axial flange 108 surrounding its central opening 109 which is adapted to have a sliding fit when not clamped on the wash pipe 72. The ring 106 is radially slotted at one side as at 110 and the vertical flange 108 is extended outwardly along each side of this slot to provide the clamping abutments 111 which are adapted to receive the clamping means 112. On the side opposite to that of the slot 110 with its clamping abutments 111 is the opening 113 adapted to have a suitable operating clearance 114 about the shoulder portion 115 of the retaining bolt 116. The top surface 117 of the spindle 19 is provided with a threaded opening 118 adapted to receive the threaded end 119 of the bolt 116. The shoulder portion 115 is sufficiently long enough to provide a suitable operating clearance 120 between the bolt head 121 and the flange boss 122. In operation the retaining ring 106 is tightly clamped about the wash pipe 72 by properly adjusting the clamping means 112, and is loosely attached to the swivel spindle 19 by the retaining bolt 116.

It is now apparent that I have provided a detachable fluid tight universal joint driving connection between the rotary swivel spindle 19 and the wash pipe 72. This connection comprises a relatively non-rotatable flexible fluid tight engagement of the wash pipe 72 with the rotary swivel spindle, whereby the wash pipe 72 is rotatable in conjunction with the spindle 19 and also has operable means for possible simultaneous gyratory motion of the said wash pipe with respect to the said rotary swivel spindle 19.

It is further apparent that my improved design of wash pipe and its packings has particular advantages in case of the need for inspection, removal, and replacement of its parts. Loosening of the clamping means 112 frees the wash pipe



axially from the retaining ring 106, and the wash pipe may be withdrawn upwardly through the gooseneck 17 by first removing the cap 18. The retaining ring 106 may be withdrawn by removal of the bolt 116. The stuffing box assembly 56 is removed as a unit by removal of the clamp cap 52, bearing ring 57, and fitting 75. The packing means 62 may be removed by removing the gland 64 from the stuffing box 59. Their reassembly is obvious.

It is also apparent that the wash pipe 72 may be locked to its associated element by means of the clamping and retaining ring 106 alone, and thus, if desired, dispense with the notches 87 in the wash pipe 72, and with its associated lock bushing 89, since the clamping and retaining ring is securely clamped to the wash pipe 72 and is non-rotatably attached to its associated element (as shown in Fig. 2 and described herein, this latter is the rotary stem 19). However, since the notched wash pipe and its associated lock bushing 89 are a more positive locking means I have shown and claim them as my preferred locking means.

I claim:

1. In a hydraulic rotary swivel, the combination of a housing body, said body comprising a lower bowl portion and an upper removable bonnet portion, said upper bonnet portion comprising exteriorly thereof an outer mounting surface and interiorly thereof a depending centrally disposed packing housing, said housing comprising an upwardly extending counterbored recess therethrough, a pipe stem rotatably supported in said lower bowl portion, a wash pipe flexibly secured at its lower end to rotate with said pipe stem and in communication therewith and having its upper end in spaced encircled relationship with said recess and substantially coaxial therewith, a gooseneck removably supported on said exterior mounting surface comprising a passageway therethrough communicating with the upper end of said wash pipe, a sealing ring mounted within the inner end of said recess, a bearing ring mounted within the outer end of said recess, said rings having opposed spherical concave surfaces of revolution of equal radii on their inside diameter, a wash pipe packing assembly comprising an outer cylindrical stuffing box having spherical end corner convex surfaces of revolution about a common center located on its axis, said convex surfaces being adapted for movable surface engagement with the respective opposed concave surfaces of said sealing and bearing rings when mounted therebetween within said recess, means for retaining said wash pipe packing assembly and said rings in said mounted relationship whereby said stuffing box has a sealed universally movable fluid-tight joint relationship with said recess, and packing means in said stuffing box in engagement with said wash pipe for maintaining a relatively rotatable fluid-tight engagement about said wash pipe.

2. In a hydraulic rotary swivel, the combination of a wash pipe, a rotary pipe stem comprising upon its upper end thereof a downwardly extending counterbored recess having intermediate the ends thereof a diametrically enlarged trapezoidiform annular notch having its outer end boundary surface obtuse angled with respect to its outer circumferential surface, the said annular notch spatially encircling a portion of said wash pipe, a wash pipe retaining means adapted to be removably attached to said wash pipe to form a unit therewith, said retaining means be-

ing further adapted to be removably and loosely attached to the upper end of said pipe stem, said loose attachment permitting limited axial oscillation of said unit with respect to the axis of said pipe stem while being substantially non-rotatable thereto, and a resilient sealing ring mounted in said annular notch having sealing engagement with said obtuse angled surface thereof and with the outer circumferential surface of said wash pipe, whereby said wash pipe has a flexible sealed relatively non-rotatable engagement with said rotary pipe stem.

3. In a hydraulic rotary swivel, the combination of a housing body, said body comprising a lower bowl portion and an upper removable bonnet portion, said upper bonnet portion comprising exteriorly thereof an outer mounting surface and interiorly thereof a depending centrally disposed packing housing, said housing comprising an upwardly extending counterbored recess therethrough, a pipe stem rotatably supported in said lower bowl portion, said pipe stem comprising within its upper end thereof a downwardly extending counterbored recess, said counterbored recesses being opposed one to the other and spaced apart vertically in substantially coaxial alignment, a gooseneck removably supported on said exterior mounting surface comprising a passageway therethrough, a wash pipe communicating said gooseneck with said pipe stem and having its ends extending into and spatially encircled by said counterbored recesses, a first end of said wash pipe having a sealed flexible relatively non-rotatable relationship with a first one of said counterbored recesses, a sealing ring mounted within the inner end of a second one of said recesses, a bearing ring mounted within the outer end of said second one of said recesses, said rings having opposed spherical concave surfaces of revolution of equal radii, a wash pipe packing assembly comprising an outer cylindrical stuffing box having spherical end corner convex surfaces of revolution about a common center located on its axis, said convex surfaces being adapted for movable surface engagement with the respective opposed concave surfaces of said sealing and bearing rings when mounted therebetween within said second one of said recesses, means for retaining said wash pipe packing assembly and said rings in said mounted relationship whereby said stuffing box has a sealed universally movable fluid-tight joint relationship with said second one of said recesses, and packing means in said stuffing-box in engagement with said wash pipe for maintaining a relatively rotatable fluid-tight engagement about said wash pipe.

4. In a hydraulic rotary swivel, the combination of a housing body, said body comprising a lower bowl portion and an upper removable bonnet portion, said upper bonnet portion comprising exteriorly thereof an outer mounting surface and interiorly thereof a depending centrally disposed packing housing, said housing comprising an upwardly extending counterbored recess therethrough, a pipe stem rotatably supported in said lower bowl portion, said pipe stem comprising within its upper end thereof a packing housing comprising a downwardly extending counterbored recess, said counterbored recesses being opposed one to the other and spaced apart vertically in substantially coaxial alignment, a gooseneck removably supported on said exterior mounting surface comprising a passageway therethrough, a wash pipe communicating said gooseneck with said pipe stem and having its ends extending into and spatially encircled by said recesses, a first end of said wash pipe having a sealed universally movable fluid-tight joint relatively rotatable relationship with a first one of said recesses, the second one of said recesses having intermediate the ends thereof a diametrically enlarged trapezoidiform annular notch having its outer end boundary surface obtuse angled with respect to its outer circumferential surface, the said annular notch spatially encircling the second end of said wash pipe, a wash pipe retaining means adapted to be removably attached to the said second end of said wash pipe to form a unit therewith, said retaining means being further adapted to be removably and loosely attached to the housing of the said second recess, said loose attachment permitting limited axial oscillation of said unit with respect to the axis of said second recess while being substantially non-rotatable thereto, and a resilient sealing ring mounted in said annular notch having sealing engagement with said obtuse angled surface thereof and with the outer circumferential surface of said wash pipe, whereby said wash pipe has a flexible sealed relatively non-rotatable engagement with said rotary pipe stem.

5. In a hydraulic rotary swivel, the combination of a wash pipe, a rotary pipe stem comprising upon its upper end thereof a downwardly extending counterbored recess having intermediate the ends thereof a diametrically enlarged trapezoidiform annular notch having its upper end boundary surface obtuse angled with respect to its adjacent outer circumferential surface, the said annular notch spatially encircling a portion of said wash pipe, means for retaining said wash pipe within said recess comprising a radially split flanged collar adapted with clamping means for removably clamping said split collar rigidly upon said wash pipe to form a unit therewith, said flange of said collar comprising a cylindrical opening parallel to and radially spaced from said wash pipe, a shouldered fastening means passing through said cylindrical opening and removably mounted upon the outer end of said pipe stem, said cylindrical opening having axial and diametrical clearance about said shouldered fastening means whereby said wash pipe and split collar unit in its assembled relationship has limited axial oscillatory movement with respect to the axis of said pipe stem while being substantially non-rotatable thereto, and a resilient sealing ring mounted in said annular notch having sealing engagement with said obtuse angled surface thereof and with the outer circumferential surface of said wash pipe, whereby said wash pipe has a flexible sealed relatively non-rotatable engagement with said rotary pipe stem.

6. In a hydraulic rotary swivel, the combination of a housing body, said body comprising a lower bowl portion and an upper removable bonnet portion, said upper bonnet portion comprising exteriorly thereof an outer mounting surface and interiorly thereof a depending centrally disposed packing housing, said housing comprising an upwardly extending counterbored recess therethrough, a pipe stem rotatably supported in said lower bowl portion, said pipe stem comprising within its upper end thereof a packing housing comprising a downwardly extending counterbored recess, said counterbored recesses being opposed one to the other and spaced apart vertically in substantially coaxial alignment, a gooseneck removably supported on said exterior

mounting surface comprising a passageway therethrough, a wash pipe communicating said gooseneck with said pipe stem and having its ends extending into and spatially encircled by said recesses, a first end of said wash pipe having a sealed universally movable fluid-tight joint relatively rotatable relationship with a first one of said recesses, the second one of said recesses comprising intermediate the ends thereof a diametrically enlarged trapezoidiform annular notch having its outer end boundary surface obtuse angled with respect to its outer circumferential surface, the said annular notch spatially encircling the second end of said wash pipe, means for retaining said wash pipe within said second recess comprising a radially split flanged collar adapted with clamping means for removably clamping said split collar rigidly upon the said second end of said wash pipe to form a unit therewith, said flange of said collar comprising a cylindrical opening parallel to and radially spaced from said wash pipe, a shouldered fastening means passing through said cylindrical opening and removably mounted upon the housing of the said second recess, said cylindrical opening having axial and diametrical clearance about said shouldered fastening means whereby said wash pipe and split collar unit in its assembled relationship has limited axial oscillatory movement with respect to the axis of said second recess while being substantially non-rotatable thereto, and a resilient sealing ring mounted in said annular notch having sealing engagement with said obtuse angled surface thereof and with the outer circumferential surface of said wash pipe, whereby said wash pipe has a flexible sealed relatively non-rotatable engagement with said second recess.

7. In a hydraulic rotary swivel, the combination of a housing body, said body comprising a lower bowl portion and an upper removable bonnet portion, said upper bonnet portion comprising exteriorly thereof an outer mounting surface and interiorly thereof a depending centrally disposed packing housing, said housing comprising an upwardly extending counterbored recess therethrough, a pipe stem rotatably supported in said lower bowl portion, said pipe stem comprising within its upper end thereof a downwardly extending counterbored recess, said counterbored recesses being opposed one to the other and spaced apart vertically in substantially coaxial alignment, a gooseneck removably supported on said exterior mounting surface comprising a passageway therethrough, a wash pipe communicating said gooseneck with said pipe stem and having its ends extending into and spatially encircled by said recesses and substantially coaxial therewith, a sealing ring mounted within the inner end of said bonnet recess, a bearing ring mounted within the outer end of said bonnet recess, said rings having opposed spherical concave surfaces of revolution of equal radii on their inside diameter, a wash pipe packing assembly comprising an outer cylindrical stuffing box having spherical end corner convex surfaces of revolution about a common center located on its axis, said convex surfaces being adapted for movable surface engagement with the respective opposed concave surfaces of said sealing and bearing rings when mounted therebetween within said bonnet recess, means for retaining said wash pipe packing assembly and said rings in said mounted relationship whereby said stuffing box has a sealed universally movable fluid-tight joint relationship with said bonnet recess, and packing means in said stuffing box in engagement with said wash pipe for maintaining a relatively rotatable fluid-tight engagement about said wash pipe, the said pipe stem counterbored recess having intermediate the ends thereof a diametrically enlarged trapezoidiform annular notch having its outer end boundary surface obtuse angled with respect to its outer circumferential surface, the said annular notch spatially encircling a portion of said wash pipe, a wash pipe retaining means adapted to be removably attached to said wash pipe to form a unit therewith, said retaining means being further adapted to be removably and loosely attached to the upper end of said pipe stem, said loose attachment permitting limited axial oscillation of said unit with respect to the axis of said pipe stem while being substantially non-rotatable thereto, and a resilient sealing ring mounted in said annular notch having sealing engagement with said obtuse angled surface thereof and with the outer circumferential surface of said wash pipe, whereby said wash pipe has a flexible sealed relatively non-rotatable engagement with said rotary pipe stem.

8. In a hydraulic rotary swivel, the combination of a housing body, said body comprising a lower bowl portion and an upper removable bonnet portion, said upper bonnet portion comprising exteriorly thereof an outer mounting surface and interiorly thereof a depending centrally disposed packing housing, said housing comprising an upwardly extending counterbored recess therethrough, a pipe stem rotatably supported in said lower bowl portion, said pipe stem comprising within its upper end thereof a downwardly extending counterbored recess, said counterbored recesses being opposed one to the other and spaced apart vertically in substantially coaxial alignment, a gooseneck removably supported on said exterior mounting surface comprising a passageway therethrough, a wash pipe communicating said gooseneck with said pipe stem and having its ends extending into and spatially encircled by said recesses and substantially coaxial therewith, a sealing ring mounted within the inner end of said bonnet recess, a bearing ring mounted within the outer end of said bonnet recess, said rings having opposed spherical concave surfaces of revolution of equal radii on their inside diameter, a wash pipe packing assembly comprising an outer cylindrical stuffing box having spherical end corner convex surfaces of revolution about a common center located on its axis, said convex surfaces being adapted for movable surface engagement with the respective opposed concave surfaces of said sealing and bearing rings when mounted therebetween within said bonnet recess, means for retaining said wash pipe packing assembly and said rings in said mounted relationship whereby said stuffing box has a sealed universally fluid-tight joint relationship with said bonnet recess, and packing means in said stuffing-box in engagement with said wash pipe for maintaining a relatively rotatable fluid-tight engagement about said wash pipe, the said pipe stem counterbored recess having intermediate the ends thereof a diametrically enlarged trapezoidiform annular notch having its outer end boundary surface obtuse angled with respect to its adjacent outer circumferential surface, the said annular notch spatially encircling a portion of said wash pipe, means for retaining said wash pipe within said pipe stem recess comprising a radially split flanged collar adapted with

clamping means for removably clamping said split collar rigidly upon said wash pipe to form a unit therewith, said flange of said collar comprising a cylindrical opening parallel to and radially spaced from said wash pipe, a shouldered fastening means passing through said cylindrical opening and removably mounted upon the outer end of said pipe stem, said cylindrical opening having axial and diametrical clearance about said shouldered fastening means whereby said wash pipe and split collar unit in its assembled relationship has limited axial oscillatory movement with respect to the axis of said pipe stem while being substantially non-rotatable thereto, and a resilient sealing ring mounted in said annular notch having sealing engagement with said obtuse angled surface thereof and with the outer circumferential surface of said wash pipe, whereby said wash pipe has a flexible sealed relatively non-rotatable engagement with said rotary pipe stem.

9. In a hydraulic rotary swivel, the combination of a housing body, said body comprising a lower bowl portion and an upper removable bonnet portion, said upper bonnet portion comprising exteriorly thereof an outer mounting surface and interiorly thereof a depending centrally disposed packing housing, said housing comprising an upwardly extending counterbored recess therethrough, a pipe stem rotatably supported in said lower bowl portion, said pipe stem comprising within its upper end thereof a packing housing comprising a downwardly extending counterbored recess, said counterbored recesses being opposed one to the other and spaced apart vertically in substantially coaxial alignment, a gooseneck removably supported on said exterior mounting surface comprising a passageway therethrough, a wash pipe communicating said gooseneck with said pipe stem and having its ends extending into and spatially encircled by said recesses and substantially coaxial therewith, a first one of said recesses comprising a sealing ring mounted within the inner end thereof and a bearing ring mounted within the outer end thereof, said rings having opposed spherical concave surfaces of revolution of equal radii on their inside diameter, a wash pipe packing assembly comprising an outer cylindrical stuffing box having spherical end corner convex surfaces of revolution about a common center located on its axis, said convex surfaces being adapted for movable surface engagement with the respective opposed concave surfaces of said sealing and bearing rings when mounted therebetween within said first one of said recesses, means for retaining said wash pipe packing assembly and said rings in said mounted relationship whereby said stuffing box has a sealed universally movable fluid-tight joint relationship with said first one of said recesses, and packing means in said stuffing box in engagement with said wash pipe for maintaining a relatively rotatable fluid-tight engagement about said wash pipe, a second one of said recesses having intermediate the ends thereof a diametrically enlarged trapezoidiform annular notch having its outer end boundary surface obtuse angled with respect to its outer circumferential surface, the said annular notch spatially encircling a portion of said wash pipe, a wash pipe retaining means adapted to be removably attached to said wash pipe to form a unit therewith, said retaining means being further adapted to be removable and loosely attached to the housing of said second recess, said loose attachment permitting limited axial oscillation of said unit with respect to the axis of said second recess while being substantially non-rotatable thereto, and a resilient sealing ring mounted in said annular notch having sealing engagement with said obtuse angled surface thereof and with the outer circumferential surface of said wash pipe, whereby said wash pipe has a flexible sealed relatively non-rotatable engagement with said second recess.

10. In a hydraulic rotary swivel, the combination of a housing body, said body comprising a lower bowl portion and an upper removable bonnet portion, said upper bonnet portion comprising exteriorly thereof an outer mounting surface and interiorly thereof a depending centrally disposed packing housing, said housing comprising an upwardly extending counterbored recess therethrough, a pipe stem rotatably supported in said lower bowl portion, said pipe stem comprising within its upper end thereof a downwardly extending counterbored recess, said counterbored recesses being opposed one to the other and spaced apart vertically in substantially coaxial alignment, a gooseneck removably supported on said exterior mounting surface comprising a passageway therethrough, a wash pipe communicating said gooseneck with said pipe stem and having its ends extending into and spatially encircled by said recesses and substantially coaxial therewith, a first one of said recesses comprising a sealing ring mounted within the inner end thereof and a bearing ring mounted within the outer end thereof, said rings having opposed spherical concave surfaces of revolution of equal radii on their inside diameter, a wash pipe packing assembly comprising an outer cylindrical stuffing box having spherical end corner convex surfaces of revolution about a common center located on its axis, said convex surfaces being adapted for movable surface engagement with the respective opposed concave surfaces of said sealing and bearing rings when mounted therebetween within said first one of said recesses, means for retaining said wash pipe packing assembly and said rings in said mounted relationship whereby said stuffing box has a sealed universally movable fluid-tight joint relationship with said first one of said recesses, and packing means in said stuffing box in engagement with said wash pipe for maintaining a relatively rotatable fluid-tight engagement about said wash pipe, a second one of said recesses having intermediate the ends thereof a diametrically enlarged trapezoidiform annular notch having its outer end boundary surface obtuse angled with respect to its outer circumferential surface, the said annular notch spatially encircling a portion of said wash pipe, means for retaining said wash pipe within said second recess comprising a radially split flanged collar adapted with clamping means for removably clamping said split collar rigidly upon said wash pipe to form a unit therewith, said flange of said collar comprising a cylindrical opening parallel to and radially spaced from said wash pipe, a shouldered fastening means passing through said cylindrical opening and removably mounted upon the housing of said second recess, said cylindrical opening having axial and diametrical clearance about said shouldered fastening means whereby said wash pipe and split collar unit in its assembled relationship has limited axial os-

cillatory movement with respect to the axis of said second recess while being substantially non-rotatable thereto, and a resilient sealing ring mounted in said annular notch having sealing engagement with said obtuse angled surface thereof and with the outer circumferential surface of said wash pipe, whereby said wash pipe has a flexible sealed relatively non-rotatable engagement with said second recess.

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## REFERENCES CITED

The following references are of record in the file of this patent:



UNITED STATES PATENTS


| Number | Name | Date |
|---|---|---|
| Re. 22,825 | Morgan, Jr., et al. | Dec. 24, 1946 |
| 904,933 | Brickner | Nov. 24, 1908 |
| 2,029,598 | Timbs et al. | Feb. 4, 1936 |
| 2,036,537 | Otis | Apr. 7, 1936 |
| 2,105,754 | Otis | Jan. 18, 1938 |
| 2,119,244 | Pranger | May 31, 1938 |
| 2,220,120 | Plummer | Nov. 5, 1940 |
| 2,394,800 | Murphy | Feb. 12, 1946 |
| 2,459,472 | Tremolada | Jan. 18, 1949 |
| 2,472,061 | Bloss et al. | June 7, 1949 |
| 2,485,940 | Tremolada | Oct. 25, 1949 |