April 12, 1938. W. D. DAVIDSON ET AL 2,113,647

ROTARY SWIVEL

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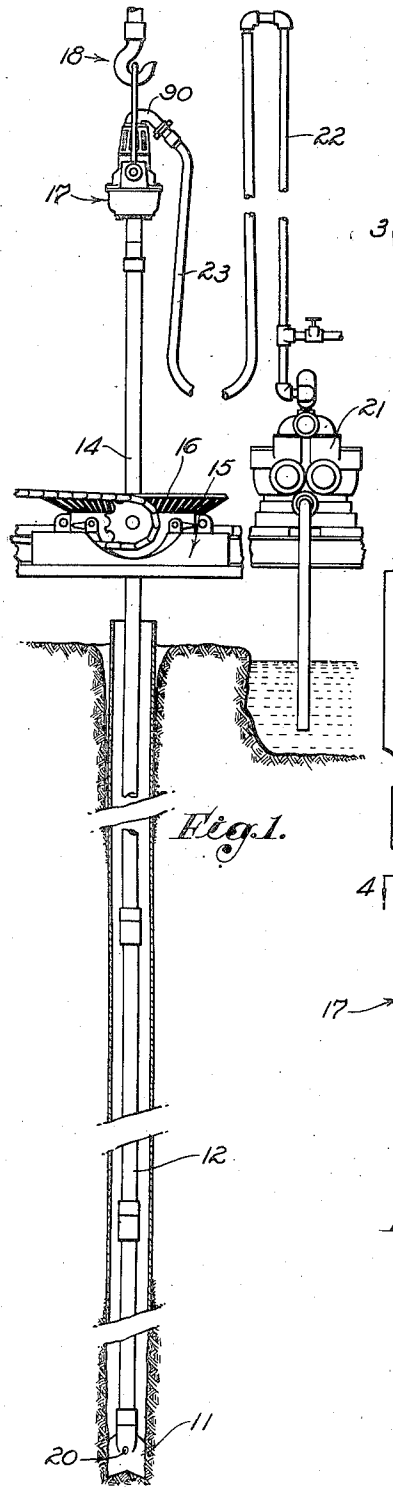

Fig. 1.

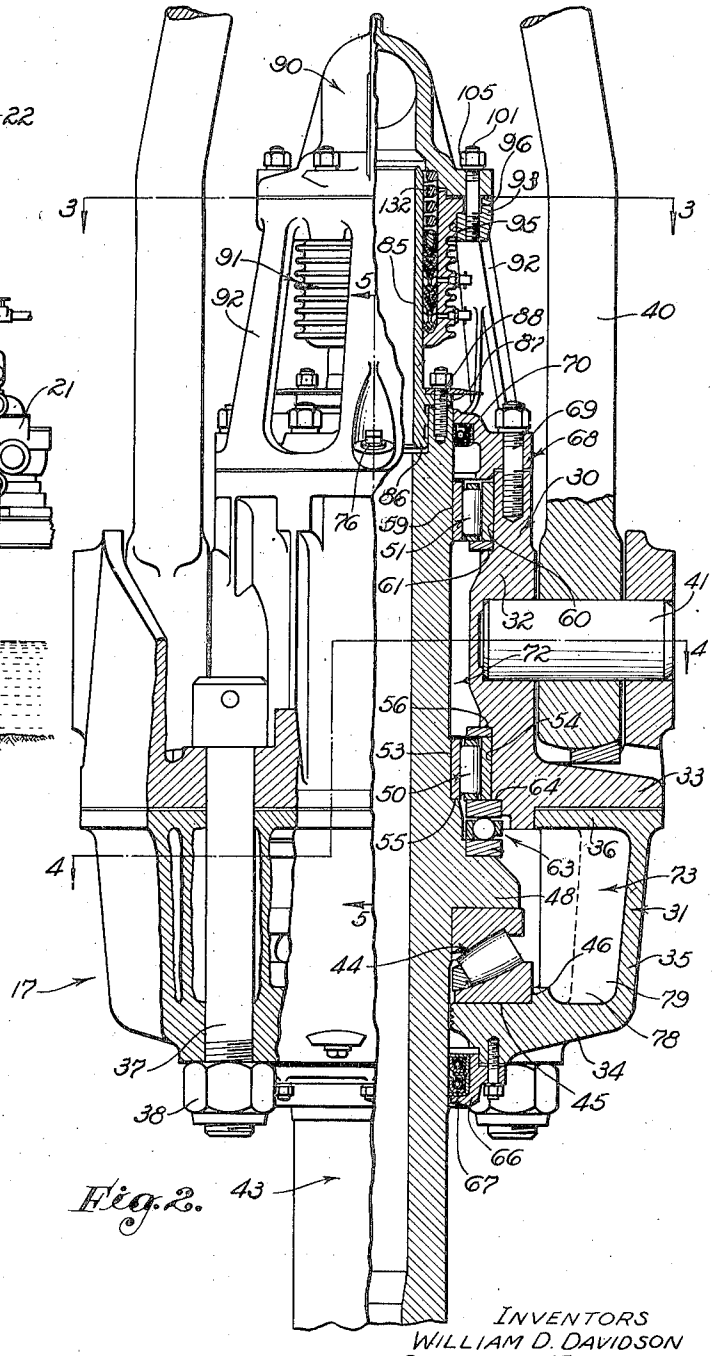

Fig. 2.

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Fig. 3.

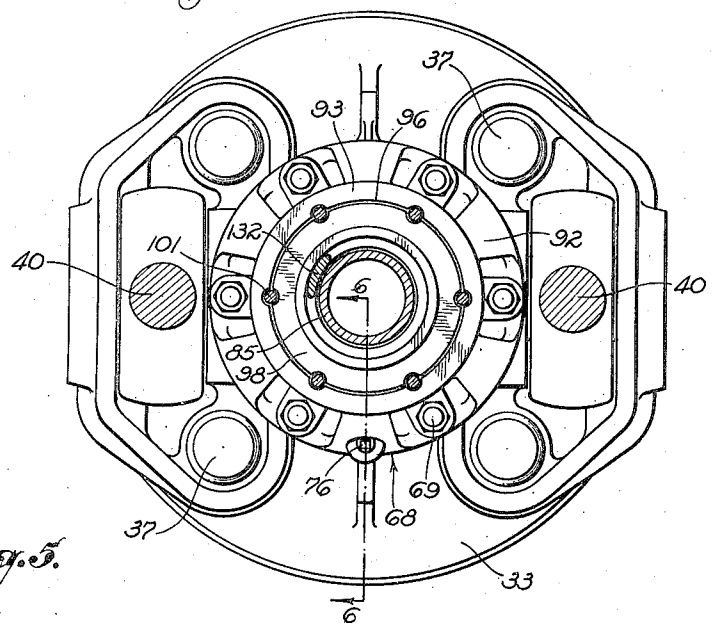

Fig. 5.

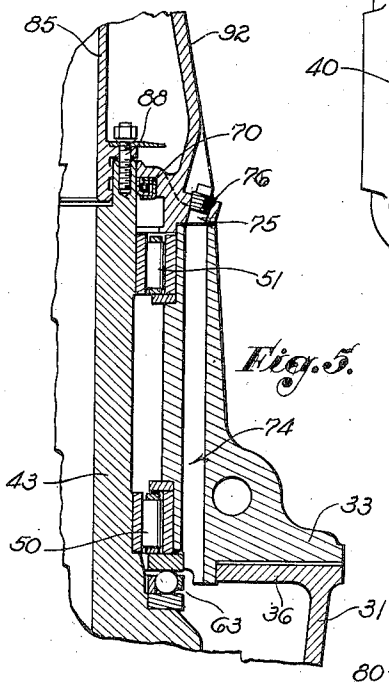

Fig. 4.

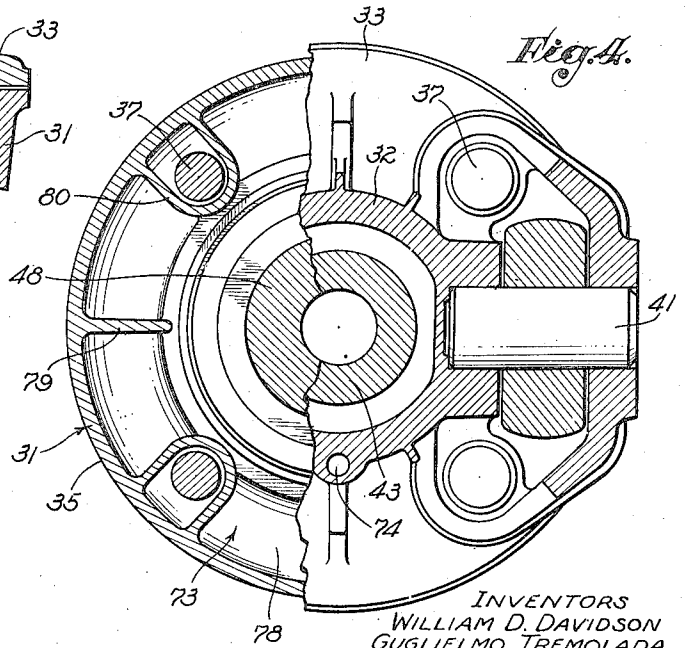

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Fig. 6.

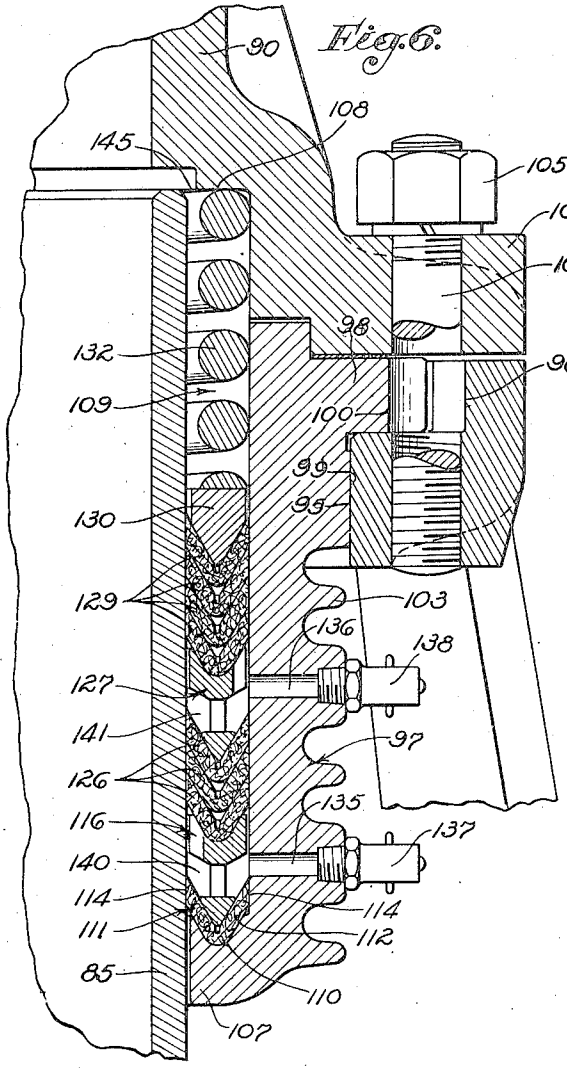


Fig. 8.

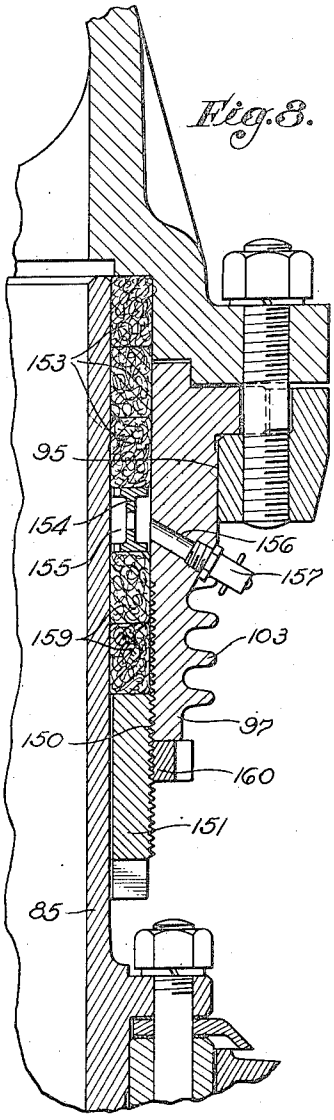
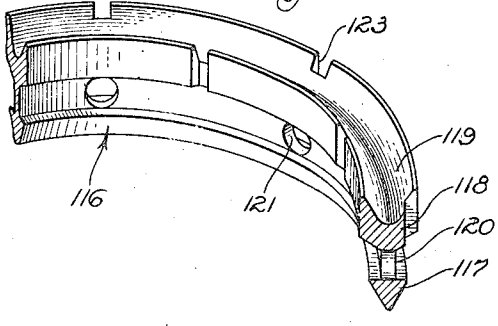


Fig. 7.



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Patented Apr. 12, 1938

2,113,647

UNITED STATES PATENT OFFICE

2,113,647

ROTARY SWIVEL

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Application January 13, 1936, Serial No. 58,868

14 Claims. (Cl. 255—25)

Our invention relates to rotary swivels which have a particular utility in the oil producing industry. In the detailed description which is to follow, our invention will be described in connection with such use.

In order that the features and advantages of our invention may be better understood brief reference will be made to the oil producing industry.

As illustrated in Fig. 1 of the accompanying drawings, which shows a utility view illustrating the use of our invention, it is common practice to drill oil wells by means of a rotary bit 11 secured to the lower end of a string of drill pipe 12. The drill pipe 12 extends to the surface of the ground and has a kelly 14 connected to its upper end which extends through a rotary machine 15 and is engaged and caused to rotate by the table 16. In accordance with standard practice, a swivel 17, to which type of apparatus our invention relates, is connected to the upper end of the kelly 14. This swivel is supported by means of a travelling block 18, the hook of which is illustrated in Fig. 1. During drilling operations it is common practice to pump rotary mud downward through the drill pipe, which rotary mud issues from openings such as indicated at 20 in the bit 11, and this rotary mud thereafter flows upward through the well to the surface of the ground and performs the valuable functions of carrying the cuttings to the surface of the ground, preventing cave-ins of the walls of the well, and when an oil formation or gas formation is penetrated in holding back the pressure. This rotary mud is pumped by means of a slush pump 21 and flows through a stand pipe 22 and a flexible hose 23 to the swivel 17.

In the present advance stage of oil well drilling, wells are drilled very deep, it being common practice to reach 8000 and 9000 feet, and it is therefore necessary that the swivel be constructed to support enormous loads. It is likewise necessary to pump the rotary mud under relatively high pressures. Due to the fact that this rotary mud contains, as a large percentage of its volume, abrasive particles, the parts of the swivel must be designed so that any parts which wear can be easily replaced and so that suitable packing of relatively long life, and which may be readily replaced, is provided. It is furthermore desirable from the standpoint of efficiency that the swivel be designed so that in case repair is necessary the parts may be quickly taken apart, the repair or replacement work done, and then quickly assembled, in order that the well will not be taken out of service for any more than a minimum length of time.

It is the principal object of our invention to provide a swivel which is designed from the standpoint of construction and also of operation to meet the present and future requirements of the oil drilling industry.

It is an object of our invention to provide a rotary swivel in which the different bearings which support the rotating parts may be readily removed, repaired, and replaced in a minimum length of time.

It is an object of our invention to provide a rotary swivel in which the bearings will be provided with ample and efficient lubrication.

It is an object of our invention to provide a rotary swivel in which the stuffing box between the stationary and moving parts is so supported that it may be readily removed, repaired, and reinstalled.

It is an object of our invention to provide a rotary swivel in which the stuffing box between stationary and moving parts is so positioned that it will be efficiently cooled, thus increasing the life of the packing.

It is an object of our invention to provide a rotary swivel in which the wash pipe which cooperates with the stuffing box and which is ordinarily subjected to considerable wear may be readily and quickly replaced, thus keeping the rotary swivel out of service for but a minimum of time.

The foregoing objects set forth the more general and comprehensive objects and advantages of the invention. There are, however, many features and objects which reside in certain preferred details of construction and arrangements of parts and which are too numerous to set forth at this point, but will be pointed out in the course of the detailed description of our invention which is to follow.

Referring to the accompanying drawings which show preferred and alternative forms of our invention:

Fig. 1 is a utility view (which has already been described) illustrating the utility of our invention.

Fig. 2 is an elevational view partly in section showing the preferred form of our invention.

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 2.

Fig. 4 is a sectional view taken on the line 4—4 of Fig. 2.

Fig. 5 is a fragmentary elevational sectional view taken on the line 5—5 of Fig. 2.

Fig. 6 is a fragmentary vertical sectional view through the stuffing box of our invention and is taken on the line 6—6 of Fig. 3.

Fig. 7 is a fragmentary perspective view of a lantern or spacer part employed in the stuffing box of our invention.

Fig. 8 is a fragmentary view similar to Fig. 6, and showing an alternative packing arrangement which may be employed in our invention.

Referring to the drawings in detail, and particularly to Figs. 2 to 5 inclusive, we provide the swivel 17 with a body consisting of an upper section 30 and a lower section 31. The upper section 30 consists essentially of a cylindrical portion 32 having an outwardly extending flange 33. The lower section 31 is essentially of cup shape having a lower wall 34, a side wall 35, and an upper flange 36 which engages the flange 33 on the upper section 30. These two parts are secured together by bolts 37 which extend through openings provided in the flanges 33 and 36 and in the bottom wall 34. These bolts have nuts 38 on the lower ends thereof and thereafter the two sections 30 and 31 may be separated by removing the nuts 38 from the bolts 37. The swivel is supported by means of a stirrup or yoke 40 which is pivotally mounted on pins 41 secured to the upper section 30.

Rotatably supported within the body is a spindle 43, the lower end of which is connected to the kelly 14. The spindle 43 is rotatably supported by a bearing arrangement which will now be described. For carrying the weight of the spring of drill pipe there is provided a thrust bearing 44. This thrust bearing is supported by the lower section 31 of the body which has a horizontal face 45 on which the thrust bearing rests and has a cylindrical concentric shoulder 46 which holds the thrust bearing in a concentric position. The spindle 43 has an outwardly extending shoulder 48 which engages the thrust bearing 44 and by means of which the weight of the drill pipe is transferred to the thrust bearing.

For the purpose of restraining the spindle 43 from radial or lateral movement, a lower radial bearing 50 and an upper radial bearing 51 are provided. The lower radial bearing surrounds a cylindrical face 53 of the spindle 43 and engages an inner cylindrical face 54 provided in the lower part of the upper section 30. There is a shoulder 55 on the spindle 43 below the cylindrical face 53 and there is a shoulder 56 above the cylindrical face 54 of the section 30. The upper radial bearing surrounds a cylindrical face 59 provided by the spindle 43 and engages an internal cylindrical face 60 provided at the upper end of the section 30. There is a shoulder 61 provided by the upper section 30 at the lower end of the internal cylindrical face 60. To prevent relative vertical movement between the spindle 43 and the body we provide a hold-down bearing 63 which is positioned between the shoulder 48 and a shoulder 64 provided by the upper section 30 immediately below the internal cylindrical face 54.

The bearings 44, 50, and 63 are all removable from the lower part of the body and the bearing 51 is removable from the upper part thereof. This particular arrangement of the bearing enables the upper section 30 to be relatively reduced in size and at the same time amply strong, and enables the rotary swivel as a whole to be made considerably smaller than the swivels in use at the time our invention was developed.

A seal is formed around the lower end of the spindle 43 by means of a lower cover 66 which is secured to the lower section 31 and which carries suitable oil seal parts 67. A seal is formed at the upper end of the spindle 43 by means of a swivel body cover 68 secured to the upper section 30 by studs 69, and which carries a suitable oil seal member 70.

The body is designed so that it may contain ample lubricant for the various bearings. The upper section is provided with an opening through it which is of sufficient size to receive the spindle 43 and at the same time provide an oil chamber 72 which carries ample lubrication for the radial bearings 50 and 51. The lower section 31 is cup shaped, as pointed out heretofore. It therefore provides a relatively large chamber 73 which carries a larger volume of lubricant so that the thrust bearing which carries the weight of the drill pipe may receive its proper amount of lubrication. The lubricant is delivered to the chambers 72 and 73 which cooperate to provide the lubricant chamber of the swivel through a passage 74 which is formed in the cylindrical wall 32 of the upper section 30. The lower end of the passage 74 is connected to the chamber 73, and the upper end thereof is connected to an opening 75 formed in the swivel body cover 68 and which is closed by a suitable plug 76. This filling passage is extended relatively high in order that the oil level may be maintained above the upper radial bearing 51.

The chamber 73 is designed so that the thrust bearing 44 is at the inner part thereof. When the parts are in operation the centrifugal force tends to throw the oil outwardly. It will be noted, however, that the chamber 73 is provided with an annular pocket 78 which is below the moving parts of the thrust bearing 44. As shown in Fig. 4, the chamber 73 is divided into sections by means of the inwardly extending webs 79 and the walls 80 which define the passages through which the bolts 37 extend. The pocket 78 which is thus divided into sections provides a sediment receptacle into which any sediment or foreign matter in the oil may settle out of circulation and not be returned to the bearings. When the lower section has been removed from the upper section the interior of the chamber 73 is readily accessible and the pocket 78 may at that time be cleaned.

Secured to the upper end of the spindle 43 is a wash pipe 85. The wash pipe 85 has a lower end 86 which extends into a counterbore of the spindle, and it also has a flange 87 through which a securing stud 88 extends. The wash pipe 85 therefore is secured to the spindle 43 and rotates therewith. The wash pipe 85 is at its upper end in communication with a gooseneck 90 and to prevent leakage between the rotating wash pipe 85 and the non-rotating gooseneck 90 a stuffing box 91 is provided.

Extended upward from the swivel body cover 68 is a plurality of arms 92 which supports a ring 93 at the upper end. The arms 92 and the ring 93 constitute what we term a "bridge". As best shown in Fig. 6, the ring 93 has a central opening 95 and a counterbore 96. Supported by the ring 93 is a stuffing box housing 97. The stuffing box housing 97 has a flange 98 at its upper end which rests in the counterbore 96 and has a cylindrical wall 99 immediately therebelow which engages the wall defining the opening 95. To prevent the stuffing box housing from rotating the flange 98 is provided with depressions 100 through which securing studs 101 extend.

The engagement of the faces forming the depressions 100 with the studs 101 prevents the stuffing box housing from rotating. The lower end of the stuffing box housing is provided with heat radiating fins 103. The gooseneck 90 has a flange 104 which rests above the ring 93 and engages the upper end of the stuffing box housing 97. The studs 101 extend through openings in the flange 104 and the parts are secured together by nuts 105 screwed onto the upper ends of the studs. When it is desired to disassemble the stuffing box arrangement the nuts 105 are removed, the gooseneck is removed by moving it upward, and thereafter the stuffing box housing may be removed by pulling it upward through the opening 95. This exposes the wash pipe 85 and permits its removal. It will be seen that these parts may be disassembled and assembled without disturbing the spindle or body of the rotating swivel. Other than described, the gooseneck 90 is made in accordance with standard practice and the rotary hose 23 is connected thereto as shown in Fig. 1.

In the preferred form of our invention we employ a packing arrangement as illustrated in Fig. 6. An alternative form of packing which may be used is illustrated in Fig. 8.

Referring to Fig. 6, the stuffing box housing 97 is of larger internal diameter than the external diameter of the wash pipe 85. The lower end of the stuffing box housing 97, however, has an inwardly extending wall 107. The flange 104 of the gooseneck 90 is provided with a passage of substantially the same diameter as the space provided within the stuffing box housing 97 and at the upper end thereof there is a shoulder 108. There is therefore provided around the upper end of the wash pipe 85 a packing chamber 109 in which the preferred form of packing of our invention is placed.

The upper face of the inwardly extending wall 107 is provided with an annular channel 110, which channel has downwardly converging walls which blend into a curved bottom wall. Placed in the packing chamber immediately above the inwardly extending wall 107 and extending into the channel 110 is a packing element 111 which is completely annular or ring shaped and which is of V-shaped or chevron shaped cross-section. The packing element has a pair of upwardly diverging walls 112 which have end faces 114 which are substantially of cylindrical shape so that the end walls 114 engage the outer wall of the wash pipe 85 and the inner wall of the stuffing box housing 97. Placed above the packing element 111 is a spacer or lantern 116. As shown best in Fig. 7, the spacer 116 has a lower annular part of V-shaped cross-section 117 which fits against the upper faces of the walls 112 and has an upper annular portion 118 which provides an upwardly exposed channel 119 which is of substantially the same shape as the channel 110. The portions 117 and 118 are connected together by a relatively thin vertical wall 120 having openings 121 therein. The upper section 118 has vertical channels 123 cut in the opposite sides thereof to permit free passage of grease. Placed above the spacer 116 is a plurality of packing elements 126 which are of the same construction as packing element 111. Placed above the packing elements 126 is a spacer or lantern 127 which is of the same construction as the spacer or lantern 116. Placed above the spacer 127 is a plurality of packing elements 129, each of which is of the same construction as the packing elements 111 and 126. Placed above the packing elements 129 is a follower 130 which is of V-shaped cross-section at its lower end so that it fits in between the walls of the uppermost packing element 129 tending to hold it against the walls defining the packing chamber 109. Compressed between the follower 130 and the shoulder 108 is a spring 132. The purpose of this spring 132 is to force the entire packing construction starting with the follower 130 downward against the inwardly projecting wall 107 in order that the packing elements will be held in proper packing position; namely, with the end faces 114 of the side walls 112 of the packing elements 111, 126, and 129 in engagement with the two cylindrical surfaces defining the side walls of the packing chamber 109. Adjacent the spacer 116 and the spacer 127 grease passages 135 and 136, respectively, are provided in the stuffing box housing 97. Suitable grease nipples, such as Alemite fixtures 137 and 138, are screwed into the passages 135 and 136 so that grease may be introduced but will be prevented from leaking from the stuffing box. It will be seen that the passages 135 and 136 communicate with grease pockets 140 and 141 provided by the spacers 116 and 127. When grease is introduced into the upper grease pocket 141 the pocket is first filled and thereafter grease will flow upwardly around and between the packing elements 129. The pressure, however, of the grease tends to force the packing elements 126 outwardly so that grease will not flow in a downward direction. When grease is forced into the lower pocket 140 the pocket is first filled and thereafter the grease is forced upwardly around the packing elements 126. It will be seen, therefore, that all of the space within the packing chamber 109 with the exception of that occupied by the various elements which have been described is filled with grease or other suitable lubricant which may be desired. The spring 132 holds the parts in proper operating position and performs its function until the rotary swivel is put into operation. When the slush pump 21, as shown in Fig. 1, is set into operation pressure is developed in the gooseneck 90 and the wash pipe 85. Rotary mud under pressure may flow through a small passage 145 into the upper end of the packing chamber 109 and press against the follower 130. It will therefore be seen that as the pressure of the rotary mud increases the force expanding the packing elements also increases. This increase in force is in direct proportion to the pressure of the rotary mud, and therefore when higher sealing characteristics are required they are automatically obtained. The pressure of the rotary mud may range between 1000 and 20,000 pounds.

As stated heretofore, the stuffing box body is provided with heat radiating fins, and therefore the temperature within the stuffing box will be maintained at a minimum. The packing may be replenished with grease at any time desired either during the operation of the rotary swivel or while it is out of service. This is possible due to the fact that the grease nipples 137 and 138 are mounted on a stationary part. The packing per se of the preferred form of our invention has been extensively used in the field and has proven to be highly satisfactory and of much longer life than those of the prior art. Even though wear occurs in the packing elements 111, 126, and 129, a seal is still maintained. This is due to the fact that the wear occurs at the faces 114 which engage the rotating wash pipe 85, and as this wear occurs the walls 111 swing downwardly and out-

wardly, thus automatically compensating for the wear. The parts will not become misplaced even though there is no rotary mud pressure due to the presence of the compression spring 132. The packing may be conveniently replaced by loosening the nuts 105, removing the gooseneck 90, and then removing the packing assembly. It is unnecessary to disturb any other parts of the device. If desired, the grease nipples 137 and 138 may be removed and the stuffing box housing lifted upwardly through the opening 95. In this way the packing parts may be very easily removed and replaced. At this time free access is had to the wash pipe and the wash pipe may be disconnected from the spindle 43 by removing the nuts from the studs 88 and lifted upwardly through the opening 95.

In the alternative form of packing all parts are of the same construction and the same numerals are applied except as follows. The lower end of the stuffing box housing 97 is opened and is provided with internal threads 150 to receive a threaded gland 151 which is screwed upwardly around the wash pipe 85. Packing rings 153 are placed in the upper part of the packing chamber 109 and a lantern 154 is placed in the packing chamber below the rings of packing 153. This lantern provides a grease pocket 155 to which grease is supplied through a passage 156 formed in the stuffing box housing 97, there being a grease nipple 157 threaded into the passage 156. Placed below the lantern 154 are packing rings 159 which are engaged by the upper end of the gland 151. By screwing upwardly on the gland 151 the packing is compressed and the gland may be locked in a desired position by means of a lock nut 160. In this form of our invention the pressure is not automatically applied to the packing but must be manually applied by first loosening the lock nut 160 and thereafter screwing the gland 151 in an upward direction. This type of construction, however, has the other advantages of the general stuffing box arrangement.

We claim as our invention:

1. In a swivel of the class described, the combination of: a body comprising upper and lower separable parts; a spindle extending axially through said body and rotatably supported exclusively by said lower part; lower spacing bearings carried by said spindle and engaging said upper part, said spindle and said bearing means being removable downwardly from said upper part when said upper and lower parts are separated; and an upper bearing carried by said upper part and engaging said spindle, said upper bearing being removable upwardly from said upper part.

2. In a swivel of the class described, the combination of: a body comprising upper and lower separable parts; a spindle extending axially through said body and rotatably supported exclusively by said lower part; a hold-down bearing carried by said spindle and engaging a lower face of said upper part; a lower radial bearing carried by said spindle and engaging said upper part; and an upper radial bearing carried by said upper part and engaging said spindle, said spindle, said hold-down bearing, and said lower radial bearing being removable downwardly from said upper part when said parts are separated. and said upper radial bearing being removable upwardly from said upper part.

3. In a swivel of the class described, the combination of: a two part body comprising upper and lower separable parts; a spindle extending axially through said parts; a thrust bearing carried within said lower part; a flange portion on said spindle and carried by said thrust bearing whereby said spindle is rotatably supported by said lower part; a hold-down bearing carried on said flange portion and engaging a lower face of said upper part; a lower radial bearing carried by said spindle and engaging an inner annular wall of said upper part; and an upper radial bearing carried by said upper part and engaging said spindle, said spindle, said hold-down bearing and said lower radial bearing being removable downwardly from said upper part and said upper radial bearing being removable upwardly from said upper part.

4. In a swivel of the class described, the combination of: a two part body comprising upper and lower separable parts, said lower part having walls forming an oil chamber; a thrust bearing within said chamber; a spindle extending axially through said body and having a flange portion engaging said thrust bearing whereby said spindle is rotatably supported solely by said lower part; and walls forming sediment pockets in the lower wall of said chamber and positioned radially outward from said thrust bearing, said sediment pockets being accessible for cleaning when said parts are separated.

5. In a swivel of the class described, the combination of: a two part body comprising upper and lower separable parts, said lower part having walls forming an oil chamber; a thrust bearing within said chamber; a spindle extending axially through said body and having a flange portion engaging said thrust bearing whereby said spindle is rotatably supported solely by said lower part; walls forming sediment pockets in the lower wall of said chamber and positioned radially outward from said thrust bearing, said sediment pockets being accessible for cleaning when said parts are separated; and sealing means between said lower part and said spindle below said oil chamber.

6. In a swivel of the class described, the combination of: a spindle rotatably supported in a stationary body and projecting upwardly therefrom; a wash pipe carried on the upper end of said spindle and rotatable therewith; a bridge comprising a lower plate supported by said body and an upper ring spaced from said lower plate by a plurality of legs, said ring supporting a gooseneck for delivering fluid into said wash pipe; and a packing housing surrounding said wash pipe and having a flange confined between said ring and said gooseneck for the support thereof, said packing housing extending downwardly from said upper ring and being exposed to the air for cooling.

7. In a swivel of the class described, the combination of: a spindle rotatably supported in a stationary body and projecting upwardly therefrom; a wash pipe carried on the upper end of said spindle and rotatable therewith; a bridge comprising a lower plate supported by said body and including sealing means engaging said spindle to seal the space between said spindle and said body, and an upper ring spaced from said lower plate by a plurality of legs, said ring supporting a gooseneck for delivering fluid into said wash pipe; and a packing housing surrounding said wash pipe and having a flange confined between said ring and said gooseneck for the support thereof, said packing housing extending downwardly from said upper ring and being exposed to the air for cooling.

8. In a rotary swivel, the combination of: an

upper body section having an opening, a lower shoulder near the lower part thereof, and an upper shoulder near the upper end thereof; a lower body section adapted to be secured to said upper body section and providing a chamber; a rotatable spindle extending into said opening and said chamber; a thrust bearing in said chamber for taking the thrust of said spindle; and upper and lower radial bearings for said spindle and being respectively in engagement with said lower and upper shoulders.

9. In a rotary swivel, the combination of: an upper body section having an opening, a lower shoulder near the lower part thereof, and an upper shoulder near the upper end thereof; a lower body section adapted to be secured to said upper body section and providing a chamber; a rotatable spindle extending into said opening and said chamber; a thrust bearing in said chamber for taking the thrust of said spindle; upper and lower radial bearings for said spindle and being respectively in engagement with said lower and upper shoulders; and a hold-down bearing for said spindle positioned between said thrust bearing and said radial bearings.

10. In a rotary swivel, the combination of: a body providing a chamber having an upper elongated small cross-sectional portion and a lower enlarged portion; a spindle extending into said chamber; a thrust bearing supported in said lower enlarged portion of said chamber for supporting said spindle; and a pair of spaced radial bearings for said spindle positioned in said upper small cross-sectional portion of said chamber.

11. In a rotary swivel, the combination of: a body providing a chamber having an upper elongated small cross-sectional portion and a lower enlarged portion; a spindle extending into said chamber; a thrust bearing supported in the lowermost part of said lower enlarged portion of said chamber for supporting said spindle; and a pair of spaced radial bearings for said spindle positioned in said upper small cross-sectional portion of said chamber.

12. In a rotary swivel, the combination of: a body providing a chamber having an upper elongated small cross-sectional portion and a lower enlarged portion; a spindle extending into said chamber; a thrust bearing supported in said lower enlarged portion of said chamber for supporting said spindle; a pair of spaced radial bearings for said spindle positioned in said upper small cross-sectional portion of said chamber; and a hold-down bearing for said spindle positioned between said upper and lower portions of said chamber.

13. A combination as defined by claim 12 in which said spindle has a shoulder of larger cross-sectional size than said upper portion of said chamber, and which is engaged by said thrust and hold-down bearings.

14. In a swivel of the class described, the combination of: a spindle rotatably supported in a stationary body and projecting upwardly therefrom; a wash pipe carried on the upper end of said spindle and rotatable therewith; a bridge supported by said body and having a supporting wall spaced above said body; a gooseneck for delivering fluid into said wash pipe, supported by said supporting wall; and a packing housing surrounding said wash pipe and having a flange confined between said supporting wall and said gooseneck for the support thereof.

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