

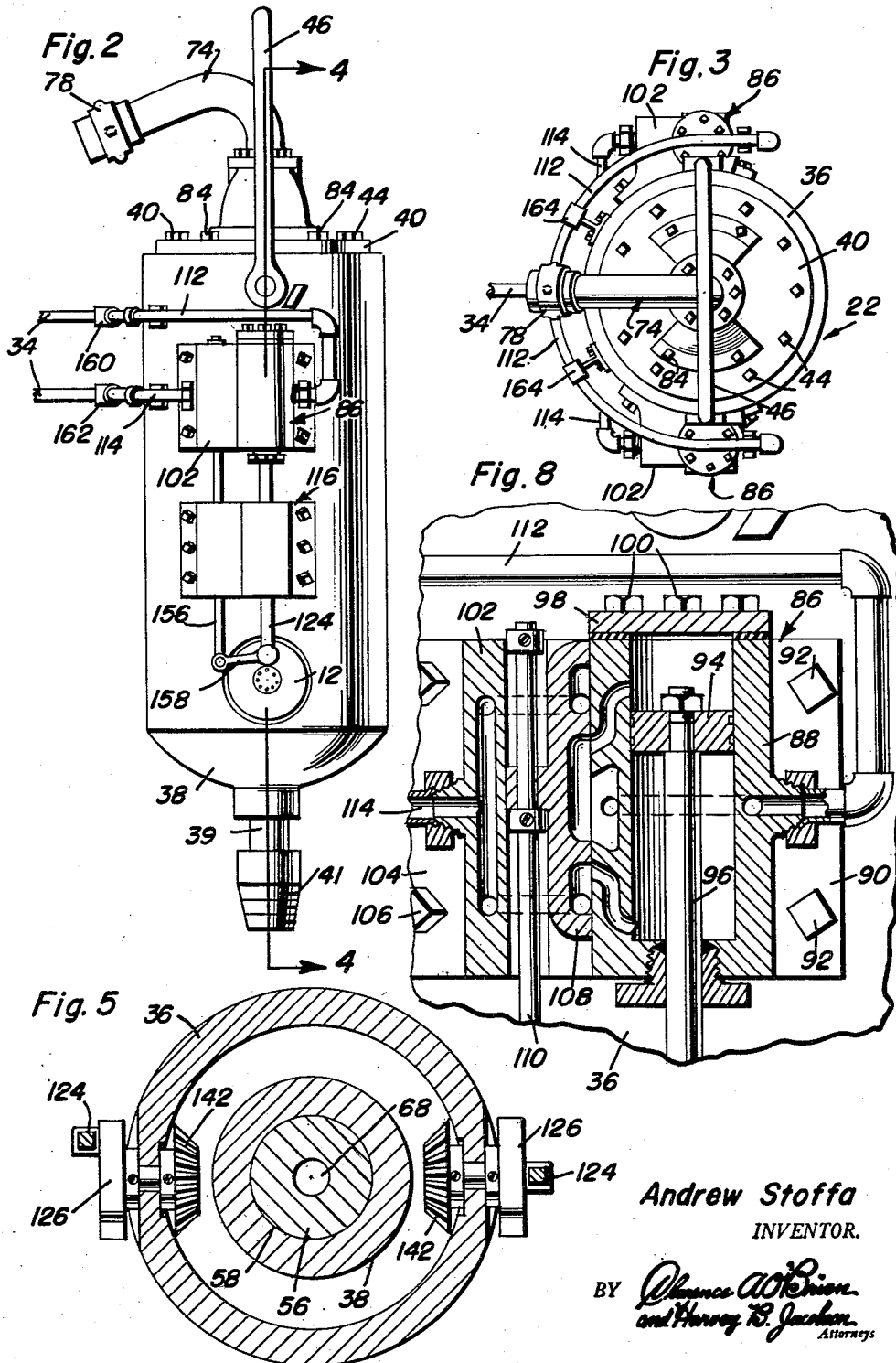
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A. STOFFA
POWER SWIVEL

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3 Sheets-Sheet 2



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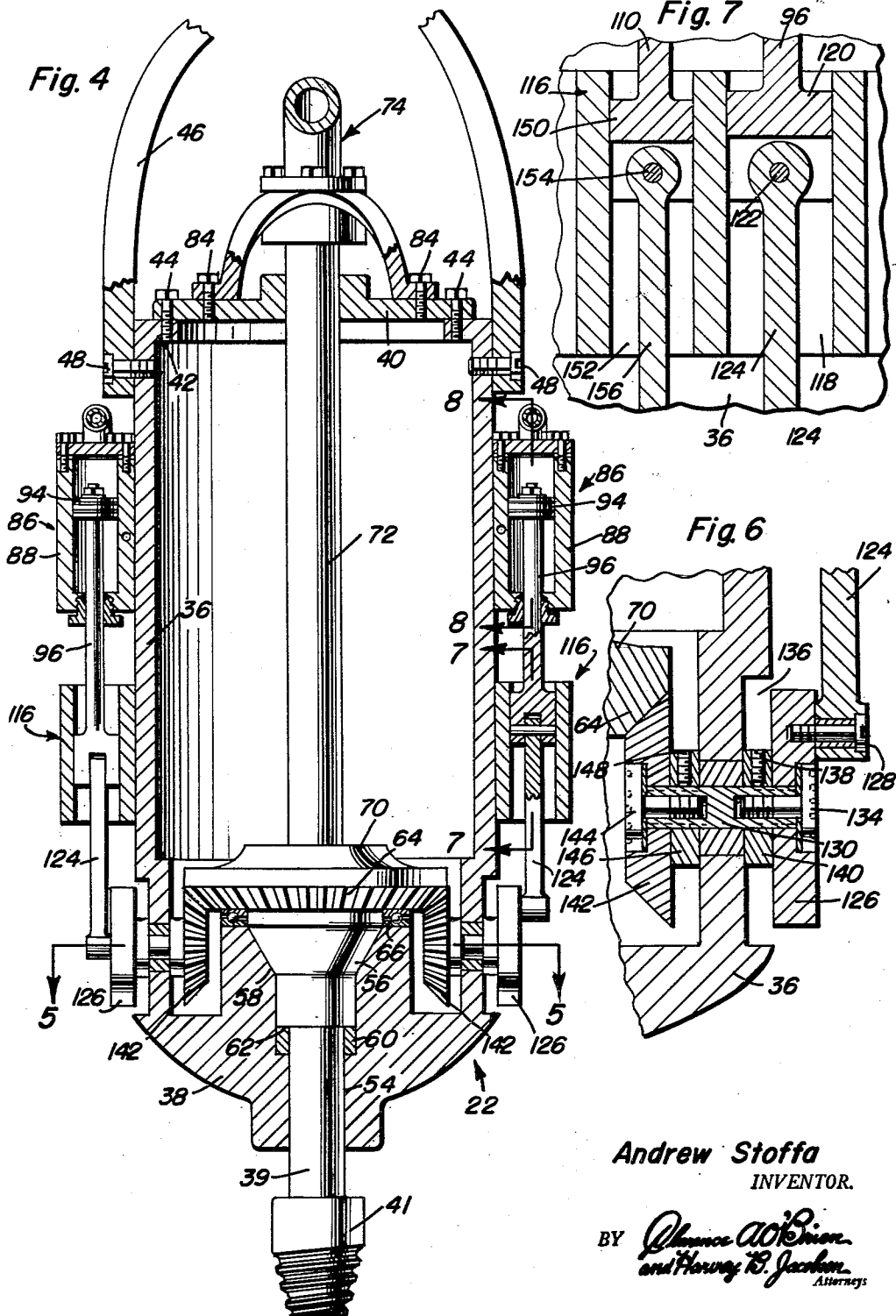
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1

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POWER SWIVEL

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3 Claims. (Cl. 255—35)

This invention relates in general to oil well derrick equipment, and more specifically to a power swivel for a Kelly shaft.

The primary object of this invention is to provide an improved power swivel for a Kelly shaft, said power swivel having associated therewith drive means for selectively rotating a Kelly shaft independently of rotation of the Kelly shaft by a rotary table during a drilling operation whereby the Kelly shaft may be utilized for setting and breaking strings of drill rods.

Another object of this invention is to provide an improved power swivel for a Kelly shaft whereby the Kelly shaft may be utilized in the drilling of rat holes and mouse holes during the initial setting up operation of an oil well derrick so as to reduce the time normally required for the setting up of an oil well derrick.

Another object of this invention is to provide an improved rotary drive means for a Kelly shaft, said rotary drive means being of a relatively simple construction and formed of readily attainable materials whereby the same is relatively inexpensive.

Another object of this invention is to provide an improved Kelly shaft construction which is so designed whereby the Kelly shaft may be utilized for the lifting and setting of drill rods in place in order that the Kelly shaft need not be disconnected from the hook of a traveling block each time it is necessary to insert a new drill rod in a drill string.

A further object of this invention is to provide an improved Kelly shaft which has associated therewith a housing rotatably supporting the Kelly shaft, said housing having mounted thereon drive means for selectively rotating the Kelly shaft whereby the Kelly shaft may be utilized either in a minor drilling operation or in the setting and breaking of joints between drill rods of a drill string.

A still further object of this invention is to provide an improved method of setting new drill rods in a drill string, said method eliminating the removal of the Kelly shaft from a traveling block as well as eliminating the use of elevators.

With these objects definitely in view, this invention resides in certain novel features of construction, combination and arrangement of elements and portions as will be hereinafter described in detail in the specification, particularly pointed out in the appended claims, and illustrated in the accompanying drawings which form a material part of this specification, and in which:

Figure 1 is a front elevational view of a portion of an oil well derrick in which the improved power swivel, which is the subject of this invention, is utilized, the power swivel being illustrated with the attached Kelly shaft thereof in its lowermost position during a drilling operation;

Figure 2 is an enlarged elevational view of the power swivel of Figure 1 and shows the general outline of one side thereof;

Figure 3 is a top plan view of the power swivel of Figure 1 and shows the arrangement of motors for rotat-

2

ing the Kelly shaft carried thereby, the hook and traveling block being omitted;

Figure 4 is an enlarged fragmentary longitudinal vertical sectional view taken substantially upon the plane indicated by the section line 4—4 of Figure 2 and shows the internal construction of the housing of the power swivel and the connection between fluid motors and the swivel shaft for rotating the same;

Figure 5 is a transverse horizontal sectional view taken substantially upon the plane indicated by the section line 5—5 of Figure 4 and shows the manner in which drive pinions are disposed within the lower end of the housing;

Figure 6 is an enlarged fragmentary vertical sectional view taken substantially through the center of a drive shaft for one of the pinions and shows the manner in which the same is mounted on the drive shaft and the relationship of a driving pitman connection;

Figure 7 is an enlarged fragmentary vertical sectional view taken substantially upon the plane indicated by the section line 7—7 of Figure 4 and shows the relationship of a piston and its associated piston rod, and a slide valve and its associated slide rod; and,

Figure 8 is an enlarged fragmentary vertical sectional view taken substantially upon the plane indicated by the section line 8—8 of Figure 4 and shows the relationship of a slide valve with respect to a cylinder of one of the fluid motors for rotating the swivel shaft.

Similar characters of reference designate similar or identical elements and portions throughout the specification and throughout the different views of the drawings.

In the normal drilling operation of an oil well, a Kelly shaft is usually attached to the upper end of an uppermost drill rod in a drill string with the Kelly shaft being disposed within a bushing of a rotary table. The Kelly shaft is rotated by the bushing and is slidable therethrough as the drill string progresses downwardly during the drilling operation. After the kelly has moved downwardly until its upper end is just above the bushing of the rotary table, the kelly, which is attached to a traveling block by a swivel, is then lifted together with the drill string until the upper end of the uppermost drill string is above the level of the rotary table. At this time the drill string is retained in an elevated position by suitable slips and the Kelly shaft uncoupled from the uppermost drill rod by a laborious operation.

After the Kelly shaft has been removed from the uppermost drill rod section, the same is swung out of alignment with the same and deposited within a rat hole drilled into the ground adjacent the main bore of the oil well. The swivel is then uncoupled from the hook and elevators carried by the traveling block are utilized. The elevators then grasp another section of drill rod and through the use of the traveling block the section of drill rod is elevated until its lower end is in alignment with the upper end of the uppermost drill rod section. The two drill rod sections are then coupled together in the same laborious manner in which the Kelly shaft was uncoupled from the uppermost drill rod section.

After the drill rod sections have been coupled together, the elevators are swung to one side of the hook and the swivel is once again coupled to the kelly which is then connected to the drill string by attachment to the new drill rod section. The slips are then removed and the entire drill string and the Kelly shaft are once again lowered into the oil well and the drilling operation continued.

Inasmuch as the coupling and uncoupling of drill rod sections is a laborious task, it is desirable to provide means for quickly and easily accomplishing this task. Therefore, it is the purpose of this invention to provide a power swivel for selectively rotating the Kelly shaft to facilitate the coupling and uncoupling of the same with drill rod sec-

3

tions and the coupling and uncoupling of drill rod sections connected to the Kelly shaft.

Referring now to Figure 1 in particular, it will be seen that there is illustrated a lower portion of an oil well rig which includes an oil well derrick which is referred to in general by the reference numeral 10. Carried by the oil well derrick 10 is a work platform 12 in which is mounted a rotary table 14. Also mounted on the work platform 12 is a motor unit 16 which is operatively connected to the rotary table 14 for rotating the same. Carried by the rotary table 14 and rotating therewith is a Kelly bushing 18 which has a square opening therethrough. Slidably mounted within the Kelly bushing 18 and rotatable therewith is a Kelly shaft which is referred to in general by the reference numeral 20. The Kelly shaft is supported by a power swivel, which is the subject of this invention, the power swivel being referred to in general by the reference numeral 22. The power swivel is supported by a hook, which is referred to in general by the reference numeral 24 which is in turn supported by a traveling block 26. The traveling block 26 is moved vertically by a line 28 mounted on a winch 30 driven by the power unit 16. Operatively connected to the power swivel 22 are a mud hose 32 and a pair of fluid lines 34.

It will be understood that all of the elements of the oil well drilling rig mentioned above are conventional with the exception of the power swivel 22. The drilling rig also includes elevators 35 connected to the hook 24 by bail 37.

Referring now to Figure 4 in particular, it will be seen that the power swivel 22 includes a cylindrical body portion 36 which is closed at its lower end by a thickened bottom 38. The upper end of the cylindrical body portion 36 is closed by a removable annular plate 40, the plate being secured to an intumed annular flange 42 integral with the top of the cylindrical body portion 36 by a plurality of fasteners 44.

In order that the power swivel 22 may be carried by the swivel 24, there is connected to the upper portions of the cylindrical body portion 36 an inverted U-shaped bail 46. The bail 46 is connected to the cylindrical body portion 36 for pivotal movement by suitable fasteners 48.

The power swivel includes a swivel shaft 39 rotatably mounted in the thickened bottom wall 38 and depending therebelow. The lower end of the swivel shaft 39 is provided with an externally threaded adapter 41 which is coupled to a cylindrical upper portion 50 of the Kelly shaft 20. The Kelly shaft 20 also includes a lower portion 52 which is square in cross section and is retained for vertical sliding movement in the rotary bushing 18 which is detachable from the rotary table 14.

An upper portion of the swivel shaft 39 is circular in cross section and is rotatably mounted in a vertical bore 54 through the thickened bottom wall 38. The extreme upper end of the swivel shaft 39 is in the form of an enlarged head 56 which is disposed within an enlarged counterbore 58 in the thickened bottom wall 38. The upper end of the swivel shaft 39 is positioned by a spacer 60 carried in the bottom of the enlarged counterbore 58 and engaging a shoulder formed by the intersection of the enlarged head 56 with the circular cross sectional portion 39, the shoulder being referred to by the reference numeral 62.

Rigidly secured to the upper end of the enlarged head 56 is a horizontal bull gear 64. Carried by the upper end of the enlarged head 56 and disposed between the bottom surface of the bull gear 64 and the top surface of the thickened bottom wall 38 is a suitable thrust bearing 66 which supports and permits rotation of the swivel shaft 39.

In order that suitable drilling fluids may be pumped down into a drill string through the swivel shaft 39, the same is provided with an internal bore 68. The bore 68 opens through the upper end of the enlarged head 56 and communicates with a bore through a connecting plate 70 carried by the upper surface of the bull gear 64. Extend-

4

ing downwardly through the circular top plate 40 of the housing which forms a major portion of the power swivel 22 is a wash pipe 72. The wash pipe 72 communicates with the interior bore of the plate 70 and is connected to the plate 70 by a suitable rotatable joint. It will be understood that the plate 70 is intended to be rotated while the wash pipe 72 remains stationary.

The upper end of the fluid conduit is secured to a goose neck which is referred to in general by the reference numeral 74. The goose neck 74 has a free end thereof connected to the mud hose 32 and overlies the top plate 40 of the swivel 22. The goose neck 74 is secured to the top plate 40 by suitable fasteners 84.

In order that the swivel shaft 39 may be selectively rotated through rotation of the bull gear 64, there is mounted on the exterior of the body portion 36 diametrically opposite fluid motors which are referred to in general by the reference numeral 86. Each fluid motor is of a conventional design and includes a cylinder 88 which is provided with a mounting flange 90 secured to the cylindrical body portion 36 by suitable fasteners 92. Disposed within the cylinder 88 is a reciprocating piston 94 which has connected thereto a piston rod 96, the piston rod 96 passing out of the lower end of the cylinder 88 and being adapted for vertical reciprocatory movement. In order that the piston 94 may be conveniently removed, the cylinder 88 is provided with a suitable cylinder head 98 which is secured to the cylinder by suitable fasteners 100.

The fluid motor 86 also includes a slide valve housing 102 which may be formed integral with the cylinder 88. The slide valve housing 102 includes a flange 104 which permits the mounting of the same. The flange 104 is secured to the exterior surface of the cylindrical body portion 36 by suitable fasteners 106.

Mounted within the slide valve housing 102 is a suitable slide valve 108 which is actuated by a slide valve shaft 110. It will be understood that the slide valve controls the flow and exhaust of fluid respectively into and out of, the opposite ends in alternation of the cylinder 88 to reciprocate the piston 94. Therefore, there is connected to the slide valve housing 102 suitable inlet and outlet fluid lines 112 and 114, respectively. It will be understood that the fluid lines 112 and 114 are connected to the fluid motor 86 by conventional fittings.

Referring now to Figure 7 in particular, it will be seen that secured to the exterior surface of the cylindrical body portion 36 below the fluid motor 86 is a guide housing which is referred to in general by the reference numeral 116. The guide housing 116 is provided with a first guide sleeve portion 118 in which is disposed for vertical reciprocatory movement a guide element 120 which is mounted on the lower end of the piston rod 96. Pivotaly connected to the guide structure 120 by a pivot pin 122 is an upper end of a crank rod 124.

Referring now to Figure 6 in particular, it will be seen that the lower end of the crank rod 124 is connected to a drive wheel 126 in eccentric relation thereto by a suitable connecting pin 128. The drive wheel 126 is splined onto a drive shaft 130 which extends through the lower portion of the cylindrical body portion 36 and is rotatably mounted within a suitable bearing mounted therein. The drive wheel 126 is retained on the outer end of the drive shaft 130 by a suitable fastener 134.

In order that the drive wheel 126 may be spaced from the exterior surface of the cylindrical body portion 36, the outer surface of the cylindrical body portion is provided with a recess 136 in which the drive wheel 126 is partially disposed. Disposed within the recess 136 and removably secured to the drive shaft 130 by a set screw 138 is a spacing collar 140. The collar 140 spaces the drive wheel 126 from the exterior surface of the cylindrical body portion 36 and permits free rotation of the same.

Mounted on the inner end of the drive shaft 130 and connected thereto by a spline connection is a beveled

5

pinion gear 142. The beveled pinion gear 142 is retained on the inner end of the drive shaft 130 by a suitable fastener 144. The beveled pinion gear 142 is spaced from the inner surface of the cylindrical body portion 36 by a suitable spacer 146 which is retained on the drive shaft 130 by a set screw 148.

As is best illustrated in Figure 4, the pinion gears 142 intermesh with the bull gear 64 for rotating the same.

Referring now to Figures 2 and 7 in particular, it will be seen that secured on the bottom end of the slide rod 110 is a guide member 150 which is slidably mounted within a guide sleeve 152 of the guide housing 116. Pivotaly connected to the slide assembly 150 by a pivot pin 154 is the upper end of a control rod 156. The lower end of the control rod 156 is connected to the lower end of the crank rod 124 by a link 158, see Figure 2. It will be understood that as the piston rod 96 is moved downwardly, the slide rod 110 is also moved downwardly due to the action of the link 158 whereby flow of fluids through the fluid motor 86 is reversed to cause a reversal of directional movement of the piston 94 and its associated piston rod 96.

It will be understood that there is one drive assembly, including a fluid motor 86, disposed on each side of the exterior surface of the cylindrical body portion 36. Inasmuch as the beveled pinions 142 associated with each drive unit are in opposed directions, it will be seen that the drive units will have to be controlled whereby the pinions will rotate in opposite directions to facilitate the rotation of the bull gear 64.

Referring now to Figures 2 and 3 in particular, it will be seen that the fluid lines 112 and 114 for the two fluid motors 86 are connected to the fluid lines 34 by suitable couplings 160 and 162, respectively. The fluid lines extend around the outer portion of the housing, which forms a major portion of the power swivel 22 and are supported therefrom by suitable mounting brackets 164.

It will be also noted that the goose neck 74 is provided at its free end with a suitable coupling 78. It is intended that the coupling 78 facilitate the connection of the goose neck 74 to the mud hose 32 in order that the same may be easily and quickly coupled to and uncoupled therefrom.

It will be understood that the extreme lower end of the Kelly shaft 20 is threaded for engagement with drill rods. During the drilling operation, the lower end of the Kelly shaft 20 is coupled to an uppermost drill rod section and the drill string and the Kelly shaft 20 is rotated by engagement of the Kelly bushing 18 with the polygonal cross-sectional portion 52 of the Kelly shaft 20.

Inasmuch as the Kelly shaft 20 is provided with means for rotating the same, it will be seen that the Kelly shaft may be selectively rotated to couple and to uncouple the same from sections of drill rods. This use of the Kelly shaft eliminates the required use of spinning chains (not shown) which normally resulted in a laborious operation for the coupling and uncoupling of the Kelly shaft with respect to drill rod sections.

When it is desired to uncouple the Kelly shaft 20 from a drill rod section (not shown) the Kelly shaft is merely rotated in the desired direction after the upper end of the drill rod section has been locked against rotation by suitable tongs. It will be understood that the tongs (not shown) are conventional oil well drilling equipment and need not be further described.

When utilizing the power swivel 22, which is the subject of this invention, a preferred method of installing a drill rod section is as follows. After the drill rod section has been lowered to a point whereby the upper end of the Kelly shaft 20 is adjacent the rotary bushing 18, the power swivel 22 and the attached Kelly shaft 20 are elevated through the use of the traveling block 26. This results in the entire drill string being lifted out of the well bore. After the lower end of the Kelly shaft 20 is positioned above the Kelly bushing 18, the drill string is anchored in its elevated position by conventional slips

6

(not shown). Then while holding the upper end of the uppermost drill rod section with a suitable pair of tongs, the Kelly shaft 20 is rotated through the use of the fluid motors 86 in a direction to uncouple the same from the upper end of the uppermost drill rod section.

After the Kelly shaft 20 has been uncoupled from the uppermost drill rod section, it is then swung into alignment with the next drill rod section (not shown) disposed in a mouse hole (not shown) and coupled thereto by rotating the same in the desired direction while holding the next drill rod section stationary through the use of tongs. After the Kelly shaft 20 has been connected to the next drill rod section, the Kelly shaft and the next drill rod section are elevated through the use of the traveling block 26.

The Kelly shaft 20 and the next drill rod section are then aligned with the uppermost drill rod section of the drill string and the lower end of the next drill rod section is coupled to the upper end of the uppermost drill rod section of the drill string by rotating the next drill rod section through the rotation of the Kelly shaft 20, the uppermost drill rod section being held stationary by suitable tongs. The drilling operation is then continued after the slips have been released and the drill string and the Kelly shaft have been lowered through the use of the traveling block 26.

It will be seen that the installation of drill rod sections in a drill string will be greatly hastened due to the fact that it is no longer necessary to uncouple the swivel from the hook carried by the traveling block each time it is desired to insert an additional drill rod section. Furthermore, it is no longer necessary to utilize elevators for lifting a new section of drill rod which is being inserted into the drill string.

It will be understood that while only the method of inserting a drill rod section into the drill string has been described in detail, that the power swivel 22 may also be utilized in the removal of a drill string. During the removal of a drill string, the operation is reversed.

In the cases of very high oil well derricks, a number of single drill rod sections may be coupled together into doubles, thribles or fourbles in the mouse hole through the use of the power swivel 22 prior to the insertion of the same as a unit into a hole being drilled, if it is so desired. Also, the power swivel 22 may be utilized in the drilling of both the mouse hole and rat hole normally found as parts of an oil well drilling assembly. These holes are normally drilled with the same drilling mechanism utilized to drill the main bore and require the shifting of heavy machinery. The drilling of these holes with the heavy machinery requires much valuable time which may be utilized in the actual drilling of the main bore. Therefore, it will be seen that the provision of the power swivel 22 provides a supplemental, portable drilling rig and thus hastens the oil well drilling operation by hastening the initial set-up of the oil well drilling rig.

The operation of this device will be understood from the foregoing description of the details thereof, taken in connection with the above recited objects and drawings. Further description would appear to be unnecessary.

Minor modifications of the device, varying in minor details from the embodiment of the device illustrated and described here, may be resorted to without departure from the spirit and scope of this invention, as defined in the appended claims.

What is claimed as new is as follows:

1. A power swivel for oil well derricks comprising a housing having a bottom wall and a suspension means, a rotatable swivel shaft journaled solely in said bottom wall and depending therefrom and having its lower end provided with a connector for attachment to a Kelly, said swivel shaft having a bull gear at the upper end thereof rotatably journaled on said bottom wall, drive shafts journaled on opposite sides of said housing and each having a pinion gear meshing with said bull gear, said

7

bottom wall having a recess providing clearances for said pinions, a pair of fluid motors including cylinders with pistons reciprocable therein and valves controlling the inlet and exhaust of pressure fluid for said cylinders, each fluid motor being mounted upon said housing, and means connecting each piston and valve to a drive shaft. 5

2. The combination of claim 1 wherein said connecting means includes guides secured to said housing and slides received in said guides, rods connecting each piston and each valve to a separate slide, and means connecting each slide to a drive shaft. 10

3. The combination of claim 1 wherein said connecting means includes guides secured to said housing and a slide received in each guide, each piston and each valve being connected to a separate slide, a rod connecting 15

8

each piston slide to a drive shaft, and each valve slide having means connecting it to one of said last mentioned rods.

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