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WELL DRILLING APPARATUS

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2 Sheets-Sheet 1

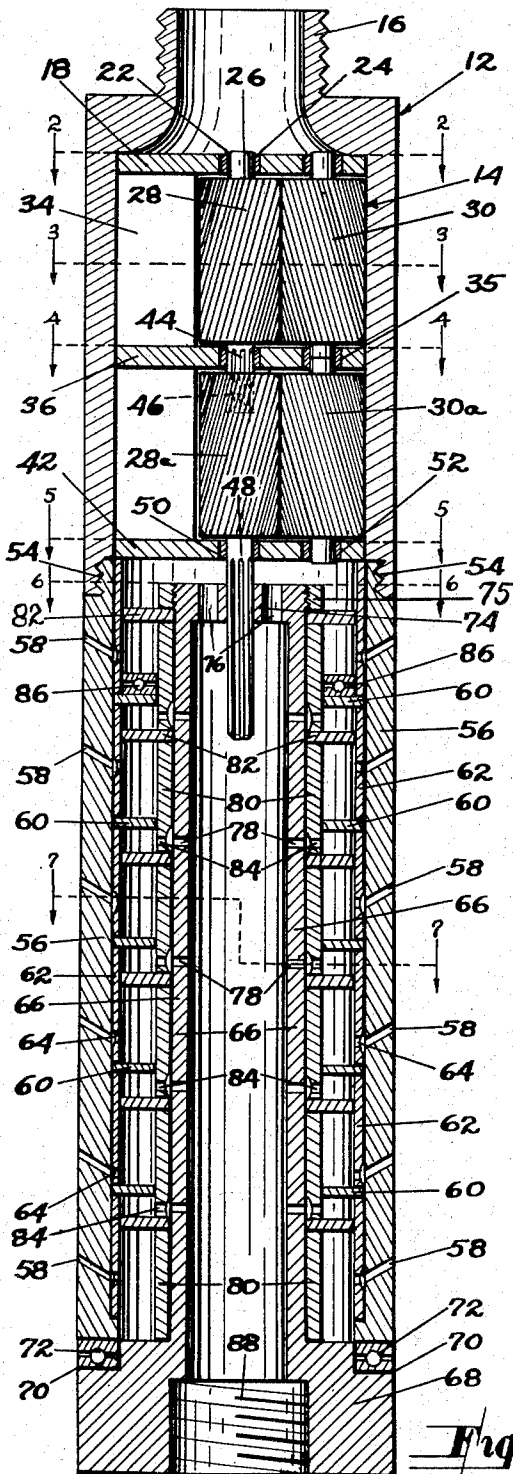


Fig. 1.

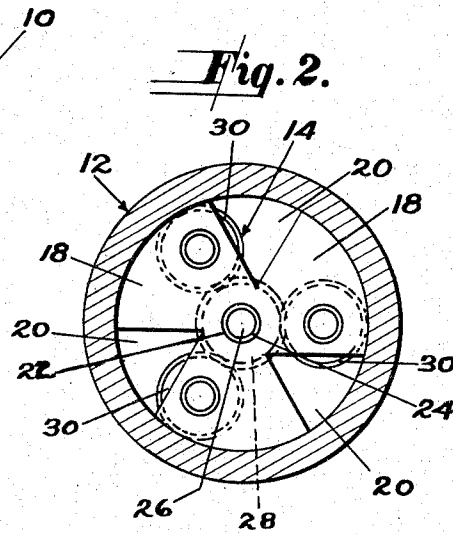


Fig. 2.

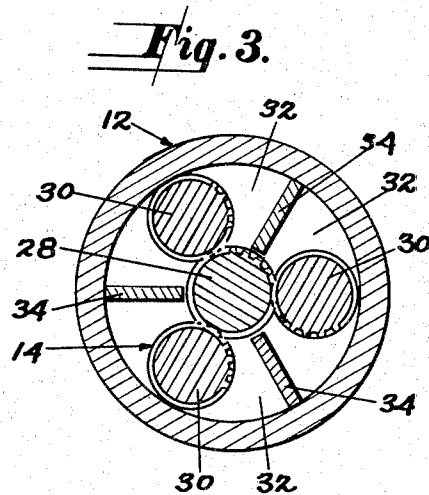


Fig. 3.

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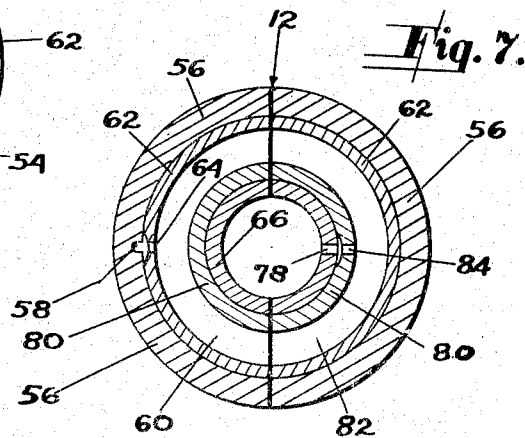
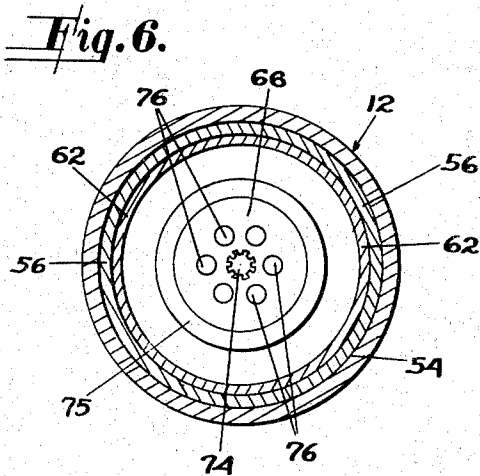
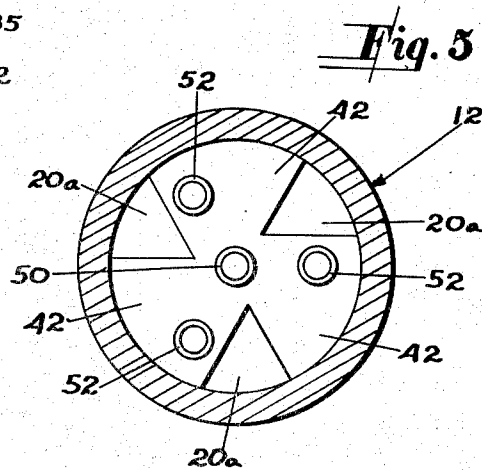
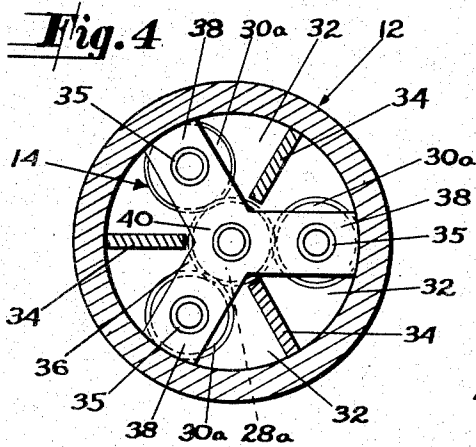
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WELL DRILLING APPARATUS

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4 Claims. (Cl. 255—4)

The present invention appertains to improvements in well drilling apparatus wherein mud or other fluid is pumped down through a hollow drill stem to operate a hydraulic turbine unit for driving the drilling bit and to wash the cuttings and particles upwardly to the surface, while, at the same time, shoring up the walls of the well bore.

A turbo-drill employed in well drilling is driven by mud or other fluid which is pumped down through the turbine unit from the top of the well. After passing through the turbine unit, the mud flows outwardly of the casing and picks up the cuttings and carries them upwardly to the surface between the drill pipe string and the walls of the well bore. The passage of the mud or other fluid through the turbine unit drives the bit at the bottom of the well.

A primary object of the present invention is to provide an improved fluid driven drive unit and a shock resistant drive connection between the hydraulic drive unit and the drill bit.

Another important object of this invention is to provide means for utilizing the mud or fluid, without detracting from the full use thereof to power the drive unit, for preventing undue wear and shock through the driving system.

A further important object of this invention is to provide a novel hydraulic bearing assembly for the bit shaft so that any shocks or impacts from the bit shaft are cushioned and not transmitted to the other parts of the mechanism and so that no downward hydraulic thrust is imposed directly on the shaft.

A still further important object of this invention is to provide a compact and sturdy type of drilling unit wherein the drive unit is connected directly with the bit shaft which is supported by a novel hydraulic bearing housing that is attached to the housing for the drive unit, which comprises multi-stage helical type gears.

Other and further objects and advantages of the invention will be understood from the following detailed description thereof.

In the drawings:

Figure 1 is a cross sectional elevation of a rotary drill.

Figure 2 is a section taken substantially along lines 2—2 of Figure 1, and in the direction of the arrows, and on an enlarged scale.

Figure 3 is a cross sectional view taken substantially along lines 3—3 of Figure 1.

Figure 4 is a cross sectional view taken substantially along lines 4—4 of Figure 1.

Figure 5 is a cross sectional view taken substantially along lines 5—5 of Figure 1.

Figure 6 is a cross sectional view taken substantially along lines 6—6 of Figure 1.

Figure 7 is a cross sectional view taken substantially along lines 7—7 of Figure 1.

While one embodiment of the invention is illustrated in the above-referred-to drawings, it is to be understood that they are merely for the purpose of illustration and that

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various changes in construction may be resorted to in the course of manufacture in order that the invention may be utilized to the best advantage according to circumstances which may arise, without in any manner departing from the spirit and intention of the device, which is to be limited only in accordance with the appended claims. And while there is stated the primary field of utility of the invention, it remains obvious that it may be employed in any other capacity wherein it may be found applicable.

Referring now more particularly to the accompanying drawings, the drilling unit 10 includes a tubular hydraulic motor housing 12, within which a hydraulic motor 14 is operatively mounted. The upper end of the housing 12 is formed with an externally threaded collar 16 for attachment to a drill tubing (not shown) through which mud or other fluid is pumped into the housing for driving the motor.

As shown in Figures 1 and 2, a partition wall or baffle plate 18 is transversely secured in the upper end of the housing 12 and is formed with circumferentially spaced triangular shaped openings 20. The openings may be of any shape. The center portion of the baffle plate 18 is formed with a centrally disposed aperture 22 housing a bearing 24 for the upper shaft end 26 of a centrally disposed rotary helical gear 28.

Rotatably mounted on equidistantly spaced fashion around the center gear 28 and in meshing engagement therewith are three similar helical gears 30. The gears 30 are rotatably journaled at their upper ends in the baffle plate 18 in the same way as the gear 28 is mounted in the plate. The gears are so positioned that, as shown in Figure 2, a portion of their periphery extends beyond the openings 20 so that the mud or fluid, passing down through the openings, engages the gears. In this respect, any number of gears 30 may be passed with the baffle plate 18 which is provided with openings 20 and mountings equal to the number of gears 30. The gears 30, as shown in Figure 3, are vertically mounted in chambers 32, which are defined by radially disposed, vertical baffles 34, and the gears are enmeshed with the center gear 28. In this respect, it will be noted from Figure 3 that all of the gears 30 coact together to rotate the center gear.

The lower shaft ends of the gear 28 and gears 30 are rotatably journaled in suitable bearing openings 35 formed in an intermediate bearing plate 36 which is secured transversely in the housing 12. The bearing plate 36 is of spider construction and includes a plurality of circumferentially spaced legs 38 that radiate from a common center juncture section 40. It will be noted that the baffles 34 extend down between the legs so that the chambers 32 are extended below the plate 36.

A lower baffle plate 42, shown in Figure 5, is positioned transversely in the housing 12 at the lower end thereof. The baffle plate 42 is constructed identical to the upper baffle plate 18. The openings 20a therein are out of vertical alignment with the openings 20 in the upper plate 18 so that a diversion of the mud or fluid is caused as it passes through the lower plate 42.

A second set of helical gears is vertically disposed between the bearing plate 36 and the lower baffle plate 42 and includes a center gear 28a and meshing gears 30a, similar to the gears 28 and 30. The gears 30 and 30a have stub shafts rotatably journaled in the same bearing sockets in the plate 36 and the gears 30a have stub shafts rotatably journaled in the lower baffle plate 42.

The center gear 28 has a lower splined shaft end 44 which fits within a splined socket 46 in the upper end of the center gear 28a. Thus, a multi-stage drive gearing is provided which consists of the upper gearing 28 and 30 and the lower gearing 28a and 30a. The center gear 28a has a splined shaft end 48 which extends

through a center opening 50 in the plate 42 to a point substantially below the plate while the gears 30a have shaft ends that are rotatably journaled in bearing sockets 52 in the plate 42.

The housing 12 has an internally threaded collar 54 which is threaded on the upper threaded end of a coaxially disposed casing 56. The annular wall of the casing 56 is formed with a plurality of axially spaced and circumferentially disposed outlet ports 58. The ports 58 are positioned at an upwardly diverging angle so that the fluid emerging therefrom will pass upwardly to cause an upwardly flushing action for carrying cuttings and the like particles upwardly in the well bore.

The casing 56 is provided at axially spaced points with radial, inwardly projecting bearing rings 60 and bearing sleeves 62 are concentrically arranged within the casing 56 and disposed intermediate the rings 60. The bearing sleeves 62 are provided with apertures 64 that are in registry with the outlet ports 58.

A tubular drill bit shaft 66 is rotatably arranged within the bearing rings 60, as will be described, and has a coaxially enlarged lower end 68 forming a shoulder 70. First roller or ball bearings 72 are interposed between the shoulder 70 and the lower end of the casing 56. The upper end of the tubular shaft is formed with a splined connection 74 to receive the splined shaft end 48 of the gear 28a. The upper end of the shaft is formed with a plurality of passages 76 for the downward flow of the mud or fluid and the annular wall of the shaft is formed with radial ports 78 for the escape of part of the mud or fluid. Some of the mud or fluid passes downward to the drill bit to lubricate and clean the bit.

As shown in Figures 1 and 7, annular bearing spacers 80 are circumposed on the shaft 66 between bearing rings 82 that extend radially from the shaft. The bearing spacers 80 are provided with ports 84 which are in registry with the ports 78 in the shaft. Suitable second roller or ball bearings 86 are provided adjacent the upper end of the shaft which is formed at its lower end with a threaded socket 88 to receive the drill bit unit. The bearings 86 are provided between the uppermost ring 60 and 82 to sustain the load when the shaft 68 is fully extended.

The bearing rings 60 carried by the casing act on the bearing spacers 80 while bearing rings 82 are carried by the shaft and, when the shaft rotates, the rings 82 bear against the sleeves 62.

From the above description, it will be noted that the shaft 66 is slidable within the casing 56, and further slidable on the splined shaft 48 of the gear 28a. In this manner a hydraulic or fluid-type bearing or cushion is maintained within the instant invention, to receive and cushion the shocks encountered in a drilling operation, and will not allow undue strain on the other parts of the mechanism.

A lock ring 75 is included and is threadedly secured to the shaft 66 for securing the bearing rings 82 and spacers 80 in position.

In operation, mud or other drilling fluid is caused to be passed into the instant device, and initially enters the motor housing 12, where it causes the gears therein to rotate, turning the central gear, which it will be noted, has splined connections on the end thereof, driving a secondary gear mechanism, and in turn rotating the bit shaft 66. As the fluid passes from the motor housing 12 into the tubular shaft 66, some of the fluid passes into the inside of the shaft, to be used for lubricating the drill bit, and also to be passed through the various ports and apertures contained within the tubular shaft and casing 56 to the outside of the casing, creating a flushing action for the removal of debris and cuttings, and also providing the necessary cushion for preventing undue wear and shock throughout the motor or driving system.

The exhaust ports 58 are not equally spaced, but from the bottom up get progressively further apart. This

gives the added advantage of a variable load hydraulic bearing as a part of the compression chambers and exhaust chambers become equalized when the ports 78 and 84 are aligned with the outlet ports 58 and apertures 64, thus relieving the load of the chamber, but still using the trapped fluid to absorb the shock of drilling operations. It should also be noted that while the tubular shaft 66 is completely telescoped from the casing 56, all ports 78 and 84 coincide (vent into same chamber) with outlet ports and apertures 58 and 64 in the same chamber, thus removing the downward hydraulic thrust from the tubular shaft 66.

Conventional bits transmit fluid through a jet or orifice thereby creating a differential pressure drop across the bit. Therefore, the pressure inside tubular shaft 66 will always be greater than the pressure in the well bore. When the tubular shaft 66 is completely collapsed in the casing 56 a series of chambers exists between bearing rings 60, as the upper limits of the chambers and bearing rings 82 as the lower limits thereof; the chambers being exposed to the pressure inside of the tubular shaft 66 through ports 78 and 84; whereas the series of chambers formed by bearing rings 60 as lower limits and bearing rings 82 as upper limits are exposed to the pressure in the well bore through apertures 64 and 58, thus creating the same pressure differential across the bearing rings as exists across the drilling bit. This pressure reacts against bearing rings 82 through bearing spacers 80 to the tubular shaft 66, causing the tubular shaft 66 to start telescoping in relation to the casing 56.

The downward thrust on the tubular shaft 66 is equal to the pressure differential in pounds per square inch across bearing rings 82 or bearing rings 60 times the area in square inches of bearing rings 82 or 60 times the number of chambers exposed to the pressure differential. By this means any downward thrust desired can be obtained by increasing the number of chambers or the pressure differential across the chambers. This same force is also transmitted through bearing rings 60 and bearing sleeve 62 to the casing 56 as an upward thrust so that it is not necessary that the openings 76 be restrictive.

As the tubular shaft 66 is telescoped downward bearing ring 82 of the uppermost chamber, between bearing ring 82, as the lower limit and bearing ring 60 as the upper limit, passes aperture 64 and port 58. Thus the pressure inside of the chamber is reduced to the pressure in the well bore because the fluid that enters through ports 78 and 84 is exhausted through apertures 64 and ports 58. Thus the pressure is the same across the bearing rings in this chamber and the downward thrust is relieved. This creates a dead chamber with bearing ring 82 as the upper limit and bearing ring 60 as the lower limit, except for the leakage of the drilling fluid around the bearing rings. The restriction in flow from this chamber and the chamber immediately above, due to the restriction to flow of the small apertures and ports will function as shock absorbers to cushion the shock due to drilling operations. As the tubular shaft is progressively telescoped downward the thrust of additional chambers is relieved. Since the apertures 64 and exhaust ports 58 are unequally spaced the pressure will be relieved in one chamber at a time so that the device functions as a variable lead hydraulic bearing.

From the foregoing specification, it will become apparent that the invention disclosed will adequately accomplish the functions for which it has been designed and in an economical manner, and that its simplicity, accuracy, and ease of operation are such as to provide a relatively inexpensive device, considering what it will accomplish, and that it will find an important place in the art to which it appertains when once placed on the market.

It is thought that persons skilled in the art to which the invention relates will be able to obtain a clear understanding of the invention after considering the de-

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scription in connection with the drawings. Therefore a more lengthy description is regarded as unnecessary.

Changes in shape, size, and arrangement of details and parts such as come within the purview of the invention claimed may be resorted to in actual practice, if desired.

What is claimed is:

1. In a well drilling fluid bearing, the combination which comprises an outer casing designed to be attached to a well string, an inner tubular shaft positioned in the casing, spaced therefrom, and mounted to telescope therein, longitudinally spaced bearing rings mounted on the tubular shaft and extended for engagement with the inner surface of the casing, longitudinally spaced bearing rings extended inwardly from the wall of the casing and extended for engagement with the outer surface of the tubular shaft, the bearing rings providing chambers between the tubular shaft and casing, the wall of the tubular shaft having spaced ports therethrough providing communicating means between the interior of the tubular shaft and chambers, and the ports being positioned whereby bearing rings extended from the tubular shaft are below the ports and bearing rings extended from the casing are above the ports, and the wall of the casing having spaced apertures therethrough, with the apertures providing communicating means between the chambers and well bore, the apertures through the wall of the casing being inclined upwardly to initiate upward flow of fluid in the well bore, a first ball bearing on the uppermost of the bearing rings extended inwardly from the casing and positioned to receive the uppermost bearing ring of the tubular shaft to take the final thrust resulting from downward or outward travel of the tubular shaft, and a second ball bearing mounted on a shoulder of an enlarged lower end of the tubular shaft and positioned to engage the lower end of the casing to take the final thrust load resulting from upward travel of the tubular shaft and being positioned whereby bearing rings extended from the casing are positioned below the apertures and bearing rings extended from the tubular shaft are positioned above the apertures.

2. In a well drilling fluid bearing, the combination which comprises an outer casing designed to be attached to a well string, an inner tubular shaft positioned in the casing, spaced therefrom, and mounted to telescope therein, longitudinally spaced bearing rings mounted on the tubular shaft and extended for engagement with the inner surface of the casing, and longitudinally spaced bearing rings extended inwardly from the wall of the casing and extended for engagement with the outer surface of the tubular shaft, the bearing rings of the casing being alternated with the bearing rings of the tubular shaft providing fluid chambers between the tubular shaft and casing, the wall of the tubular shaft having spaced ports therethrough, the ports providing communicating means between the interior of the tubular shaft and chambers and being positioned whereby bearing rings of the shaft are positioned below the ports and bearing rings of the casing are positioned above the ports, the wall of the casing having spaced upwardly inclined apertures therethrough and the spacing between the apertures increasing from the lower end of the casing upwardly, said apertures providing communicating means between the chambers and well bore and being positioned whereby bearing rings of the shaft are positioned above the apertures and bearing rings of the casing are positioned below the apertures, a first ball bearing positioned on the uppermost of the bearing rings extended inwardly from the casing and positioned to

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receive the uppermost bearing ring of the tubular shaft to take the final thrust of the tubular shaft in the outward and downward movement thereof, said tubular shaft having an enlarged lower end and said enlarged lower end having a drill bit receiving socket therein and a shoulder around the upper end, and a second ball bearing mounted on the shoulder of the enlarged lower end of the tubular shaft and positioned to engage the lower end of the casing to take the final thrust resulting from upward movement of the tubular shaft.

3. In a well drilling apparatus, the combination which comprises an elongated cylindrical casing, means for attaching the casing to a well string, a rotatable tubular shaft positioned in the casing and spaced therefrom, a fluid motor positioned in the casing and operatively connected to the tubular shaft for rotating the shaft, means for connecting a drill to the lower end of the shaft, longitudinally spaced bearing rings integrally connected to the tubular shaft and extended for sliding engagement with the inner surface of the casing, longitudinally spaced bearing rings integrally connected to and extended inwardly from the casing, the bearing rings of the casing being alternated with the bearing rings of the shaft and extended for sliding engagement with the outer surface of the shaft, the tubular shaft having ports in the wall thereof and the ports being positioned whereby bearing rings of the shaft are positioned below the ports and bearing rings of the casing are positioned above the ports, the casing having upwardly inclined apertures therein and said apertures being positioned whereby bearing rings of the casing are positioned below the apertures and bearing rings of the shaft are positioned above the apertures, the parts being arranged whereby fluid under pressure supplied to the tubular shaft passes through the ports of the shaft into the areas between the bearing rings of the shaft and casing driving the shaft outwardly and actuating the bearing rings thereof to force mud and the like through the upwardly inclined apertures of the casing into an area around the casing initiating upward flow of fluid from the casing, a first ball bearing mounted on the uppermost of the bearing rings extended inwardly from the casing and positioned to receive the uppermost of the bearing rings of the tubular shaft to take the final thrust load resulting from outward movement of the tubular shaft, and a second ball bearing mounted on the lower end of the tubular shaft and positioned to engage the lower end of the casing to take the load resulting from upward movement of the tubular shaft.

4. A well drilling apparatus as described in claim 3 wherein liners are positioned on the outer surface of the shaft and between the bearing rings, and also on the inner surface of the casing between the bearing rings thereof, the liners being positioned between the bearing rings, providing spacing and holding means of the rings.

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