

[54] **REMOTE CONTROL DIRECTIONAL DRILLING SYSTEM**

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[22] Filed: **Jan. 4, 1973**

[21] Appl. No.: **320,901**

[52] U.S. Cl. **175/73**

[51] Int. Cl. **E21b 7/04, E21b 9/34**

[58] Field of Search 175/61, 24, 26, 73, 231, 175/325, 398-400

[56] **References Cited**
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[57] **ABSTRACT**

According to the invention a downhole remote control directional drilling system uses a downhole motor to operate the drill bit and provide power to generate the electrical and hydraulic power used to operate the systems remote control guidance system and direct the drill bit. Also the remote control guidance system is controlled by receiving direction commands radiated down the drill pipe string by electromagnetic waves and the remote control guidance system transmits direction and direction control components of the remote control directional drilling system to the top of the well hole.

3 Claims, 3 Drawing Figures

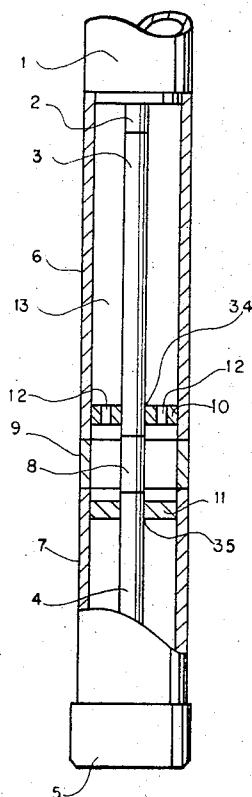
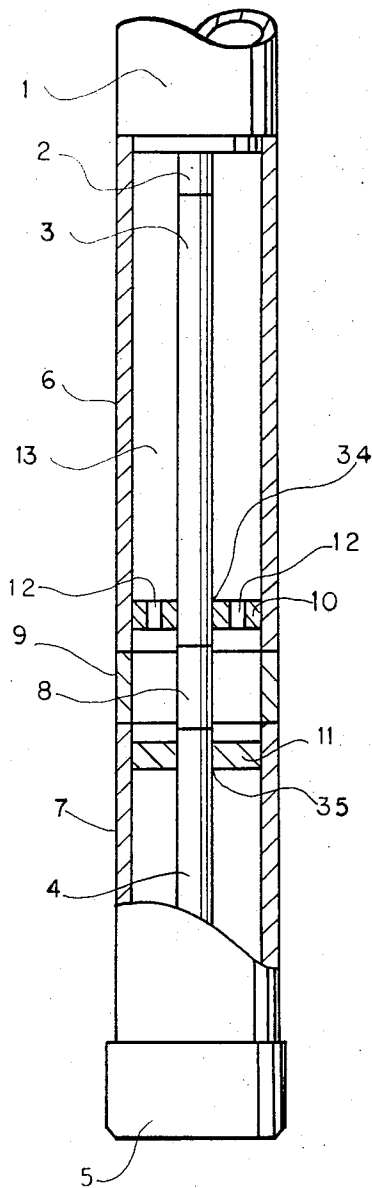


FIG. 1



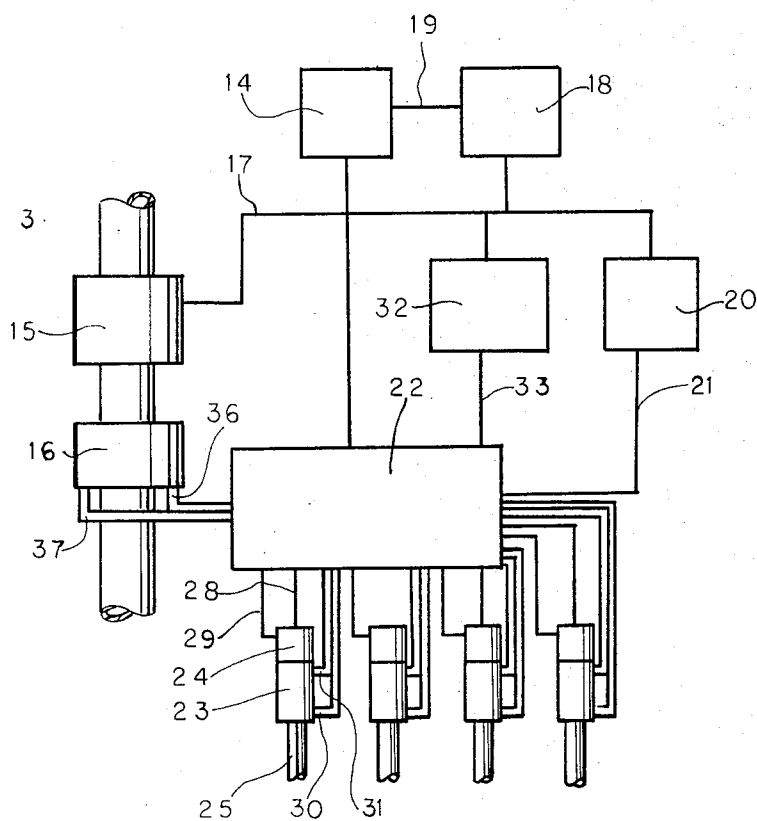


FIG. 2

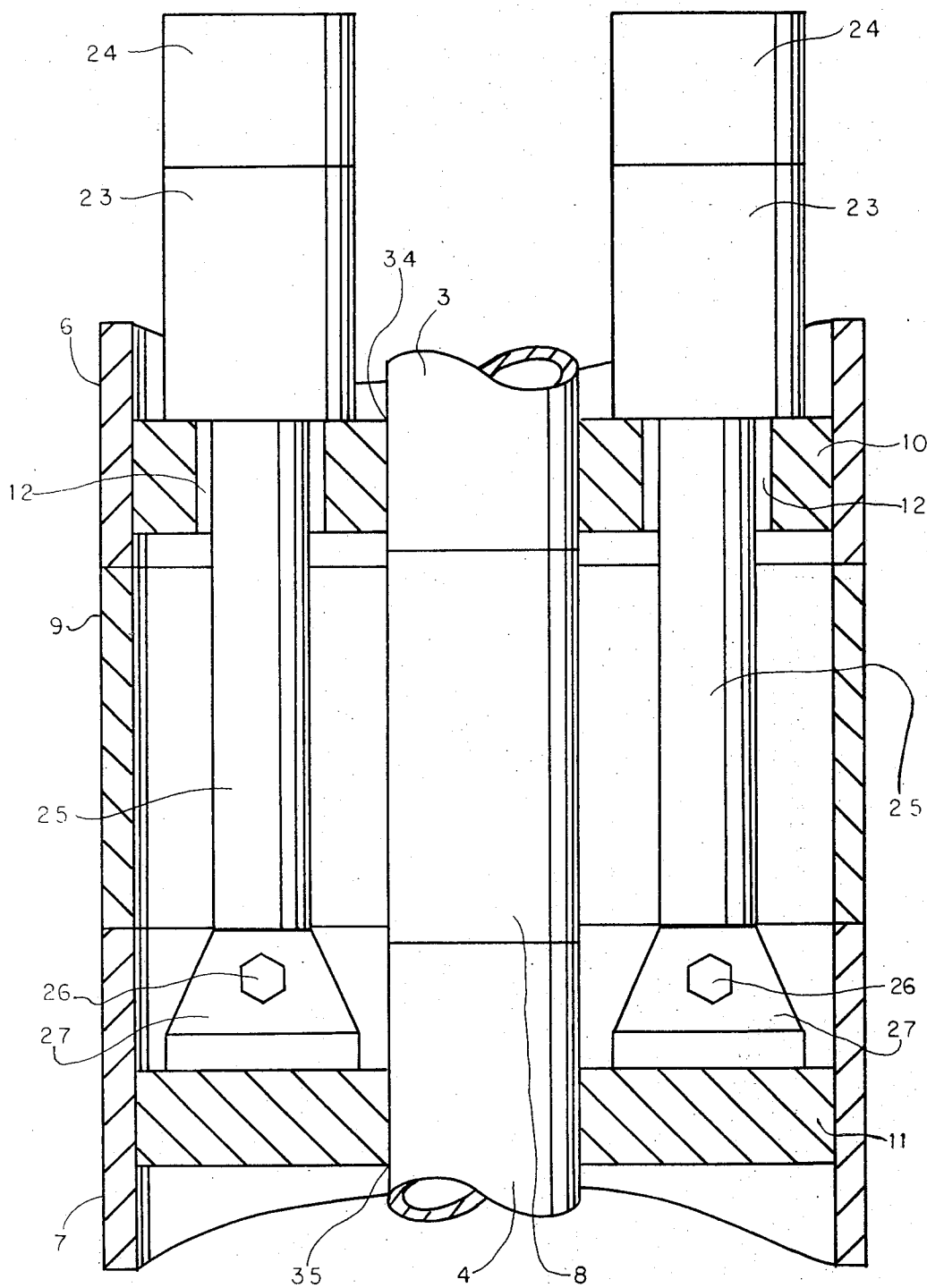


FIG. 3

REMOTE CONTROL DIRECTIONAL DRILLING SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the directional drilling of well holes in the earth, such as gas or oil wells.

2. Prior Art

Various methods are being used to directionally drill oil or gas wells today. The method most commonly used is to lower a deflecting tool down the hole and set it in the direction desired to drill, and then lower the drill bit on the downhole end of a drill pipe string through the deflecting tool. Another method is to operate the drill bit by a downhole motor through a bent deflecting sub, or the uphole end of the motor can be attached to the bent deflecting sub. This method like the one before requires the bit to be removed from the well hole to make changes in the angle the bit is to drill. There is a system that can measure the direction and attitude of the drill bit and change the direction the bit will drill without removing the drill bit from the well hole, but the system is operated by wire down through the drill pipe string and the drilling operation is stopped or slowed considerably when the direction of the drill bit is being changed. Also all methods presently used can only change the angle of the drill bit a few degrees per hundred feet, and as stated are not very flexible when changes in direction of the bit are made.

SUMMARY OF THE INVENTION

An object of the invention is to provide a remote control directional drilling system in which changes can be made in the direction the drill bit is drilling with little or no interruption to the drilling operation.

An object of the invention is to provide a remote controlled directional drilling system, which can be controlled by commands radiated down the drill pipe string by electromagnetic waves.

Another object of the invention is to provide a remote control directional drilling system, which can provide, by electromagnetic waves radiated up the drill pipe string, data on the attitude, direction and direction control components of the system.

Another object of the invention is to provide a remote control direction drilling system, which uses a downhole motor to operate the drill bit and generate the electrical and hydraulic power to operate the directional control of the drill bit and provide power to the attitude and remote control guidance system.

DESCRIPTION OF THE DRAWINGS

In the accompanying drawing,

FIG. 1 is a view showing how the downhole motor is connected by the drive shaft sections to the drill bit and the drive shaft housing sections support the drive shaft sections.

FIG. 2 is a schematic of the major components of the attitude and remote control guidance system.

FIG. 3 is a view of how the position cylinders, which direct the drill bit, are mounted on the uphole flange mount and attached to the downhole flange mount. Shown are only two of the four position cylinders.

DESCRIPTION OF THE PREFERRED

EMBODIMENT Referring to the accompanying drawings which form a part of this disclosure and initially to FIG. 1, the configuration of the major elements of the remote control directional drilling system is shown not including the attitude and remote control guidance system. As shown the output shaft 2 of downhole motor 1 is attached to and turns drive shaft section 3, which is connected to drive shaft section 4 by flexible connection 8. Drive shaft section 4 is attached to and turns drill bit 5. Drive shaft housing section 6 is attached to downhole motor 1 and encloses drive shaft section 3. The downhole end of drive shaft housing section 6 is attached to drive shaft housing section 7 by flexible connection 9, which is located in conjunction with flexible connection 8. The downhole end of drive shaft housing section 7 supports the connection (not shown) of drive shaft section 4 with drill bit 5, so that drive shaft section 4 can operate in the center of the downhole end of drive shaft housing section 7.

Uphole flange mount 10 has a hole 34 in its center in which drive shaft section 3 can slip and operate through. Uphole flange mount 10 holds drive shaft section 3 in the center of the downhole end of drive shaft housing section 6, and uphole flange mount 10 is mounted inside drive shaft housing section 6 near where drive shaft section 3 is attached to flexible connection 8. Four holes 12 are drilled in uphole flange mount 10 and are located ninety degrees apart. The four holes 12 are drilled from the uphole side to the downhole side of uphole flange mount 12, so that the four holes 12 will be located in uphole flange mount 10 between the inside wall of drive shaft housing section 6 and drive shaft section 3.

Downhole flange mount 11 has a hole 35 in its center in which drive shaft section 4 can slip and operate through. Downhole flange mount 11 is mounted in the uphole end of drive shaft housing section 7 near where drive shaft section 4 is attached to flexible connection 8, and downhole flange mount 11 holds drive shaft 4 in the center of drive shaft housing section 7. The space 13 between the inside wall of drive shaft housing section 6 and drive shaft section 3 is the area where the attitude and remote control guidance system and their power generating components are located and mounted. The downhole motor 1 is operated by drilling fluids pumped down through the drill pipe string (not shown), through downhole motor 1. The drilling fluids are exhausted from downhole motor 1 through output shaft 2, through drive shaft section 3, through flexible connection 8, through drive shaft section 4, and through drill bit 5 into the well hole.

FIG. 2 is a schematic of the attitude and remote control guidance system. The attitude and direction detector 14 detects the attitude and direction in which drive shaft housing section 6 is pointing, and this data is transmitted to the attitude and direction transmitter 18 over data line 19. The attitude and direction transmitter 18 radiates the attitude and direction data up the drill pipe string by electromagnetic waves to a receiver (not shown) at the top of the well hole, so the data can be displayed to an operator. The attitude and direction detector 14 and the attitude and direction transmitter 18 receive electrical power from electric generator 15 by power cable 17. Electric generator 15 has a hollow

rotor shaft, which is large enough to slip over, attach to and be operated by drive shaft section 3. The drill pipe string acts as an antenna for attitude and direction transmitter 18. Control receiver 20 receives directional commands radiated by electromagnetic waves down the drill pipe string from a transmitter (not shown) at the top of the well hole. The control receiver 20 sends the received directional commands by data line 21 to the control unit 22. The control receiver 20 receives electrical power from electrical generator 15 by power cable 17. When control unit 22 receives a directional command it directs hydraulic fluid to or from one or more of four position cylinders 23, which orientate drive shaft section 4, drive shaft housing section 7, and the drill bit 5 so the remote control directional drilling system will drill in the direction the directional commands directed. The control unit 22 receives electrical power from power cable 17.

Four position cylinders 23 are used to control the direction of the remote control directional drilling system by changing the attitude or orientation of drive shaft section 4, drive shaft section 7, and drill bit 5. The position cylinders 23 are double acting cylinders with double shafts. Each position cylinder 23 is mounted on the uphole side of uphole flange mount 10 so the downhole shaft 25 of each position cylinder 23 will extend through a hole 12 in uphole flange mount 10 and is attached to one of the four mounting brackets 27, which are mounted on the uphole side of downhole flange mount 11. Each one of the mounting brackets 27 is mounted directly below a hole 12. Each position cylinder 23 has its downhole shaft 25 attached to a mounting bracket 27 by a hinge bolt 26. The control unit 22 sends hydraulic fluid to or from the uphole port of each position cylinder 23 by one of four hydraulic lines 31 and the control unit 22 sends hydraulic fluid to or from the downhole port of each position cylinder 23 by one of four hydraulic lines 30. The uphole shaft (not shown) of each position cylinder 23 is attached to and operates a transducer 24, which receives electrical power from one of four electrical lines 28 from the control unit 22. The output from each of the transducers 24 is sent by one of four data lines 29 to the control unit 22. The output from each of the transducers 24 indicates the position of the piston of its respective position cylinder 23 and is directly proportionate to the attitude of the drill bit 5. The control unit 22 uses the data output of each transducer 24 to determine when the drill bit 5 has been orientated in the position directed by the directional commands.

The control unit 22 sends the piston position data from each position cylinder 23 over a data line 33 to control transmitter 32, which transmits the piston position data by electromagnetic waves up the drill pipe to a receiver at the top of the well hole.

The control unit 22 receives hydraulic fluid from hydraulic pump 16 by hydraulic output line 36 and sends hydraulic fluid to hydraulic pump 5 by hydraulic input line 37. Hydraulic pump 5 has a hollow rotor shaft large enough to slip over, attach to and be operated by drive shaft section 3, and the housing of hydraulic pump 16, like the housing of electric generator 15, is attached to a point (not shown) on the inside wall of drive shaft housing section 6.

I claim:

1. A remote control directional drilling system which is used for the purpose of drilling directional well holes,

attaches to the downhole end of a standard drill pipe string and consists of a downhole motor and the downhole motors input is connected to the downhole end of said drill pipe string, a drive shaft that is attached to the output shaft of the downhole motor and the drive shaft consists of two sections, a flexible connection that connects the two drive shaft sections, a drill bit that connects to the downhole end of the drive shaft, a drive shaft housing that is attached to the downhole end of the downhole motor and encloses and provides support for the drive shaft, the drive shaft housing consists of two sections, a flexible connection that connects the two drive shaft housing sections and corresponds in location with the flexible connection that connects the two drive shaft sections, an uphole flange mount which holds the drive shaft section attached to the output shaft of the downhole motor in the center of the drive shaft housing section attached to the downhole end of the downhole motor and the uphole flange mount is mounted inside the said drive shaft housing section near the point where said drive shaft housing section is attached to the flexible connection which connects the two sections of drive shaft housing, a downhole flange mount which holds the drive shaft section attached to the drill bit in the center of the drive shaft housing section connected to the downhole end of the flexible connection that connects the two sections of the drive shaft housing and the downhole flange mount is mounted inside the said drive shaft housing section near where the said drive shaft housing is connected to said flexible connection and the said drive shaft housing section supports the drive shaft where the drive shaft attaches to the drill bit, an attitude and remote control guidance system which controls the direction of the remote control directional drilling system by receiving direction commands radiated down the drill pipe string by electromagnetic waves and orientating the drive shaft section attached to the drill bit and the drive shaft housing section enclosing said drive shaft section and the drill bit in the direction directed by the direction commands, the drive shaft housing section attached to the downhole end of the downhole motor encloses the attitude and remote control guidance system, an electrical generator which provides electrical power to the attitude and remote control guidance system and is operated by the drive shaft section attached to the output shaft of the downhole motor, an hydraulic pump which provides hydraulic power to the attitude and remote control guidance system and is operated by the drive shaft section attached to the output shaft of the downhole motor, the drilling fluids pumped down through the drill pipe string to operate the downhole are exhausted through the output shaft of the downhole motor through the drive shaft sections through the flexible connection that connects the drive shaft sections and through the drill bit.

2. The invention of claim 1 including an attitude and remote control guidance system which consists of an attitude and direction detector which detects the attitude and direction of the drive shaft housing section attached to the downhole end of the downhole motor, an attitude and direction transmitter which receives attitude and direction data from the attitude and direction detector and transmits said data up the drill pipe string by electromagnetic waves, a telemetry receiver at the top of the well hole and the telemetry receiver receives the attitude and direction data transmitted up the drill

pipe string so said data can be displayed to an operator, a data line which is connected from the attitude and direction detector to the attitude and direction transmitter and carries attitude and direction data from the attitude and direction detector to the attitude and direction transmitter, a control receiver which receives direction commands radiated by electromagnetic waves down the drill pipe string, a command transmitter at the top of the well hole that an operator uses to transmit direction commands by electromagnetic waves down the drill pipe string to the control receiver, a control unit which receives the direction commands received by the control receiver and controls the hydraulic fluid flow from the hydraulic pump to position the drive shaft section and drive shaft housing section on the downhole side of said sections respective flexible connections and the drill bit in the direction directed by the direction commands, a data line connected from the control receiver to the control unit and carries direction commands received by the control receiver to the control unit, a hydraulic line which provides hydraulic fluid from the hydraulic pump to the control unit, a hydraulic line which provides hydraulic fluid from the control unit to the hydraulic pump, four position cylinders which are double acting cylinders with double shafts, the position cylinders are mounted on the uphole side of the uphole flange mount, the position cylinders are located ninety degrees apart around the uphole flange mount, four drilled holes from the uphole side to the downhole side of the uphole flange mount and one hole is located under each position cylinder, the downhole shaft of each position cylinder extends through the hole located under the position cylinder, four mounting brackets which are mounted on the uphole side of the downhole flange mount and one mounting bracket is located under each position cylinder, four hinge bolts which attach the four downhole

shafts of the position cylinders to the four mounting brackets, one transducer mounted on the uphole end of each position cylinder and is activated by the uphole shaft of the position cylinder, each transducer transmits continually to the control unit the piston position of each transducer's respective position cylinder, one power line which is connected from each transducer to the control unit that provides electrical power from the control unit to the transducer, one data line from each transducer to the control unit that carries position cylinder piston position data from the transducer to the control unit, two hydraulic lines from each position cylinder to the control unit which uses the two hydraulic lines to provide hydraulic fluid to the position cylinder to control the position cylinder piston position, a control transmitter which receives position cylinder piston position data from the control unit and transmits said data by electromagnetic waves up the drill pipe string to the telemetry receiver at the top of the well hole so said data may be displayed to an operator, a data line from the control unit to the control transmitter that carries position cylinder piston position data from the control unit to the control transmitter, an electrical power line which provides power from the electrical generator to the attitude and direction detector, the attitude and direction transmitter, the control receiver, the control unit and the control transmitter.

3. In claim 1 wherein the rotor shaft of the electrical generator is hollow and large enough in internal diameter to slip over and be attached to the drive shaft section attached to the output shaft of the downhole motor, the rotor shaft of the hydraulic pump is hollow and large enough in internal diameter to slip over and be attached to the drive shaft section attached to the output shaft of the downhole motor.

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