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(11) Publication number:

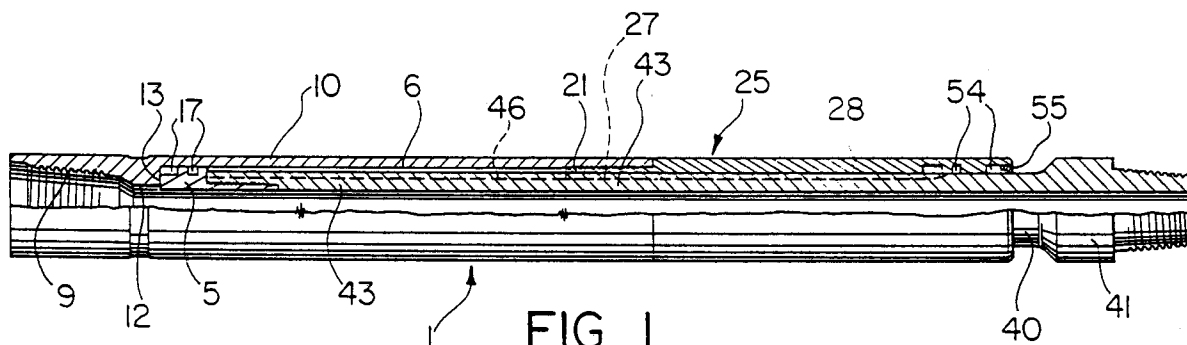
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EUROPEAN PATENT APPLICATION(21) Application number: **95106737.0**(51) Int. Cl.⁶: **E21B 44/00, E21B 17/07**(22) Date of filing: **04.05.95**(30) Priority: **05.05.94 CA 2122959**(43) Date of publication of application:
08.11.95 Bulletin 95/45(84) Designated Contracting States:
AT DE GB NL SE(71) Applicant: **CANADIAN FRACMASTER LTD**
1700 Fracmaster Tower,
355 Fourth Avenue SW.
Calgary,
Alberta, T2P OJ1 (CA)(72) Inventor: **Smith, Donald Alexander**
105A Oak Avenue
Okotoks,
Alberta T0L 1T3 (CA)(74) Representative: **Müller-Boré & Partner**
Patentanwälte
Grafinger Strasse 2
D-81671 München (DE)(54) **Coiled tubing thruster.**

(57) There is described a coiled tubing thruster comprising a tubular housing (10,25) having a continuous bore formed therethrough, a piston assembly (5) slidably received in the bore for longitudinal movement therein, an extensible shaft (43) passing axially through the bore for connection to the piston assembly, the tubular housing, the piston assembly and the

shaft all being adapted to permit the flow of pressurized fluid through the thruster; and rotation preventers (27,46) between the housing and the shaft, wherein pressurized fluid acting on the piston assembly causes extension of the shaft relative to the housing in the direction of flow of the pressurized fluid.

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FIELD OF THE INVENTION

There is described a thruster and more particularly a coiled tubing thruster that provides a thrust or force to a drill bit for the directional drilling and/or servicing of oil and gas wells when using coiled tubing.

BACKGROUND OF THE INVENTION

Increasingly, the drilling of oil and gas wells is no longer a matter of drilling vertically straight bore holes from the surface to a zone of hydrocarbon recovery using a drilling platform surmounted by a derrick that supports a string of jointed drill pipe having a bit at the lower end thereof. Rather, technology and techniques have been developed to deviate the bore's trajectory at angles of up to and sometimes exceeding 90° from the vertical. Directional drilling offers numerous advantages including new approaches to oil and gas traps having non-conventional geometries, economic zone enhancement as can occur for example if the bore hole actually follows an oil or gas bearing strata, improved economics particularly in an over-pressured environment (when formation pressure is sufficient to force hydrocarbons to the surface at potentially explosive rates) and reduced environmental degradation.

After deviating a bore hole from the vertical, it's obviously no longer completely practical to sustain continuous drilling operations by rotating the drill String in order to also rotate the bit. Preferably, only the bit, but not the string, is rotated by a downhole positive displacement motor (PDM) attached to the lower end of the drill string, the motor typically consisting of a rotor-stator to generate torque as drilling fluid passes therethrough, a bent housing to deviate the hole by the required amount and which also encloses a drive shaft therethrough to transmit the rotor/stator's torque to a bearing assembly, and a bit rotatably supported at the downhole end of the bearing assembly for cutting the bore hole.

Electronic means supported by a mule shoe in the bottom hole assembly and connected to the surface by a wire line passing through the interior of the drill string transmits information with respect to the degree and azimuth of the bore hole's trajectory so that it can be plotted and necessary adjustments made. Once the required direction of the hole's trajectory has been attained, the motor must be withdrawn from the well, the bent housing either removed or straightened (if it's of the adjustable sort) and the motor is then tripped back into the hole to resume drilling operations. Each time the motor requires service, or a change in the hole's trajectory is required, this process must be re-

peated. This results in substantial costs and down time largely due to the time required to make and break all of the joints as the drill string is tripped in and out of the hole.

SUMMARY OF THE INVENTION

To overcome this problem, discrete lengths of jointed drill pipe are being replaced where feasible with coiled tubing which is a single length of continuous, unjointed tubing spooled onto a reel for storage in sufficient quantity to exceed the maximum length of the bore hole being drilled. The injection and withdrawal of the tubing can be accomplished much more rapidly in comparison with conventional drill pipe in large part due to the elimination of joints. However, as with conventional pipe, drilling mud and wire lines for downhole instrumentation pass through the tubing's interior.

Coiled tubing has been extensively used for well servicing as well as for workovers within previously drilled holes.

More recently, tools and methods have been developed for the actual drilling of bore holes using coiled tubing and reference is made in this regard to U.S. Patent 5,215,151 disclosing such a system.

A problem arises however when drilling directional wells of transmitting sufficient compressive force to the drill bit/rock interface. In the drilling of conventional vertical wells, the weight of the drill string bearing down on the bit provides most or all of the required force. In directional wells, and particularly in wells which deviate substantially from the vertical and approach the horizontal, a substantial component of the drill string's weight proportional to the deviation will be lost. This can be compensated for in some instances by applying an additional downward force to the drill string from the surface. This is not always feasible however with coiled tubing which lacks the rigidity of conventional drill pipe. The effect is similar to pushing on a rope, including possible buckling of the tubing if too much force is applied.

Accordingly, it is an object of the present invention to provide a thruster that can provide thrust to the bit/rock interface based on the pressure differential between the pressure of hydraulic drilling fluid inside the tool string and in the annulus between the tool string and the well bore.

According to the present invention then, there is provided a coiled tubing thruster comprising tubular housing means having a bore formed longitudinally therethrough, piston means slidably received in said bore for longitudinal movement therein, extensible shaft means passing axially through said bore for connection to said piston means, said tubular housing means, said piston means and said shaft means all being adapted to

permit the flow of pressurized drilling fluid through said thruster, and means preventing rotation of said housing means relative to said shaft means, wherein said drilling fluid acting on said piston means generates a thrust transmitted through said shaft means in the direction of flow of said drilling fluid.

According to the present invention then, there is also provided a method of providing additional thrust to a drill bit for the forming particularly of non-vertical bore holes, said method comprising the steps of establishing a flow path for pressurized drilling fluid from the top of the bore hole to the drill bit and a return path for the flow of said fluid from said bit back to the top of said bore hole, creating a pressure differential between said flow and return paths for said fluid such that the pressure in said flow path exceeds that in said return path, and directing said pressurized fluid in said flow path through a tubular housing having piston means longitudinally movable therein, said piston means being adapted to permit said pressurized fluid to flow therethrough, said piston means having extensible shaft means connected thereto for transmitting the pressure of said fluid acting on said piston means in a downhole direction towards said drill bit.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the present invention will now be described in greater detail and will be better understood when read in conjunction with the attached drawings in which:

Figure 1 is a side elevational, cross-sectional view of a coiled tubing thruster as described herein; and

Figure 2 is an exploded isometric view of the thruster of Figure 1.

DETAILED DESCRIPTION

With reference to Figures 1 and 2, thruster 1 generally comprises a tubular piston housing 10, a tubular splined housing 25 threadedly connected to the piston housing downstream thereof, a piston 5 and a tubular splined shaft 40 adapted for threaded connection to piston 5.

Piston housing 10 is internally drill-threaded at its uphole end 9 for connection to the uphole portion of a tool string. The bore 6 formed through housing 10 initially narrows at neck 12 and then widens again at shoulder 13 to slidably receive piston 5 for back and forth axial movement within bore 6. The extent of the piston's travel is limited in the uphole direction by shoulder 13 and in the

downhole direction by uphole end 21 of splined housing 25.

Splined shaft 40 includes a drill-threaded collar portion 41 at its downhole end for connection to the downhole tool string and an oppositely extending mandrel 43. Mandrel 43 extends axially in the uphole direction through bore 28 of housing 25 and bore 6 of piston housing 10 for threaded connection to piston 5.

The thruster will be subject to considerable reactive torque from the downhole motor. To prevent relative rotation between housings 10 and 25 and splined shaft 40 responsive to this torque, the shaft is provided at its upper end with a plurality of longitudinal, radially outwardly extending splines 46 that engage cooperating inwardly radiating splines 27 provided at the uphole end of splined housing 25. The length of splines 46 is sufficient to ensure engagement with splines 27 for the full extent of piston's 5 travel within housing 10.

Sealing between piston 5 and bore 6 is provided by a pair of polypak seals 17 (Nitroxile*4274) and between mandrel 43 and bore 28 by another pair of polypak seals 54. A VITON (trade-mark) wiper 55 for cleaning the mandrel is provided at the downhole end of splined housing 25.

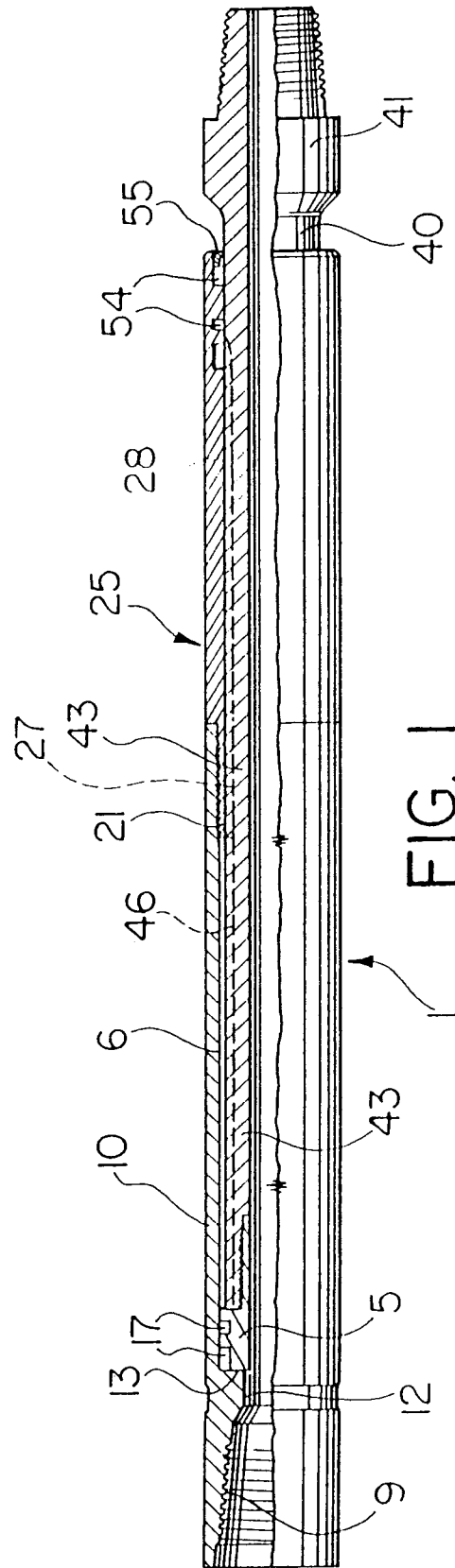
Restrictions to the flow of drilling mud in the inner bore of the tool string downhole of the present thruster result in a pressure differential between the fluid flowing through the thruster and the return flow in the annulus between the tool string and the well bore. This differential acting against piston 5 will therefore develop a thrust causing extension of spline shaft 40 in the downhole direction. This thrust will be transmitted directly to the bit/rock interface and can exceed 12,000 psi. If the reactive force at the bit/rock interface equals the thrust being transmitted through shaft 40, shaft 40 will remain stationary relative to housing 25. If the reactive force varies due for example to changes in the hardness of the material being drilled shaft 40 might oscillate somewhat relative to housing 25. If piston 5 reaches the limit of its downhole travel, reducing the mud pressure or pushing on the coiled tubing itself will result in a relative displacement of the piston in an uphole direction.

For a given pressure differential, the amount of developed thrust can be varied by substituting pistons and piston housings of different sizes, including the diameter of the bores formed therethrough. The present thruster can be installed at any suitable location in the tool string such as between the Monel collar and the PDM.

* - Trade-mark

Claims

1. A coiled tubing thruster (1) comprising:
 - tubular housing means (10, 25) having a bore (6, 28) formed longitudinally therethrough; 5
 - piston means (5) slidably received in said bore (6) for longitudinal movement therein;
 - extensible shaft means (40) passing axially through said bore (6, 28) for connection to said piston means (5); said tubular housing means (10, 25), said piston means (5) and said shaft means (40) all being adapted to permit the flow of pressurized drilling fluid through said thruster (1); and 10
 - means (46, 27) preventing rotation of said housing means (10, 25) relative to said shaft means (40), wherein said drilling fluid acting on said piston means (5) generates a thrust transmitted through said shaft means (40) in the direction of flow of said drilling fluid. 15 20
2. The thruster of claim 1 wherein said means preventing rotation (46, 27) comprise cooperating spline means (27) disposed on an inner surface of said housing (25) and (46) on an opposed outer surface of said shaft means (40). 25
3. The thruster of claim 2 wherein said tubular housing means (10, 25) comprise first uphole (10) and second downhole (25) axially aligned tubular housings adapted for threaded connection together, wherein said spline means (27) are circumferentially disposed on an inner surface of said second housing (25). 30 35
4. The thruster according to any of claims 1 to 3 wherein said piston means (5) are slidably received for back and forth longitudinal movement within said first housing (10). 40
5. The thruster of claim 4 wherein the extent of travel of said piston means (5) in the direction of pressurized fluid flow is limited by said connection between said first (10) and second housings (25). 45
6. The thruster according to any of claims 1 to 5 wherein said piston means (5) and said shaft means (40) have a bore formed therethrough for passage of said pressurized drilling fluid. 50
7. The thruster according to any of claims 1 to 6 wherein the pressure of said drilling fluid acting on said piston means (5) can cause extension of said shaft means (40) relative to said housing means (10, 25) in the direction of flow of said fluid for exerting a thrust. 55
8. The thruster of claim 7 wherein the amount of said thrust can be altered by varying the diameter of said first housing (10) and said piston means (5) and of said bores formed therethrough.
9. A method of providing additional thrust to a drill bit for the forming particularly of non-vertical bore holes, said method comprising the steps of:
 - establishing a flow path for pressurized drilling fluid from the top of the bore hole to the drill bit and a return path for the flow of said fluid from said bit back to the top of said bore hole;
 - creating a pressure differential between said flow and return paths for said fluid such that the pressure in said flow path exceeds that in said return path; and
 - directing said pressurized fluid in said flow path through a tubular housing (10, 25) having piston means (5) longitudinally movable therein, said piston means (5) being adapted to permit said pressurized fluid to flow therethrough, said piston means (5) having extensible shaft means (40) connected thereto for transmitting the pressure of said fluid acting on said piston means (5) in a downhole direction towards said drill bit.
10. The method of claim 9 wherein the pressure of said drilling fluid acting on said piston means (5) can cause axial extension of said shaft means (40) relative to said housing means (10, 25) in the direction of flow of said fluid for exerting a thrust.
11. The method of claim 10 wherein the amount of said thrust can be adjusted by varying the diameter of said tubular housing (10, 25) and said piston means (5) and of the paths formed therethrough for the flow of said drilling fluid.
12. The method according to any of claims 9 to 11 wherein said shaft means (40) are prevented from rotating relative to said housing means (10, 25).
13. The method according to any of claims 9 to 12 wherein said piston means (5) can be moved in the uphole direction relative to said tubular housing (10, 25) by reducing the pressure in said flow path relative to said return path.



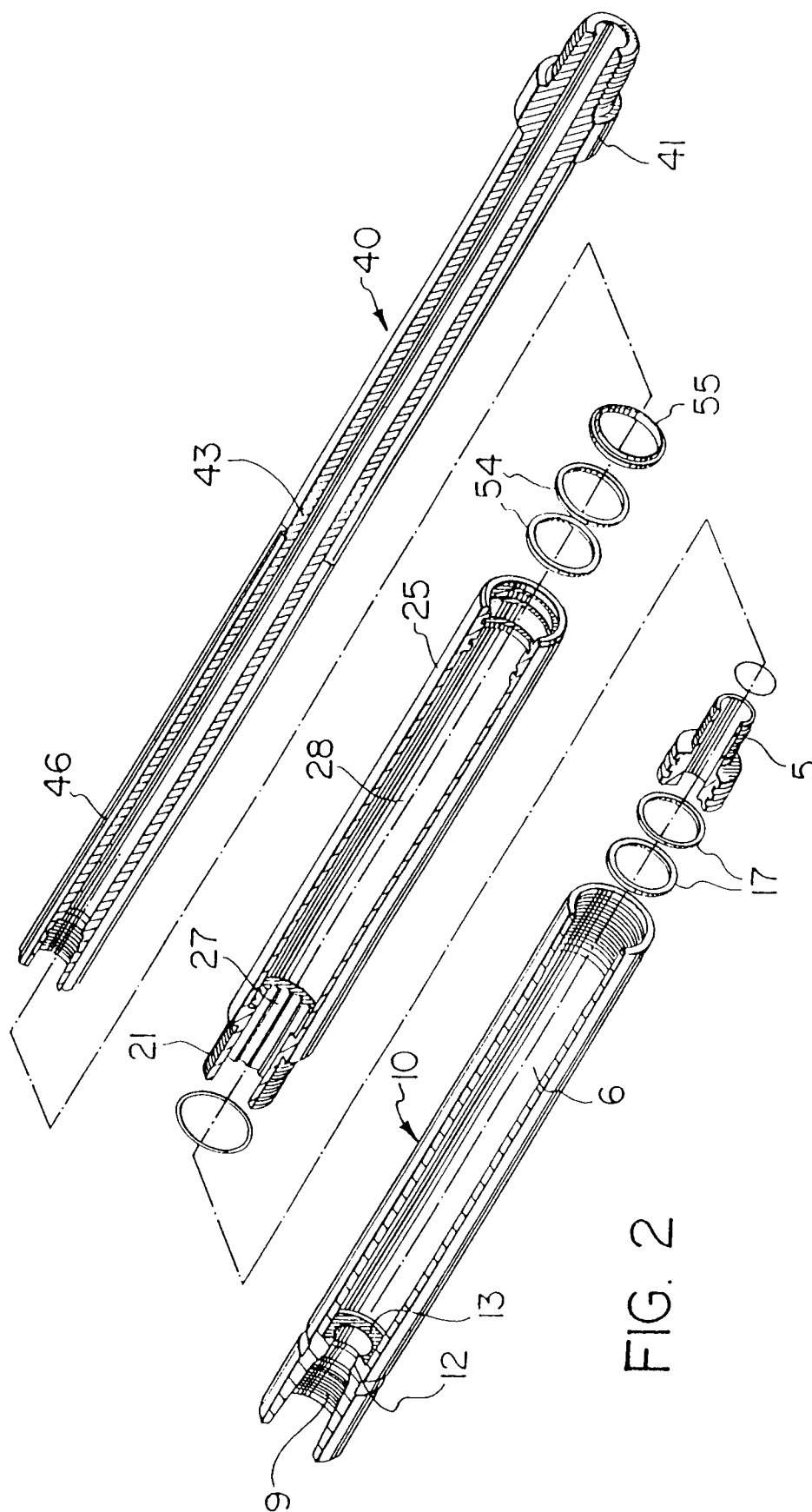


FIG. 2



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EUROPEAN SEARCH REPORT

Application Number
EP 95 10 6737

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP-A-0 469 317 (BAKER HUGHES) * column 3, line 55 - column 4, line 48; figures * ---	1-13	E21B44/00 E21B17/07
X	US-A-1 357 564 (HUGHES) 2 November 1920 * figures * ---	1,4-13	
X	US-A-4 440 241 (ANDERS) * abstract; figure 2 * ---	1,9	
X	US-A-2 684 835 (MOORE) * figures * ---	1,9	
X	BE-A-536 490 (SELIGMAN) 22 March 1954 * page - * ---	1,9	
X	US-A-2 776 817 (GREGORY) * figures * ---	1,9	
X	US-A-3 225 843 (ORTLOFF) * figures * -----	1,9	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.6) E21B
Place of search THE HAGUE		Date of completion of the search 17 August 1995	Examiner Weiland, T
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document			