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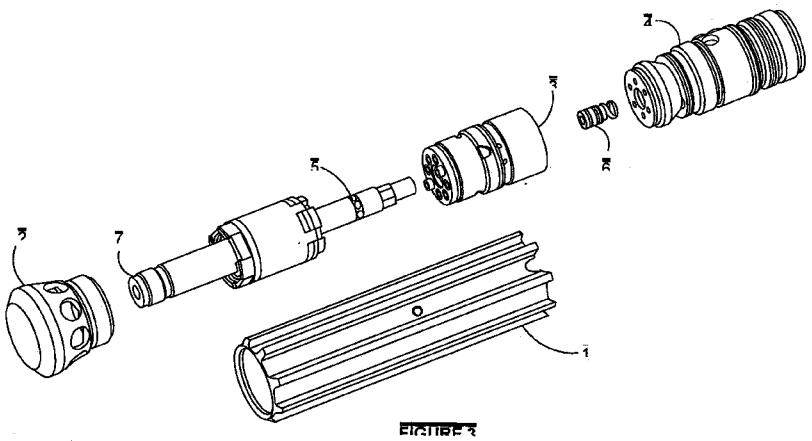
Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

(54) **Title**: FLUID DRILLING HEAD WITH POWERED SWIVEL ASSEMBLY



(57) **Abstract**: A fluid drilling head of the type adapted to cut a bore hole in rock by the rotation of a swivel assembly (5) within a body (1) typically has high pressure fluid nozzles providing cutting and reaming jets at the leading end (7) with the reaming jets angled to provide reaction forces to rotate the swivel assembly (5). The invention provides a positive displacement fluid driven motor (3) coupled to the swivel assembly (5) to control the rotational speed of the swivel assembly by restricting fluid flow to the motor through a metering nozzle (8).

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FLUID DRILLING HEAD WITH POWERED SWIVEL ASSEMBLY

Field of the Invention

[0001] This invention relates a fluid drilling head with a powered swivel assembly and has been devised particularly though not solely for the drilling of lateral bore holes in horizontal rock seams.

Background of the Invention

[0002] It has become known to use fluid drilling heads of the type adapted to cut a bore hole in rock by the rotation of a swivel assembly at the leading end of a tool body. The swivel assembly typically has a plurality of nozzles arranged to provide cutting and reaming jets of fluid with the swivel assembly being rotated by reaction forces from one or more of the reaming jets. Such fluid drilling heads have the disadvantage that when the tool is lightly loaded in operation, the reaction forces from the reaming jets can produce high levels of torque driving the rotation of the swivel assembly. This torque can significantly exceed the drag generated by various sources of friction within the tool resulting in an unabated speed increase in the rotation of the swivel assembly which can lead to seal or bearing failure within the tool.

Summary of the Invention

[0003] Accordingly, the present invention provides a fluid drilling head operable by the rotation of a swivel assembly at the leading edge of a tool body and having a plurality of nozzles arranged to provide cutting and reaming jets of fluid in use, the swivel assembly being driven to rotate at least partially by reaction forces from one or more of the reaming jets, wherein the swivel assembly is coupled to a positive displacement fluid driven motor arranged to control the rotational speed of the swivel assembly.

[0004] Preferably, fluid is supplied to the motor through a flow rate control device.

[0005] Preferably, the flow rate control device comprises a metering nozzle configured to deliver fluid to the motor at a pressure significantly less than the pressure of the fluid supplied to the nozzles in the swivel assembly.

[0006] Preferably, the positive displacement fluid driven motor is a water powered vane motor.

Brief Description of the Drawings

[0007] Notwithstanding any other forms that may fall within its scope, one preferred form of the invention will now be described by way of example only with reference to the accompanying drawings in which:

[0008] Figure 1 is an end view of a powered swivel assembly on a fluid drilling head according to the invention;

[0009] Figure 2 is a longitudinal cross-section on the line A-A of Figure 1; and

[0010] Figure 3 is an exploded perspective view of key components of the powered swivel assembly shown in Figures 1 and 2.

Preferred Embodiments of the Invention

[0011] In the preferred form of the invention a fluid drilling head is provided with a powered swivel assembly at the leading end of the drilling head having a generally cylindrical body assembly 1 on which is typically mounted a shroud ring 2 designed to control the forward progress of the fluid drilling head as a bore hole is formed in the rock as is well known in the art of fluid drilling.

[0012] The fluid drilling head incorporates a swivel assembly 5 rotatable in bearings within the body of the tool and designed for the mounting of a cutting head on the leading end 7 which is provided with a plurality of nozzles arranged to provide cutting and reaming jets of fluid in use.

[0013] In the fluid drilling head according to the invention, the rotating shaft and bearing pack of the swivel assembly 5 is coupled to a positive displacement fluid driven

motor 3 arranged to control the rotational speed of the swivel assembly. The motor is typically a water powered vane motor where the rotational speed is directly proportional to the flow rate of fluid through the motor.

[0014] The drive shaft through the motor and to the swivel assembly is sealed by a seal assembly 6 incorporated within the swivel body rear end 4.

[0015] A proportion of the fluid normally provided to the fluid drilling head at high pressures of up to 15,000 psi. is diverted through a flow rate control device in the form of a metering nozzle 8 configured to deliver fluid to the motor 3 at a pressure significantly less than the fluid supply pressure. In the preferred form of the invention the metering nozzle 8 incorporated within the swivel body rear end 4 is sized to deliver water flow to the motor 3 at approximately 10 litres per minute compared with the general flow rate within the tool of approximately 240 litres per minute.

[0016] The flow rate to the motor 3 is set by the metering nozzle diameter and the supply pressure.

[0017] The fluid supply line to the motor 3 also incorporates a relief valve in passage 9 set for example to 1,000 psi. which is much lower than the supply pressure of 10,000 – 15,000 psi. This means that if the positive displacement motor 3 stops rotating due to external loading, the relief valve will actuate and protect the motor from destruction.

[0018] It will be appreciated by those skilled in the art that some quantity of torque is required to rotate the shaft 5 at the nominal speed. This torque is the sum of friction from the high pressure seal 6, friction from the oil seals in the bearing pack assembly, and friction from the bearings in the bearing pack. The high pressure of the supply fluid generates high axial loads on the shaft 5 so the bearing loads are correspondingly very high.

[0019] All up, this friction typically adds up to about 1 – 2 Nm of torque. However, it is easy to configure a water jet head so that up to 4 Nm of torque is generated. The problem with existing fluid drilling heads is that this torque is generated regardless of the speed. Without a braking or speed regulating mechanism, if the reactive torque

generated by the cutting and reaming jets exceeds the drag generated by the various sources of friction, the rotational speed of the shaft 5 would increase unabated, resulting in seal or bearing failure.

[0020] The use of a positive displacement water powered motor 3 means that when used in conjunction with a torque generating cutting head, the motor acts as a brake, spinning at near or no load or even acting as a pump. This has been found to be an excellent way of minimising wear in the motor as for most of the time there would be no net load on the motor.

[0021] However, should the cutting head contact the rock at the end of the hole, the motor will be loaded up and supply positive torque to maintain rotation.

[0022] One other advantage of the present invention is that the waste water from the motor 3 is clean, and is useful for the purpose of keeping environmental water (typically laden with e.g. coal fines) away from the oil seals in the bearing pack. It is directed around the bearing pack and released between the sizing ring and the rotating shaft in a thin gap. This thin gap generates a slight back pressure (e.g. 50 psi.) in the bearing housing void, and stops environmental water from getting in and around the bearing seals.

[0023] The waste water can also be used in the sliding shroud ring 2 in order to keep the shroud ring clean.

Claims :-

1. A fluid drilling head operable by the rotation of a swivel assembly at the leading end of a tool body and having a plurality of nozzles arranged to provide cutting and reaming jets of fluid in use, the swivel assembly being driven to rotate at least partially by reaction forces from one or more of the reaming jets, wherein the swivel assembly is coupled to a positive displacement fluid driven motor arranged to control the rotational speed of the swivel assembly.

2. A fluid drilling head of the type claimed in claim 1, wherein fluid is supplied to the motor through a flow rate control device.

3. A fluid drilling head as claimed in claim 2, wherein the flow rate control device comprises a metering nozzle configured to deliver fluid to the motor at a pressure significantly less than the pressure of fluid supplied to the nozzles in the swivel assembly.

4. A fluid drilling head as claimed in any one of the preceding claims, wherein the positive displacement fluid driven motor is a water powered vane motor.

5. A fluid drilling head as claimed in any one of the preceding claims, wherein waste fluid from the motor is directed to keep environmental water away from oil seals in bearings of the swivel assembly.

6. A fluid drilling head as claimed in any one of the preceding claims when fitted with a shroud ring, wherein waste water from the motor is directed to keep the shroud ring clean.

7. A fluid drilling head when constructed, arranged and operable substantially as described herein with reference to the accompanying drawings.

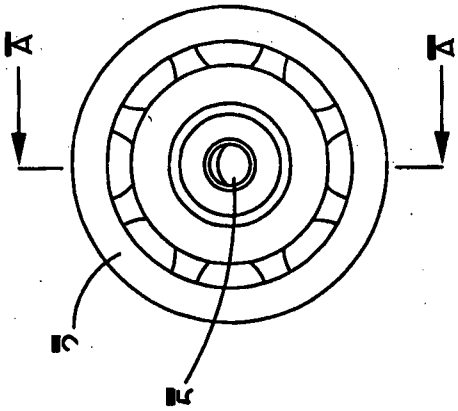

FIGURE 1

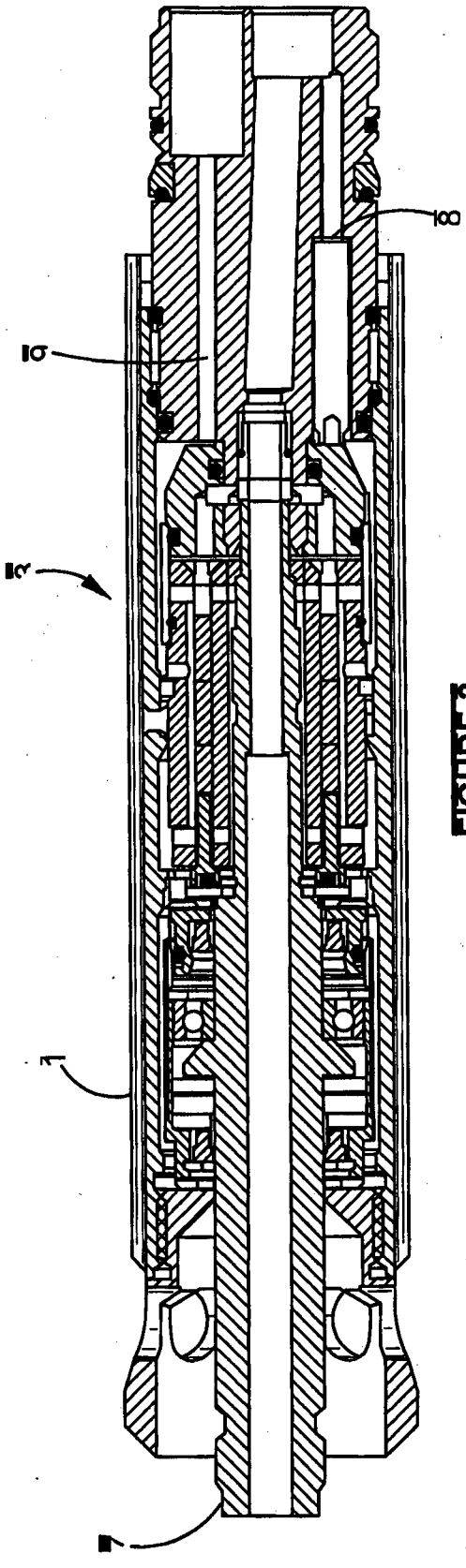

FIGURE 2

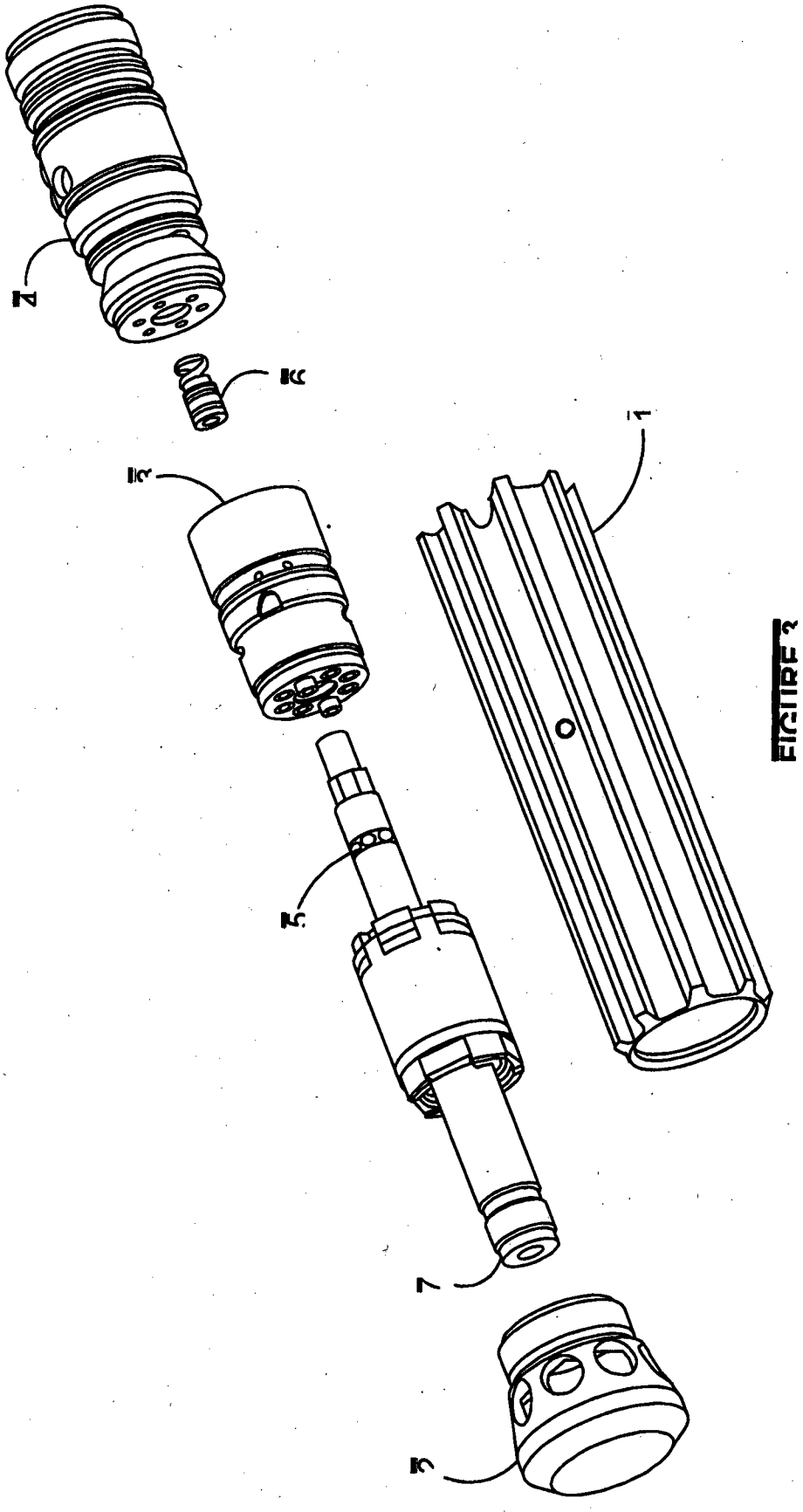

FIGURE 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2012/000762

A. CLASSIFICATION OF SUBJECT MATTER

E21B 3/00 (2006.01) E21B 4/02 (2006.01) E21B 10/60 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC: IPC, ECLA: E21B & Keywords: drill, ream, swivel, rotate, fluid, hydraulic, jet, nozzle, positive displacement, motor, vane, turbine, braking, control, speed, torque and like terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 September 2012	25 September 2012

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INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation).	DOCUMENTS CONSIDERED TO BE RELEVANT	**PCT/AU2012/000762**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2007/0227779 A1 (SWINFORD) 04 October 2007 See item 26 in figures 1-4	1-6
Y	US 3964558 A (FOGLE) 22 June 1976 See column 1 line 45-column 2 line 61	1, 4-6
Y	US 2005/0211471 A1 (ZUPANICK) 29 September 2005 See paragraphs 0012-0025	1-6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2012/000762

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 7
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
The claim/s do/does not comply with Rule 6.2(a) because it/they rely on references to the description and/or drawings.

3. ☐ Claims Nos:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2012/000762**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		**Patent Family Member/s**	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
US 2007/0227779 A1	04 Oct 2007	CA 2646326 A1	11 Oct 2007
		US 2007227779 A1	04 Oct 2007
		US 7686102 B2	30 Mar 2010
		US 2010078219 A1	01 Apr 2010
		US 8151908 B2	10 Apr 2012
		WO 2007115119 A2	11 Oct 2007
		WO 2007115119 B1	27 Nov 2008
US 3964558 A	22 Jun 1976	US 3964558 A	22 Jun 1976
US 2005/0211471 A1	29 Sep 2005	US 2005211471 A1	29 Sep 2005
		WO 2005100731 A1	27 Oct 2005

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.