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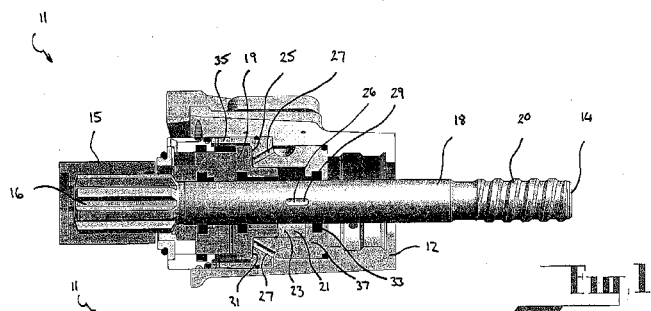
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(54) Title: DRILL HEAD ASSEMBLY



(57) Abstract: The present invention provides a drill head assembly (11) adapted to be incorporated in a tool such as a rock drill. The drill head assembly (11) comprises a drill housing (12) adapted to support a shank (18), which transmits motion to a drill bit. The assembly (11) also comprises a reciprocating piston (19) which acts against the shank, to move the shank in a reciprocating manner. A chamber (23) is defined by the housing and a front face (25) of the piston and has an inlet (27) and an outlet (29) through which a fluid enters and leaves the chamber. As the shank moves towards a first position the chamber is partially sealed such that further movement of the shank towards the first position causes an increase in pressure in the chamber causing a dampening effect upon the piston.

Drill Head Assembly

Field of the Invention

The present invention generally relates to a drill head assembly for use with a drill. In particular the invention relates to a rock drill configuration which provides
5 a dampening effect upon the drill when the rock drill is operating under certain conditions.

The invention also has applications in other machinery whereby a piston reciprocates to provide a hammer type action, such machinery includes jack hammers, surface percussion drills and rock breakers.

10 Background Art

Rock drilling is, as its name suggests, a drill for penetrating rock. These drills are widely used in the mining industry and are often used in very harsh conditions. Furthermore, the drills are often used to complete tasks that they were not particularly designed to execute.

15 Rock drills are a percussion tool with a hammering action. This action provides a short, rapid hammer thrust to a drill bit, allowing the drill to proceed further into the rock with less effort than a conventional drilling action. When drilling rock the hammering action transfers significant force to the rock face through the drill bit. The hammering effect in a rock drill is typically caused by the action of a
20 reciprocating piston fixed to a drill shank moving rapidly in a drill housing whilst the shank is rotating.

In a typical configuration, the drill bit is located at the end of a drill steel, each of which may be up to 5 metres long. The drill steel threadingly engages a shank incorporated in the drill head assembly. The shank comprises a shaft, a series of
25 spines at one end adapted to engage a driver of the rockdrill, and a thread at the other end adapted to engage the drill steel. The reciprocating piston of the rock drill acts upon the shank, transmitting the hammering action through the drill steel to the drill bit.

Most current rock drills are designed to be used specifically for engaging with drilling consumables when the bit is in contact with a rock formation. This is achieved by ensuring the drill bit is constantly engaged with the rock formation, therefore exerting a rearward force upon the shaft and piston to ensure the shank does not engage a fixed surface of the drill housing. When the rock drill is operating without the bit adequately engaged with the rock the reciprocating piston moves through a longer stroke. Without adequate rock contact there is minimal to zero force acting rearwardly upon the drill bit. The stroke is then only limited by the piston exerting energy against the fixed surface of the drill housing.

10 In practice the rock drill is used in other applications. This includes unblocking or unbogging of drill steels, scaling and bolting. In these other applications there is also minimal to zero force acting rearwardly upon the drill bit.

During operation, when there is minimal to zero force acting rearwardly upon the drill bit the reciprocating piston repetitively engages the fixed surface of the drill housing. This creates significant vibration, stress and ultimately damages the drill components.

This problem is a significant issue within the mining industry. Several solutions have been identified, however, these solutions involve the use of hydraulic oil, require large and heavy machinery, and/or have many components. As a result, these solutions cannot be used on development drills or smaller drills, and have proven to be unreliable.

The preceding discussion of the background to the invention is intended only to facilitate an understanding of the present invention. It should be appreciated that the discussion is not an acknowledgment or admission that any of the material referred to was part of the common general knowledge as at the priority date of the application.

SUMMARY OF INVENTION

It is an object of this invention to provide a drill head assembly which has a dampening effect on the hammering action when there is minimal force acting rearwardly upon a drill bit.

The present invention provides a reciprocating head assembly adapted to be incorporated in a tool such as a rock drill, jackhammer or similar percussion tool, the reciprocating head assembly comprises:

5 a housing adapted to support a shank, the shank being adapted to transmit motion to a working end;

a reciprocating piston which acts against the shank, to move the shank in a reciprocating manner, the piston being slidingly received in a hollowed portion of the housing;

10 a chamber defined by the hollow portion and a front face of the piston, the chamber having an inlet and an outlet through which a fluid may enter and leave the chamber, the chamber varying in size as the piston moves relative to the hollow portion;

whereby as the shank moves towards a first position the chamber is partially sealed such that further movement of the shank towards the first position causes
15 an increase in pressure in the chamber causing a dampening effect upon the piston.

The present invention provides a drill head assembly adapted to be incorporated in a tool such as a rock drill, the drill head assembly comprises:

20 a drill housing adapted to support a shank, the shank being adapted to transmit motion to a drill bit;

a reciprocating piston which acts against the shank, to move the shank in a reciprocating manner, a chamber defined by the housing and a front face of the piston, the chamber having an inlet and an outlet through which a fluid may enter and leave the chamber, the chamber varying in
25 size as the piston moves relative to the hollow portion;

whereby as the shank moves towards a first position the chamber is partially sealed such that further movement of the shank towards the first position causes

an increase in pressure in the chamber causing a dampening effect upon the piston.

Preferably the first position of the shank corresponds to the forward most position of the shank relative to the housing when there is minimal to zero force acting
5 rearwardly upon the drill bit.

In use, when the drill bit of the tool is not engaged with a surface, the shank moves to the first position, the chamber is partially sealed. This dampens further forward movement. Eventually the shank will reach the first position whereby the pressure in the chamber is of sufficient magnitude to prevent the forward
10 movement of the shank and piston, preventing the piston from engaging the housing. This significantly reduces vibration, stress and damage to the tool components.

Preferably the piston is slidably received in a hollowed portion of the housing. The hollowed portion of the housing and the front face of the piston define the
15 chamber.

The fluid may be a liquid or a gas.

The chamber may be sealed by soft or mechanical sealing techniques. The mechanical seal may be provided as a result of minimal tolerance between the components.

20 Preferably the shank has a first end adapted to threadingly engage a drill steel, whereby the drill steel has a drill bit at an opposed end for engaging the rock formation.

Preferably the shank has a second end adapted to be received in a driver of the drill whereby the driver exerts a rotational force on the shank.

25 Preferably when the shank is in the first position the front face of the piston is adjacent or just in contact with a fixed surface of the housing.

The outlet may move between an open condition and a partially closed condition, such that the partially closed condition corresponds to the first position of the shank.

5 In another aspect of the invention the outlet may move between an open condition and a closed condition, such that the closed condition corresponds to the first position of the shank, whereby in the closed condition the outlet is completely blocked.

10 Preferably the piston reciprocates within the hollow portion in a direction along the longitudinal axis of the housing. Preferably the piston moves the shank between the first position and the second position, the second position being defined by the maximum distance the piston may extend away from the fixed surface of the housing. This may be determined by the configuration of the drill head assembly.

15 The shank may have a hollow passage extending therealong. The hollow passage may have an open end at the first end of the shank, and a second closed end.

The shank may have a portion which passes through the chamber.

The shank may have an aperture extending from an outer surface of the shank to the hollow passage.

20 The aperture may provide the outlet for the chamber. The outlet may be unrestricted when the shank is in a third position. The third position is spaced from the first position and corresponds to the position of the shank relative to the housing when there is a force acting rearwardly upon the drill bit, as would be experienced when the tool drill bit is in engagement with a surface. When in this
25 position, the chamber is in fluid communication with the outlet, allowing fluid from the chamber to flow into and along the hollow passage to the drill bit. This provides the flushing fluid required at the rock formation being drilled.

Preferably when the shank is in the third position the entire aperture is located in the chamber allowing full flow therethrough.

Preferably when the shank is in the first position the aperture is at least partially blocked by the housing or piston.

- 5 The housing may have a shoulder extending into the hollow portion to provide the fixed surface, preventing the piston moving forward there beyond.

The drill head assembly may comprise a second inlet to provide fluid to the chamber. The second inlet may act as a second stage pressurisation system. The inlet may provide fluid at a point between the fixed surface of the housing
10 and the front face of the piston.

The drill head assembly may comprise a one way valve to minimise the vacuum or pulsation which may be created as the piston moves the shank from the first position.

The inlet of the chamber may be in fluid communication with a fluid supply,
15 whereby when the shank is in the third position the chamber outlet is completely open allowing the fluid to flow from the chamber, through the shank before eventually passing to the rock formation. When the outlet is partially blocked, as is the case when the shank is in the first position, the fluid supply pressurises the chamber, thereby providing an increased dampening effect on the piston.

20 The fluid supply may be provided by the flushing medium typically utilised in a conventional rock drill assembly. That is to say that rock drill assemblies of the prior art include a supply of flushing medium which is delivered to the rock formation during drilling. In the current invention this supply of fluid may also be used to provide the fluid, and hence the required pressure to the chamber. The
25 flushing medium may be water, air or a combination of both.

The shank's first position may be varied according to the pressure in the chamber and/or the location of the outlet with respect to the chamber. Preferably the pressure is varied by adjusting the flow of the fluid supplied through the inlet.

In contrast to the prior art, the present invention provides an efficient and effective assembly which minimises the vibration and heat created by excessive piston stroke. Excessive piston stroke in a rock drill occurs in at least those applications in which the rock drill does not have sufficient resistive force exerted there along to maintain the piston in a position whereby the front surface of the piston does not engage a fixed surface of the housing. The present invention provides a means in which damage to the rock drill assembly is minimised when there is insufficient resistive force to prevent the piston forcibly engaging the fixed surface of the housing. This is as a result of an increase in pressure in the chamber when the resistive force is insufficient.

Brief Description of the Drawings

The invention will be better understood by reference to the following description of a specific embodiment thereof as shown in the accompanying drawings in which:

Figure 1 is a cross sectional view of a drill head assembly according to an embodiment of the invention wherein a drill bit is in a first position; and

Figure 2 is a view similar to figure 1 but with the drill bit in a second position.

In the attached drawings like structures are referred to by like numerals throughout the several views. The drawings shown are not necessarily to scale, with emphasis instead generally being placed upon illustrating the principles of the present invention.

Best Mode(s) for Carrying out the Invention

Referring to figures 1 and 2, the invention according to an embodiment is in the form of a drill head assembly 11. In this embodiment the drill head assembly 11 is particularly adapted to be used in conjunction with a rock drill for use in underground mining. However, it is to be appreciated that the present invention may be used in any percussion type tool, such as surface percussion drills, rock

breakers and jackhammers. These alternatives are considered to be within the scope of this invention.

The drill head assembly 11 comprises a drill housing 12 adapted to support a drill shank 13. The shank comprises a shaft, a thread 20 at a first end 14 and a series of drive splines at a second end 16. The threaded end 20 of the shank 13 is adapted to engage a drill steel (not shown) which supports the drill bit (not shown), which in turn engages the rock formation during a drilling operation. The shank 13 has a hollow passage (not shown) extending along a portion of the length of the shank 13. The hollow passage has an opening at the first end 14 to allow a flushing medium to be delivered into the drill steel.

The shank 13 also has an aperture 26 located along the shank 13. The aperture 26 extends from the outer surface of the shank 13 to the hollow passage within the shank 13. In other embodiments the shank may have more than aperture located there along. The aperture 26 acts as a flushing port.

The second end 16 of the shank 13 is adapted to be received in a driver 15 of a drill (not shown) to provide rotational movement to the shank 13.

Adjacent the second end 16 of the shank 13 a reciprocating piston 19 which is received in a hollow portion 21 of the housing 12.

The housing 12 has a fixed surface in the form of a shoulder 31. The shoulder 31 is adapted to prevent the piston moving there beyond.

In the present embodiment, the shank 13 slides forward and back to a length of about 20mm relative to the piston 19. When in the first position the shank 13 engages the shoulder 31 of the housing 12, whilst at the second position it engages a dampening piston (not shown) and the piston 19. The dampening piston remains relatively stationery and acts as a shock absorber to dampen vibration reverberating back up the shank 13 during normal or high bit contact (forward force).

The housing 12 has a forward portion which, in cooperation with a front face 25

of the piston 19, defines a chamber 23. The size of the chamber 23 varies according to the position of the piston 19 within the hollow portion 21.

The chamber 23 incorporates an inlet 27 for the delivery of fluid, such as water, to the chamber 23. The inlet 27 is in fluid communication with a fluid supply and
5 water pump, neither of which are shown. In the present embodiment the fluid supply is integral with the flushing medium system of the rock drill.

The aperture 26 incorporated in the shank 13 acts as the outlet 29 for the chamber 23 such that when the outlet 29 is open, fluid may pass into the hollow passage of the shank 13 to be delivered to the rock being drilled.

10 In operation, the shank 13 moves from a first position where the piston is in engagement with the shoulder 31, defining the forward most position of the shank 13, as shown in figure 1, and a second position, whereby the shank 13 is in a rearmost position, as shown in figure 2.

As illustrated in figure 1, the outlet 29 provided by the aperture 26 of the drill
15 shank 13 is partially blocked by a front region 37 of the housing 12. This, in co-operation with seals 33, partially seals the chamber 23.

When drilling, the reactive force acting upon the first end 14 of the shank 13 causes the shank 13 to move rearwardly with respect to the housing 12. This causes the piston 19 to move in the same direction and draws the aperture 26 of
20 the shank 13 into the chamber 23. The aperture 26 then provides the outlet 29 allowing fluid to pass from the chamber 23 through the hollow passage of the shank 13 to the rock formation.

When the reactive force is removed from the thread 20 at the first end 14, the aperture 26 of the shank 13 moves within the housing 12. Therefore, the outlet
25 29 begins to close causing pressure to build up in the chamber 23 as the fluid is retained therein. The increase in pressure provides a reactive force acting against the front face 25 of the piston 19. This has the effect of dampening the motion of the piston 19 as it moves from the second position towards the first position.

In the current embodiment, this dampening effect ensures the front face 25 of the piston 19 does not engage the shoulder 31 of the housing 12 with excessive force (if at all). Therefore, the risk of damage to the drill housing assembly 11 is minimised. In addition the heat and vibration which would otherwise be
5 generated by the drill head assembly 11 is significantly reduced.

In the embodiment shown, the front face 25 of the piston 19 engages the shoulder 31 when in the first position. However, the size of the chamber 23 and the position of the piston when the shank is in the first position may be varied according to the position of the aperture 26 along the drill shank 13. Hence, the
10 drill head assembly 11 can be designed such that the front face 25 of the piston 19 is a distance from the housing shoulder 31 when the drill head assembly 11 is in the first position.

By regulating the volume of the fluid/flushing medium entering through the inlet 27 of the chamber 23, the operator is also able to regulate the dampening effect
15 the fluid in the chamber 23 provides to the piston 19.

Modifications and variations such as would be apparent to the skilled addressee are considered to fall within the scope of the present invention.

Throughout the specification, unless the context requires otherwise, the word “comprise” or variations such as “comprises” or “comprising”, will be understood
20 to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

Also, future patent applications maybe filed in Australia or overseas on the basis of, or claiming priority from, the present application. It is to be understood that the following provisional claims are provided by way of example only, and are not
25 intended to limit the scope of what may be claimed in any such future application. Features may be added to or omitted from the provisional claims at a later date so as to further define or re-define the invention or inventions.

The Claims Defining the Invention are as Follows:

1. A drill head assembly adapted to be incorporated in a tool such as a rock drill, the drill head assembly comprises:

5 a drill housing adapted to support a shank, the shank being adapted to transmit motion to a drill bit;

 a reciprocating piston which acts against the shank, to move the shank in a reciprocating manner;

10 a chamber defined by the housing and a front face of the piston, the chamber having an inlet and an outlet through which a fluid enter and leave the chamber, the chamber varying in size as the piston moves relative to the hollow portion;

15 whereby as the shank moves towards a first position the chamber is partially sealed such that further movement of the shank towards the first position causes an increase in pressure in the chamber causing a dampening effect upon the piston.

2. The drill head assembly according to claim 1 wherein the first position of the shank corresponds to the forward most position of the shank relative to the housing when there is minimal to zero force acting rearwardly upon the drill bit.

20 3. The drill head assembly according to claim 1 or 2 wherein the piston is slidably received in a hollowed portion of the housing, the hollowed portion of the housing and the front face of the piston defining the chamber.

25 4. The drill head assembly according to claim 1, 2 or 3 wherein the chamber is sealed by soft or mechanical sealing techniques.

5. The drill head assembly according to any one of the preceding claims wherein the shank has a first end adapted to threadingly engage a drill

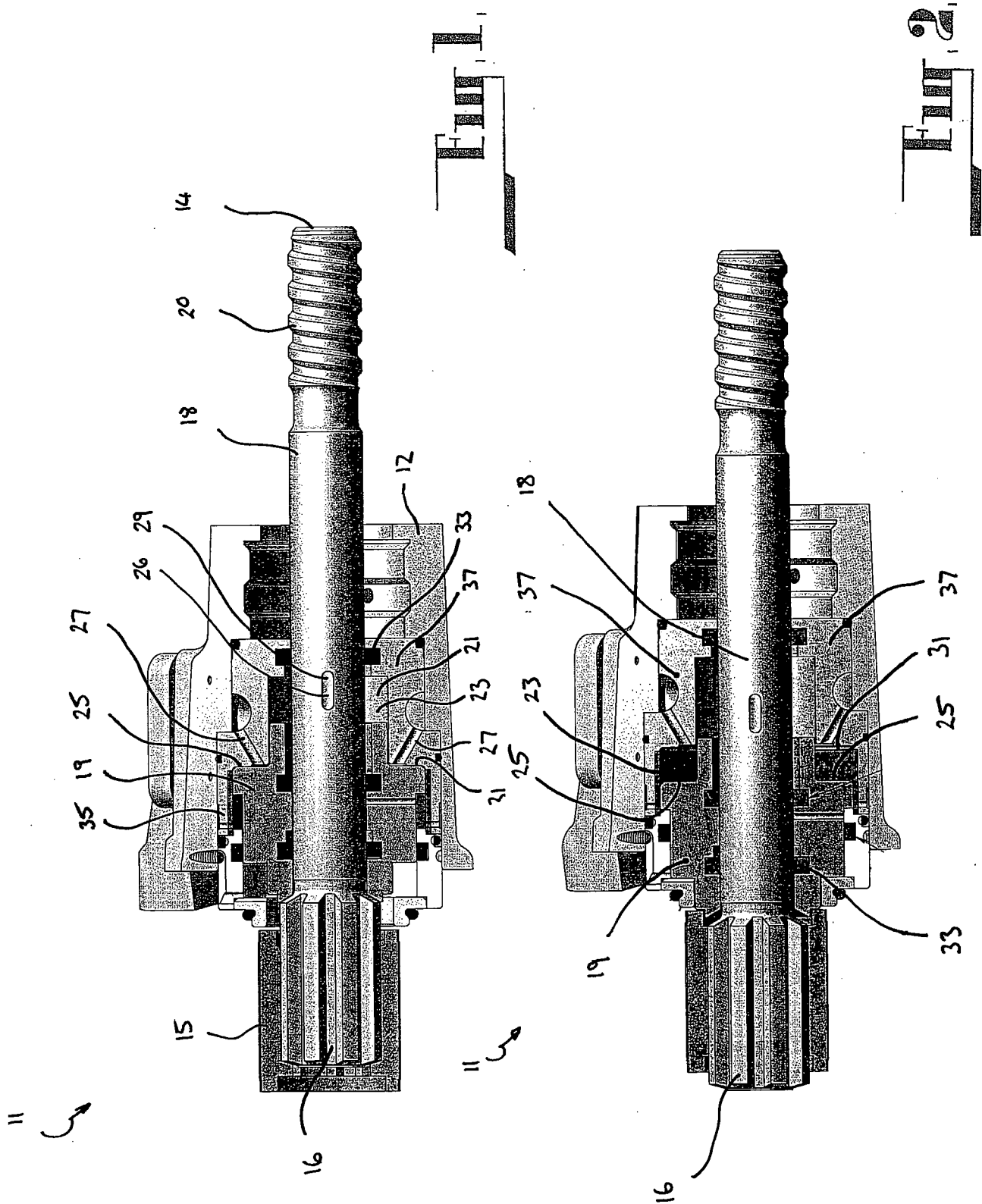
steel, whereby the drill steel has a drill bit at an opposed end for engaging the rock formation.

- 5 6. The drill head assembly according to any one of the preceding claims wherein the shank has a second end adapted to be received in a driver of the drill whereby the driver exerts a rotational force on the shank.
7. The drill head assembly according to any one of the preceding claims wherein when the shank is in the first position the front face of the piston is adjacent or just in contact with a fixed surface of the housing.
- 10 8. The drill head assembly according to any one of the preceding claims wherein the outlet moves between an open condition and a partially closed condition, such that the partially closed condition corresponds to the first position of the shank.
- 15 9. The drill head assembly according to any one of claims 1 to 7 wherein the outlet moves between an open condition and a closed condition, such that the closed condition corresponds to the first position of the shank, whereby in the closed condition the outlet is completely blocked.
- 20 10. The drill head assembly according to claims 7, 8 or 9 wherein the piston moves the shank between the first position and a second position, the second position being defined by the maximum distance the piston extends away from the fixed surface of the housing.
11. The drill head assembly according to any one of the preceding claims wherein the shank has a hollow passage extending therealong, the hollow passage having an open end at the first end of the shank, and a second closed end.
- 25 12. The drill head assembly according to any one of the preceding claims wherein the shank has a portion which passes through the chamber.

13. The drill head assembly according to claims 11 or 12 wherein the shank has an aperture extending from an outer surface of the shank to the hollow passage.
- 5 14. The drill head assembly according to claims 13 wherein the aperture provides the outlet for the chamber.
15. The drill head assembly according to claims 14 wherein the outlet is unrestricted when the shank is in a third position.
- 10 16. The drill head assembly according to claim 14 or 15 whereby when the shank is in the third position the entire aperture is located in the chamber allowing full flow therethrough.
17. The drill head assembly according to claim 14, 15 or 16 wherein when the shank is in the first position the aperture is at least partially blocked by the housing or piston.
- 15 18. The drill head assembly according to any one of claims 7 to 17 wherein the housing has a shoulder extending into the hollow portion to provide the fixed surface.
- 20 19. The drill head assembly according to any one of the preceding claims further comprising a second inlet to provide fluid to the chamber between the fixed surface of the housing and the front face of the piston, creating a second stage pressurisation system.
20. The drill head assembly according to any one of the preceding claims further comprising a one way valve to minimise the vacuum or pulsation which is created as the piston moves the shank from the first position.
- 25 21. The drill head assembly according to any one of the preceding claims wherein the inlet of the chamber is in fluid communication with a fluid supply.

22. The drill head assembly according to claims 21 wherein the fluid supply is provided by the flushing medium typically utilised in a conventional rock drill assembly.
23. The drill head assembly according to any one of the preceding claims wherein the shank's first position is varied according to the pressure in the chamber and/or the location of the outlet with respect to the chamber.
24. The drill head assembly according to claim wherein the pressure is varied by adjusting the flow of the fluid supplied through the inlet.
25. A reciprocating head assembly adapted to be incorporated in a tool such as a rock drill, jackhammer or similar percussion tool, the reciprocating head assembly comprises:
- a housing adapted to support a shank, the shank being adapted to transmit motion to a working end;
 - a reciprocating piston which acts against the shank, to move the shank in a reciprocating manner, the piston being slidingly received in a hollowed portion of the housing;
 - a chamber defined by the hollow portion and a front face of the piston, the chamber having an inlet and an outlet through which a fluid enter and leave the chamber, the chamber varying in size as the piston moves relative to the hollow portion;
- whereby as the shank moves towards a first position the chamber is partially sealed such that further movement of the shank towards the first position causes an increase in pressure in the chamber causing a dampening effect upon the piston.
26. A drill head assembly as substantially herein described with reference to the drawings.

27.A reciprocating head assembly as substantially herein described with reference to the drawings.



INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2010/000815

A. CLASSIFICATION OF SUBJECT MATTER	
<i>Int. Cl.</i>	
<i>E21B 17/07</i> (2006.01) <i>E21B 1/38</i> (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: E21B1, E21B4, E21B6, E21B10/36/low, E21B17/07/low, E21C27/12/low, E21C37/22/low, E21C37/26, B25D9, B25D11, B25D13, B25D15, B25D17, B28D1/26/low & Keywords (impact, percussion, impulse, reciprocate, hammer, breaker, strike, anvil, damp, attenuate, cushion, dashpot, shock, energy, vibration, force, absorb) liquid, fluid, water, hydraulic, pneumatic, flow, flush, resist, restrict, block, obstruct, slow, reduce, prevent, stop, piston, plunger, sleeve, chamber, cylinder, enclosure, compartment, barrel, pressurise, increase, head) & like terms - PATENT LENS: Keywords (downhole, drill, dampen, pressure, increase, build, piston, sleeve, chamber, barrel, impact, percussion, impulse, reciprocal, hammer, strike, anvil)	
C. DOCUMENTS CONSIDERED TO BE RELEVANT	
Category*	Citation of document, with indication, where appropriate, of the relevant passages
X	US 4718500 A (MORI) 12 January 1988 abstract, figure 1 and column 3, line 14 to column 4, line 17
X	US 6273199 B1 (KIIKKA et al.) 14 August 2001 abstract, figure 1, 3-4 and column 4, line 15 to column 7, line 19
X	US 4886128 A (ROEMER) 12 December 1989 abstract and figures 1-3
☒ Further documents are listed in the continuation of Box C ☒ See patent family annex	
* "A"	Special categories of cited documents: 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 09 September 2010	Date of mailing of the international search report 14 SEP 2010
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaaustralia.gov.au Facsimile No. +61 2 6283 7999	Authorized officer ALLAN SMAILES AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No : +61 2 6283 2154

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2010/000815

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 9070774 A (TOYODA MACHINE WORKS LTD) 18 March 1997. English abstract retrieved from EPODOC database. abstract and figure 2	1-13, 18, 20-21, 23-25
X	US 3827410 A (ERMA et al.) 6 August 1974 abstract, figures 1, 3 and column 4, line 1 to 23	1-13, 18-21, 23-25

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2010/000815**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.: 26-27
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 claims do not comply with Rule 6.2(a) because they rely on references to the description and 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.

This Annex lists the known "A" publication level 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 Cited in Search Report			Patent Family Member				
US	4718500	NONE					
US	6273199	AU	65012/98	CA	2285971	FR	2761112
		NO	994556	SE	9903385	WO	9842481
		ZA	9802270				
US	4886128	EP	0283734				
JP	9070774	NONE					
US	3827410	DE	2260342	JP	48066268		
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.							
END OF ANNEX							