

Wombat: Evolution of a World Class Reamer

Background

Hard Metals Australia based in Eastern Creek NSW, was first introduced to Trenchless Technology by local drilling company UEA in 2007. Director, Keith Whittaker was looking for reliable hole openers with Polycrystalline Diamond Composite (PDC) cutters for use in Sydney Sandstone. PDC requires low cutting forces and has excellent wear resistant properties making it ideally suitable for drilling in Sydney Sandstone which is typically a soft to medium strength formation but highly abrasive.



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The first hole openers were fixed wing (Fig 1) and similar to others already being used in the market. The primary method of manufacture was fabrication and while they were effective and relatively inexpensive, maintaining accuracy of axial and radial run-out of the cutter

segments always presented a challenge.

They were also limited being fixed diameter requiring a new tool being built for



even minor changes in bore diameter. Repairs and modifications could only be undertaken in a select number of engineering facilities throughout the country often leading to drilling delays.

Customers wanted field replaceable wings of varying diameter to fit onto a standard body similar to the principal utilised on a roller cone

body that was imported from the US. Engineering carrier arms to suit this US roller cone body, Hard Metals produced their 1st PDC hole opener with field replaceable wings. (Fig 2)

Fig 2

On smaller diameters and over short distances, these were very successful generating high ROP and good bore quality. Difficulties, however were encountered when attempting to upsize over 13" and reaming over 200m. The reasons for this were not initially clear until it was discovered the fasteners were not fit for purpose. This necessitated a review and it was decided to fit a stabilising ring that would tie the wings together and improve structural

stability of the reamers. (Fig 3)



Fig 3

An immediate performance improvement became apparent when an 18" reamer completed a forward ream of 530m off a 6 ¾" pilot bore in a single pass. That was September 2008.

This style of reamer became standard issue over the next 2 years. There was further development of the concept to

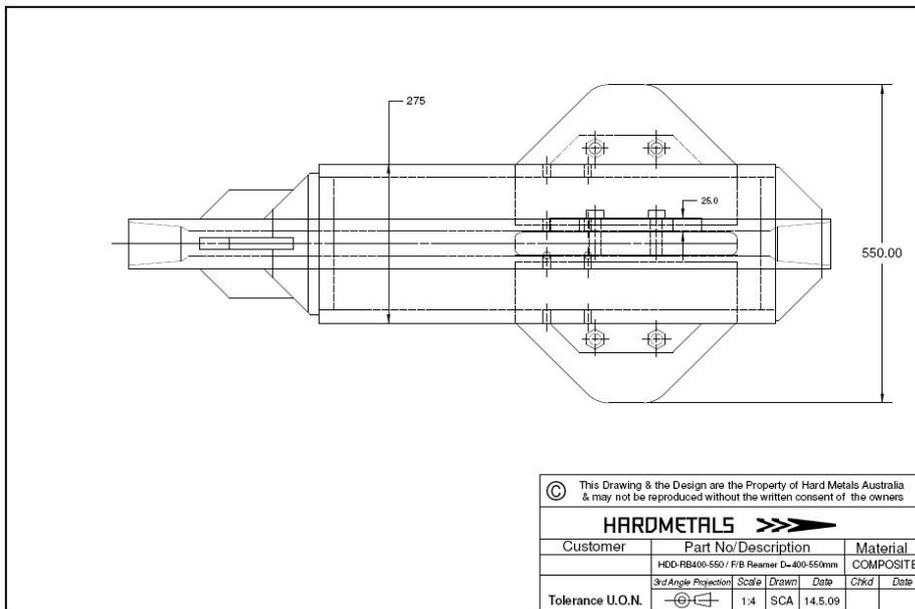
increase the number of blades from 3 to 6 (Fig 4) for better performance. Goods results were achieved with one single ream over 500m at 24" off a 9 ½" pilot through a mixture of competent sedimentary and broken rock in 5 days. While it ticked most the boxes it could not be regarded as being easily field serviceable. Hard Metals Australia Director Stephen



Ainge was not satisfied and set about creating a totally product new which would become the Wombat Hole Opener.

Wombat Hole Openers Created

The first or Series 1 Wombat Reamer was a development of the roller cone body concept. What changed was a complete review of the fastening system to achieve greater security of the cutter wings. Incorporating the stabilising ring presented some engineering obstacles and so it was decided to stabilise



off the body. This necessitated a large diameter central body. (Fig. 5)

Fig 5

While this concept had merit, it also had some problems. Much of this was related to weight. For smaller machines with low torque and small rods, it was difficult to establish a smooth and even rotational progression. Quite often the rods would wind up before the reamer would start to rotate and then the reamer would whip. While it was a critical development step, it was literally weighed down and it was not long before a replacement was on its way.

The Series 2 was shelved before it left the drawing board or computer screen as it is nowadays. The next development was the Series 3. The concept of the body as a stabiliser was discarded. The stabiliser was to be connected directly in line fore and aft of the reamer and the body was to have the single purpose of carrying the wings and as many as possible for high ROP.



The series 3 (Fig 6) discarded weight but was more robust in design. It was more easily field serviced and delivered excellent ROP. On one particular site, the ROP was in excess of 30 metres/hour. Still it suffered from insufficient stabilisation and as a consequence, PDC life was short and service costs were higher than anticipated.

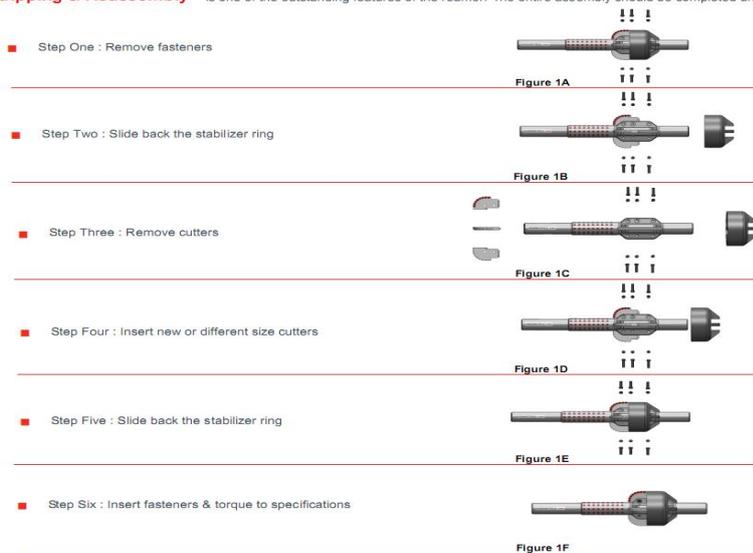
Fig 6

Series 4 Wombat Hole Opener

The series 4 was the culmination of all that been learnt from the very early



Stripping & Reassembly- is one of the outstanding features of the reamer. The entire assembly should be completed under an hour.



(Fig 7)

It also was an upgrade for the following features

- A long body that could be easily removed from the drill string using conventional break-out jaws.
- Large clearance paths to minimise the incidence of clogging at high ROP.
- Could be used for both forward and back reaming.

concepts right through to the Series 3. It was a quantum leap forward in every respect. It was very stable in operation making it suitable in less favourable conditions. It was simple in design and yet it incorporated in built stabilisation close to the cutters and all easily field serviceable.

Of all the new features, it was incorporation of near face stabilisation that is the most critical advance in design. This was especially apparent in the vastly improved life of the cutters over previous reamer concepts especially in difficult ground conditions.

The first real trial of the Series 4 Wombat reamer was on a crossing of the Nepean River in March 2012. This was a particularly difficult project and due to the existence of large cobbles on entry and exit. Casing had been installed



however the conditions in the bore were highly unfavourable and it was decided to use less expensive Tungsten Carbide Cutting Wings (Fig 8) through these sections as sacrificial cutters until the bore progressed into more favourable mudstones and sandstones.

Fig 8

The Tungsten Carbide cutters were changed out for PDC cutters while the body was on the drill string (Fig 9) in under an hour. Reaming of the mudstone at 12



1/2" went successfully with only 1 chipped PDC. General ROP was 13 min/rod on 6.1m rods at 50RPM. The overall consensus was that the reaming was highly successful enabling pipe pull within 2 weeks of starting the process.

Fig 9

Field Test Results

Field Test Result – Central Coast

Length of Bore: 280m Finished Diameter: 24" Sandstone 80 MPa
Machine: Vermeer D100 Rods: 3 ½" x 20' Fire Stick
Process: 6 ¾" Pilot, 18" ream (Wombat S4), 24" ream (Roller Cone)
Wombat Series 4 ROP: 20-30 min / rod
Inrock Rock Roller ROP: 150-180 min / rod

Field Test Result – Cowan July 2013

Length of Bore: 700m Finished Dia: 9" Geology: Sandstone w/- Ironstone
Machine: Vermeer D100 Rods: 3 ½" x 20' Fire Stick
Process: 6 ¾" Pilot (PDC Bit on Mud Motor), 9" Ream (Wombat S4)
PDC Pilot: Damaged and replaced 31 PDC inserts. Repair Cost: \$3060
Wombat S4: No damage whatsoever.



Field Test Result – Galston, April 2015

Length of Bore: 650m Finished Dia: 10.5"
Geology: Sandstone
Machine: Vermeer D100 Rods: 3 ½" x 10' Fire Stick
Process: 6 ¾" Pilot (PDC Bit on Mud Motor), 10.5" Ream (Wombat S4)
Wombat Series 4 ROP: 20-25 min / rod
Wombat S4: No damage whatsoever.

Basic Strategy

While field results in varying strata are limited, they challenge the long held belief that PDC are only applicable to soft sedimentary rock in trenchless applications. This belief is also at odds with the the utilisation of PDC in oilfield and gas drilling operations where PDC is now the first choice for drilling a wide range of strata. The basic strategy that has led to this has been largely dependant on quantum leaps in stabilising the PDC at the drill bit rock interface. While PDC is less impact resistant than conventional tungsten carbide cutters, PDC's capacity for wear resistance can exceed that of Tungsten by more than 30 times. By creating a more stable environment at the cutting face, PDC's excellent wear characteristics can be exploited to the great benefit of the drilling operation. Leading PDC Bit manufacturers are aware of this and much of their R&D focuses on this very subject. In the Series 4 Wombat reamer Hard Metals have made good progress in following this strategy and yet Hard Metals Director Mr. Ainge believes there is still much more that can be achieved.

Worldwide Recognition

There has been a high level of interest in the Wombat worldwide. Recently the Wombat was displayed at No Dig Madrid 2014, Trenchless Middle East in Dubai 2015 and will be at Global Petrloeum Show 2015, Aimex 2015, No Dig Dowunder 2015, Drillfest 2015, and Bauma Germany 2016.

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