DARTS HISTORY

(formerly *Dr. Darts' Newsletter*)

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A BRIEF HISTORY OF TUNGSTEN AND THE MAKING OF TUNGSTEN DARTS – PART 1

Introduction

When tungsten darts were first introduced into the sport of darts in the late 1960s, I thought that 'tungsten' was something very new. I had heard rumours that it was used in the aircraft industry and indeed, as we will find later, that was where it all began.

Part of darts mythology demands that men in their hundreds in the aircraft business used to manufacture sets of tungsten darts during their lunch breaks – presumably from 'off-cuts' – to later sell to their friends down the pub. However, as shown in *Darts History* #167 February 2023, one of the possible 'inventors' of tungsten darts was Ben Drake, co-founder of Elkadart in the late 1960's. (Ben is pictured on the left in this photo, with English cricketer Ian Botham back in the day. Image: *Darts World*/PC Archive.) However, there have been other claims and indeed legal challenges in the early days claiming copyright of the 'invention' all of which remained disputed.

Note: If you don't have a copy of #167, you can now easily access it (and the other 197 copies) at

https://darts501.com/patrick-chaplin.html

For some time, I had been wondering what 'tungsten' really is and how tungsten darts are made. OK, so I knew that tungsten was denser than other metals and so tungsten darts of the same weight as brass were much thinner but that's about the extent of my technical knowledge and guesswork. So, back in 2004, in order to satisfy my curiosity, I decided to try and trace the history of tungsten. I must admit to not relishing the task. I thought it would take ages. Then – Spooky! – I received an e-mail from Phil Wells, (pictured, below) the then General Manager of A & M Tungsten Powders Ltd., at that time based in Maxted Road,

Hemel Hempstead, Hertfordshire, asking for my estimate of the number of folks currently participating in darts across our planet.

After that I viewed the A & M website (now unavailable) and immediately realised that my search for information about tungsten was about to end before it had hardly started.

I am indebted to Phil for allowing me to use the information from the then A & M Tungsten Powders website in the construction of this article.

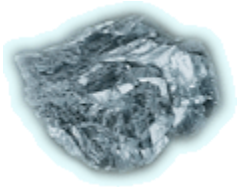
The History of Tungsten

The first thing I realised was that tungsten isn't new at all.

Known by German tin miners for interfering with tin smelting since the 17th century, tungsten metal was first produced in 1785. It's dramatic hardening effect on steel was discovered in the 1850's but the commercial exploitation of this property really began in earnest when Bethlehem Steel displayed a range of high-speed steel cutting tools at the World fair in Paris in 1900.

(**NOTE:** The Bethlehem Steel Corporation was an American steelmaking company headquartered in Bethlehem, Pennsylvania. Until its closure in 2003, it was one of the world's largest steel-producing and shipbuilding companies.)

The modernised version of *wolfrahm,* wolfram, gives rise to the chemical symbol for tungsten: W.



Tungsten 's high melting point literally sparked the next industrial use. Electricity allowed the replacement of flickering gas-lights with a cleaner and brighter substitute.

By 1909, the American metallurgist W. D. Coolidge (1873-1975) had succeeded in developing a method for making tungsten filaments for electric light bulbs and other solid tungsten components such as mill products. In the process he founded a whole new branch of manufacturing – powder metallurgy.

Powder metallurgy was the driving force behind the next advance. German metallurgists, and particularly the Krupp industrial conglomerate, pioneered the use of tungsten carbide in combination with cobalt to make cemented carbides or hard metals. These extremely hard materials proved even more effective than high speed steel as cutting tools.

To this day tungsten carbide remains one of the most important industrial applications of tungsten.

Other industrial applications followed. Price, Smithells, and Williams developed Heavy Metals or High-Density Alloys in the late 1930's. These W-Fe-Ni (iron and nickel) or W-Cu-

Ni (copper and nickel) alloys found important applications in areas as diverse as counterweights and radiation shielding. These alloys were eventually introduced in the manufacture of the barrels of tungsten darts.

Other metallurgists developed electrical contact materials such as tungsten-silver and tungsten-copper. Tungsten-copper was also used as a support for silicon chips in computers: usage that grew rapidly from the 1980s.

New uses for tungsten continued to abound. A rapidly growing area was in lead replacement. Here, tungsten is combined with other materials such as plastics or polymers to make a material the same density as lead. These tungsten lead replacement materials are far less toxic to the environment than the materials they replace.

With nearly three decades of the 21st Century behind us who knows what uses tungsten will have when we enter the 22nd? But, of course, the most important development of interest to *Darts History* readers: tungsten darts.

Darts Billet Manufacture

As all dart players know, a dart is made up of a number of different materials.
The point is generally made of hardened steel or plasticdepending on the type of board and whether you are playing steel tip or soft-tip. The barrel is either made of a tungsten alloy or of brass, the shaft of aluminium or plastic and the flights of a plastic material.

Back in 2004 A & M Tungsten Powders had been making tungsten alloy billets from which dart barrels are machined for a good number of years. These were shipped all over the world to manufacturers who machined the billets into the complex shapes required by modern amateur and professional dart players.

Why does darts *need* tungsten?

Darts has been played as an organised sport for nearly a century and its origins go back well before that. Tungsten darts have been available since the mid-to-late 1970's. Before then the traditional dart had a brass barrel and before that a wooden-bodied dart with lead pressed around it for added weight.

The set of brass darts shown right was regularly used in the 1940s and is a familiar style produced by many darts companies. Notice that this example, (Image from subscriber Michael Paul Glennon's private collection) boasted of 'Hardened steel points,' Selected Turkey Vanes' (flights) and 'Hardwood flight stems.'

Brass has a density of about 8 g cm^{-3}. Tungsten alloys can have a density as high as 18.5 g cm^{-3}. This means that, for equal weights, the diameter of a tungsten dart is far less than the corresponding brass dart. This smaller diameter makes it easier to group darts in the doubles and trebles and even the bullseye – making tungsten darts the choice of all serious players since the late 1970s/early 1980s.

Manufacture of Tungsten Dart Billets

Tungsten darts are made by powder metallurgy. This is a special technique that allows solid metal components to be made from fine powders without melting the metal. Tungsten has such a high melting point – 3,400 degrees Centigrade – that it would be impossible to make it any other way.

The first stage of making a tungsten dart is to blend tungsten together with other metal powders to meet the customer's specifications, with tungsten content ranging from 65%-95% as required. Depending on the manufacturer, the tungsten will either be alloyed with copper and nickel, (W-Cu-Ni), or iron and nickel, (W-Fe-Ni).

Either during the blending stage, or immediately afterwards, approximately 1% of a special wax is added to the blended metal powder. This is known as a 'binder' and is added because the metal powders alone have insufficient strength to hold together after pressing.

The blended powder is then pressed into cylinders of tungsten alloy, closely controlled for weight and pressing load. This degree of control is essential to ensure the cylinders will shrink to the correct diameter and length during the later sintering operation. (See examples of billets above.)

At this stage the metal powders have been pressed into the general shape of the finished billet, but the billet is both larger in size and lower in density than the finished part – successive operations will result in the size decreasing and the density increasing.

After sintering the billets are 'de-waxed'. This involves heating the billets to 800ºC in a hydrogen-containing atmosphere. Heating to 800ºC both removes the wax and increased the mechanical strength of the billet, while the protective atmosphere is necessary to prevent the metal powders reacting with the oxygen in the air.

The next operation is sintering. This involves heating the billets to a temperature sufficient to cause the metal powders to shrink and density. Like the de-waxing operation, this is carried out in a hydrogen-containing atmosphere to prevent the metal powders reacting with the oxygen in the air. Temperatures range from 1,200 – 1,650 degrees Centigrade, the higher temperatures being required for the alloys of higher tungsten content, while the time at temperature is of the order of two hours.

After the sintering operation the billets have shrunk to become fully dense and metallic in character – a metal alloy in every sense of the word.

One of the consequences of the sintering operation is that the billets may have become slightly bowed along the length – the next operation is called ‘reeling’ and results in the billets becoming perfectly straight.

The billets are then centreless-ground so that the outside diameter is ground and polished to within very narrow limits, allowing the billets to be fed into the highly automated machining equipment used by the customers as were supplied by A & M Tungsten Powders.

Finally, the finished billets are carefully inspected to close dimensional tolerances. Any chipped or cracked billets are also rejected at this stage.

For anyone having trouble visualising the manufacturing operation, consider it like making a loaf of bread. The ingredients are first mixed together (the metal powders are blended). They are then formed to shape, (pressed), before being put into the oven, (sintered), to finish them.

Production of Completed Tungsten Darts

A & M Tungsten Powders only produced the billets from which the barrels of tungsten darts were made. These barrels were machined to their final shape by their customers using carefully programmed Computer Numerically Controlled (CNC) equipment.

This typically involved drilling and tapping one end to accept the shaft, and either drilling the other end to accept a steel point, or drilling and tapping the second end to accept a plastic point for the soft tip market. A design can then be machined on to the barrel. This can be done with cutting and knurling tools, while laser-engraving equipment can be used to add manufacturer’s names, etc.

As well as the barrels, CNC equipment was used to machine aluminium shafts, while injection moulding is often used to make plastic shafts. Sophisticated printing and stamping equipment are used to make the flights, each manufacturer striving to bring something different and distinctive to the market. Finally, the darts are assembled and packaged using purpose-designed packaging and artwork.

Your tungsten darts might look simple in construction, after all it’s ‘just a dart,’ but, trust me, a succession of sophisticated machines have been used to produce the product that you hold in your hand. Or, in the case, above, created for the Dutch master, Vincent van der Voort’s hands.) (Image © Winmau Dartboard Co. Ltd., used with permission.)

Doubtless some parts of the processes in the manufacture of your tungsten darts have changed since this article was first researched in 2004 but I hope that this archival piece still serves as an introduction to the manufacture of the modern darts and that the images of the very top-class tungstens show what is available to each and every darts player today.

In Part Two I will check out the early progress, development, and the acceptance, or otherwise, of the introduction of tungsten darts.

FEEDBACK FROM #197

A very special announcement

Apologies to everyone who tried to access the full set of *Dr. Darts' Newsletter/Darts History* on immediately receiving #197 on 7th August. In my leading article notifying everyone of the change I wrote that the archive was available 'now.' Sadly, one or three subscribers tried to access the archive *immediately* upon receipt and found that it didn't work. However, if they had read to the end of the newsletter, they would have found a not that it would be available from Monday 10th August.

Having profusely apologised to David King, who told me that a good number of folks had already tried to access the archive obviously without success, so he worked straightaway to launch it early on 7th. Thanks David.

I have put myself in the corner. I should have included the starting date on Page One, within the lead article. Silly me. Silly ol' Dr. Darts. See me humbled in the corner for my error. The cartoon, left, is courtesy of my good friend Chris Murray. Thanks Chris.

The first subscriber to write about the uploading of the complete set of *Dr. Darts' Newsletters/Darts History* was Mike Cowell who wrote:

'Hi Patrick. Many thanks for the latest newsletter, and especially for making all of the past editions available for download,

I've been looking at them again and realised a couple of weeks ago that I was actually missing one - issue 111. I don't know whether I deleted the email by accident before saving this issue but now thanks to both yourself and David at Darts501 I have been able to complete the set.

I shall enjoy re-reading all the issues again over the next few months, and I will be starting with issue 111 this afternoon :-) Many thanks once again, and best regards, Mike'

Brian H. wrote:

'Thanks for another great read, Patrick, and the chance to go back to the beginning of DDN & catch up on the issues I've missed!'

From Jerry Feather

'Thank you. Always love your Darts History! 50 plus years for me & to think I started playing darts because the Bull & Bush in Denver was the hottest Singles area in Denver, then the Darts took over & I didn't care about the hot women but just threw darts 4 or 5 nights a week!'

From Mick Simpson:

Morning Patrick Wow! What a write up! Blimey, that's incredible you have your Darts History in so many Countries it's fantastic well done. It's true to say you never cease to amaze me. Long May you keep writing I doubt anyone will ever manage what you have managed over the years. Well done, Patrick. I hope Maureen and yourself are doing well? As ever yours in Darts Mick.

Thanks Mick. Maureen and I are OK. Just getting older. Hopefully now that *Darts History* has gone global via Darts501.com, so many more fans will read about my work and learn from nearly 200 issues of *Dr. Darts' Newsletter/Darts History* (and more to come) and, of course, my website www.patrickchaplin.com.

From Australia. From Warren Ackary:

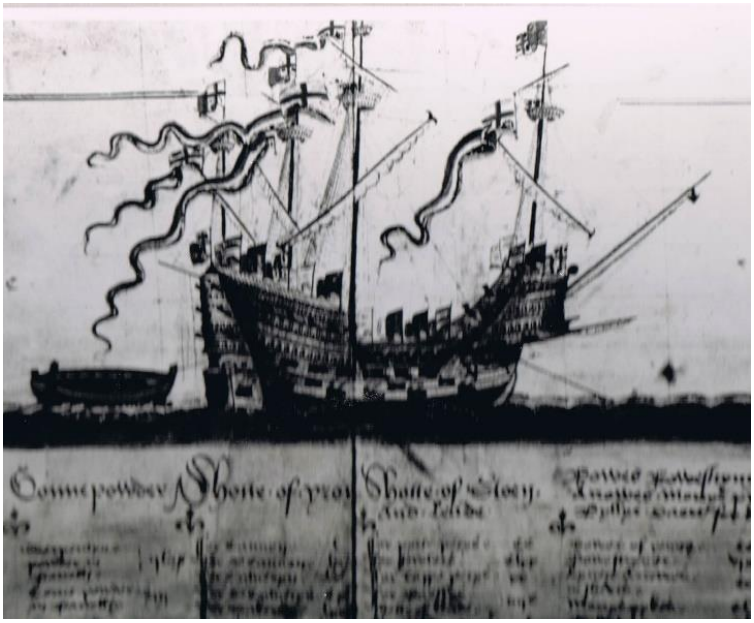
Got your newsletter. As always a great read but I was worried when I started reading. I thought you may go into retirement! I have EVERY edition of DDN and want to see you get to edition 200! I have updated your link on my website, the new page on the site looks very nice indeed.

Thanks to each and everyone of you who have provided feedback.

DARTS AND THE MARY ROSE

Although in issue #196, I put to bed (hopefully for ever) the myth that King Henry VIII had a habit of wandering down to the *Headless Woman* pub to throw a set of tungstens that the luckless Queen Anne (Boleyn) had bought him as a birthday present, it is only right and proper to recognise that 'dartes' (Note the spelling) of another kind were employed in warfare in the 16th Century. (Image, below right, © Magdalen College, Cambridge and the Mary Rose Trust. Used with permission.)

Purely by having always been interested in the Tudor period and Henry VIII and his wives in particular, it was in those moments when I wasn't thinking about the history of darts that I can across 'dartes,' or more accurately, 'darts for wildfire' being used on *The Mary Rose*.



These were utilised to set fire to enemy sails and were normally thrown by hand are first mentioned by historian Michael Oppenheim in his *A History of the Administration of the Royal Navy and of merchant shipping in relation to the Navy Volume 1 1509-1660* (London: John Lane, 1896), p. 57 as appearing in the inventory of 'The Sovereign,' another ship, part of King Henry VIII's fleet. Oppenheim also mentions that 'Dartes…lvij dossen,' are listed immediately after the entry for 'Javelyns' in an inventory for the 'Henry Grace a Dieu' compiled in 1514.

In a letter to me dated 23rd June 1986, Dr. Margaret Rule, C.B.E., F.S.A., the Research Director at The Mary Rose Trust, Dr. Rule informed me that The 'Mary Rose' inventory dated 1546 lists forty dozen 'dartes for tops;' 'tops' being the fighting tops on the masts. In a subsequent letter to me dated 29th March 1989, Ms. Alexandra Hildred, a Research Archaeologist at The Mary Rose Trust confirmed that 'dartes for tops' were missive weapons; small spears or javelins, thrown from the fighting tops situated on the masts and were not dissimilar to 'darts for wildfire.' Most warships of the period were armed with darts; The 'Mary Rose' by no means being unique in this respect.

'Dartes for tops' were thrown by hand and so, in my view, there appears no reason why they could not be thrown for amusement too. Finding evidence is the problem!

NEXT ISSUE:

Part Two of The Tungsten Story plus Bobby George's *News of the World* record.

PLEASE REMEMBER:

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