

Gunfounding At Tintern Ironworks in South Wales during the latter part of the Eighteenth Century*

John A.H.EVANS** and Fumihiko Satofuka***

Cannon making took place at Tintern during the tenure of David Tanner, the last of the great charcoal ironmasters in South Wales before the transition to fuelling blast furnaces with coke to smelt iron. Tanner owned and leased many ironworks in South Wales and the Forest of Dean between c.1770 and 1798. (Fig.4)

Tintern had originally been established to manufacture wire and the first water powered wireworks in Britain was established there in 1556. The production of wire required a high quality ductile iron known as Osmond iron which needed special forging. Manufacture of wire remained an important activity during Tanner's occupancy of the site. (Fig.1~3)

The other main product besides wire produced by David Tanner was cannon when he took over at Tintern in around 1771. He may also have made ordnance at Cyfarthfa, Merthyr Tydfil, during his brief lease of the forge there but his manufacture of cannon at Tintern pre-dates his tenancy of the Merthyr site. In November 1781 John Bedford of Cefn Cribwr in Glamorgan observed the methods adopted by David Tanner. Tanner was attempting to manufacture cannon acceptable to the Board of Ordnance and the gun Bedford saw being made was eventually re-
(1)
jected by the board.

Lord Torrington also saw cannon at Tintern during his tour of the west in 1781. He claimed that the products made at Tintern ranged 'from the smallest wire to a large cannon'. Torrington appears to have been impressed with Tanner's enterprises and made the grossly ex-

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** Extra-mural, University of Wales, College Cardiff

*** University of Wales, College Newport

(1) NLW, John Bedford Papers, 22 Aug. 1786.



Fig1 Tintern Furnace



Fig3 Waterwheel Pit for Waterwheel for Blowing Engine



Fig2 Tintern Furnace Store House for Charcoal and Ironore

aggerated claim that Tanner 'pays daily 1500 workmen'⁽²⁾.

Some details are known of the processes at Tintern. The original furnace had been constructed of sandstone using mortar made from lime and charcoal. It had been about 23ft high and the walls had been between about 16in. and 18in. thick. The outer walls measured about 24ft 9in. square⁽³⁾. The furnace exterior was not changed by Tanner, but the internal structure was altered and the hearth replaced. The standard practice in furnace management was in any case to replace the hearth after every campaign. The furnace measured approximately 23ft in height from the hearth to the throat. The internal lining was made up of dressed sandstone blocks averaging about 2ft by 1ft. The associated waterwheel has been estimated from the remaining scour marks to have been about 25ft 6in. in diameter⁽⁴⁾.

The output of the furnace at the end of the eighteenth century was claimed to be around

(2) Hon. John Byng, *The Torrington diaries, Tour to the west, 1781* (1934), p.24.

(3) J. Pickin, *Excavations at Abbey Tintern, Historical Metallurgy*, (1982), p.12.

(4) J. Pickin, 'Excavations at Abbey Tintern Furnace', *Historical Metallurgy*, (1982), p.14.



Fig4 "Map of Monmouthshire" John Cary, 1787

1,500 tons p.a., but this would appear to be far higher than one would normally expect from a charcoal furnace.⁽⁵⁾

Tanner held the works until March 1798. In April the lease was being advertised to let by the Duke of Beaufort's agent with vacant possession.⁽⁶⁾

In the 1770s the growing demand for armaments by the Board of Ordnance had encouraged ironmasters in South Wales to manufacture cannon. Most of the iron produced in South Wales was sold as bar iron and the making of cannon was one of the few methods attempted in the region to add value by producing a finished saleable product.

The Carron Company in Scotland had made great advances in the manufacture of cheaper cannon, causing the demise of several of their competitors, but in 1773 the quality of cannon manufactured by the Carron Company had been thrown into great doubt. The British Royal Navy began to report a large number of guns bursting during training. Almost all the faulty guns had been produced by Carron. The company blamed the decrease in quality on the problems encountered during their expansion of production to meet the requirements of the recent Falkland Island War.⁽⁷⁾ As a result of these Navy reports, the Board of Ordnance took five of Carron's guns and five guns from the surviving Weald gunfounders and carried out comparative tests in London. All the guns from the Carron Company burst before they had completed ten test firings while all of the Sussex guns survived 45 proof firings each.⁽⁸⁾ These findings resulted in the rejection of all the Carron Company guns laid down for proof on 1, 5 and 26 May, irrespective of whether they had passed proof or not. The board suspended all further orders with the company, quarantined all their guns in storage and withdrew all Carron guns from the service. The crisis caused by the withdrawal of these cannon resulted in a review of the technology of gun making.⁽⁹⁾

In South Wales, Sir Herbert Mackworth of Neath proposed to the board in November 1776 that he be allowed to supply them with brass ordnance.⁽¹⁰⁾ This was refused because the board had employed Jan Verbruggen as the master founder at the Royal Arsenal. Verbruggen had previously been the master founder at the Hague Foundry and he and his son Pieter were to refurbish the Royal Arsenal at Woolwich so that it could supply all the board's needs for brass ordnance.⁽¹¹⁾ All further external contracts issued by the board were to be for iron ordnance only.

(5) H.W.Paar & D.G.Tucker, 'The old wireworks and ironworks of Angidy Valley at Tintern, Gwent'. *Historical Metallurgy*, (1975), p.5.

(6) *Glos. Journal*, 16 Apr.1798.

(7) M.H.Jackson & C.de Beer, *Eighteenth century gunfounders* (Newton Abbot, 1973), p.49-50.

(8) H.Cleere and D.W.Crossley, *The iron industry of the Weald* (Leicester, 1985), p.210.

(9) Jackson and de Beer, *Eighteenth-century gunfounders*, p.50.

(10) PRO, WO 47/88, 12 Nov.1776.

(11) Carel de Beer, *The Art of Gunfounding* (Rotherfield, 1991), pp.9-19.

The board increased their demand for ordnance as the War of American Independence continued. David Tanner first approached the board on 22 June 1779 when he requested a contract for making 200 tons of cannon for delivery before 24 June the following year. The largest size of cannon Tanner was initially prepared to make were 18 pdrs.⁽¹²⁾ The cannon were almost certainly to be manufactured at Tintern.

The board minuted warrants of justification made out to Tanner on 23 January and 1 May⁽¹³⁾ 1781 with the first recorded delivery from Tanner occurring on 23 June 1781, when a report on the receipt of 40 cannon was minuted. The cannon were all 9 ft long, 18 pdrs. The inspection of 38 of them had been postponed because, of the first two cannon tested, one had burst during testing and the other had one bad and rotten trunnion. The board issued instructions to the Verbruggens to inspect both the guns that had burst. They were to assay the metal in order to assess its quality and texture so that the reason for the burst could be determined.⁽¹⁴⁾

The Verbruggens reported their findings to the board on 29 June. Their inspection of the burst gun had shown that the metal had been full of dirt at the point of fracture. On receiving this information the board ordered that another five of Tanner's cannon be tested in the 'severest manner'⁽¹⁵⁾ in an effort to determine whether or not the remaining cannon should be condemned. General Williamson, whose job it was to carry out the testing, queried whether the test should conform to the tests he had previously carried out at a frequency of five times an hour.⁽¹⁶⁾

On 3 and 4 August Tanner delivered more cannon, which were all condemned by the board on 9 August after it was discovered that they were made from the same cast as the first batch that he had delivered in June.⁽¹⁷⁾ On receiving the news, Tanner wrote to the board requesting that they reconsider condemning all the guns merely because some had burst during proof testing. The board replied that they would take ten guns which had been proved by General Williamson but were unwilling to take the rest unless Tanner undertook the expense of having the remaining cannon proof tested to the same standard as the ten that had passed the test.⁽¹⁸⁾ Tanner agreed to defray the expense of the inspection and on 15 September the board agreed to the proof testing being carried out.⁽¹⁹⁾ Before the testing could be carried out, however, William Tanner, acting

(12) PRO, WO 47/93, 25 June 1779.

(13) PRO, WO 47/97 30 Jan. and 1 May 1781.

(14) PRO, WO 47/97, 23 June 1781.

(15) PRO, WO 47/98, 4 July 1781.

(16) PRO, WO 47/98, 7 July 1781.

(17) PRO, WO 47/98, 9 Aug. 1781.

(18) PRO, WO 47/98, 9 Aug. 1781.

(19) PRO, WO 47/98, 15 Sept. 1781.

on behalf of his brother David, withdrew his consent for the guns to be subjected to proofing when he discovered how much it would cost for the cannon to undergo the most rigorous testing that Woolwich could undertake. He was only willing to commit his brother to the expense of normal proof testing and even this was conditional on the board accepting all the guns that survived the test. The board agreed to Tanner withdrawing his guns from the severest tests but refused to accept them tested to any other standard.⁽²⁰⁾ Just over a year later, on 8 October 1782, Tanner wrote again to the board indicating that he would agree to have the trunnion removed from any of his guns which did not pass proof testing. He again requested that the board issue instructions for the testing of all of the rest of his cannon which had been lying at Woolwich for a 'considerable time'.⁽²¹⁾

Despite the problem with the quality of the cannon supplied to the board and the their refusal to accept them, Tanner supplied a further seventeen larger calibre cannon. The cannon were 24 pdrs which measured 91/2ft in length. These were all tested and this time eleven were accepted after passing inspection. Of the other six, one failed a visual inspection by a searcher and five others failed apparently because of dimensional irregularities revealed by instrument checks.⁽²²⁾

On 26 June the board issued instructions for another warrant of justification to be made out to David Tanner.⁽²³⁾

Two weeks later the board were informed of serious problems with the latest delivery of guns from Tanner. They received a report from Major Blomefield concerning one of the 24 pdr cannon that had failed test. Blomefield had been suspicious about the reason for the gun's failure to conform to the board's standards and had ordered it to be cut up so that it could be thoroughly inspected. His suspicions were confirmed when five screws were discovered which had been used to conceal internal defects within the gun. The use of plugs and screws inserted into defects in the bores of guns was a well known method for concealing potentially lethal faults. In bronze ordnance, screws and plugs used to fill defects in the outer surface of the barrel were almost impossible to detect once they had been burnished into the surrounding metal.⁽²⁴⁾ Major Blomefield also suspected that some of the other cannon from the same batch, that had

(20) PRO, WO 47/98, 27 Sept.1781.

(21) PRO, WO 47/100, 10 Oct.1781.

(22) PRO, WO 47/100, p.516 (not in index of minutes).

(23) PRO, WO 47/101, 26 June 1783.

(24) Sir Thomas Blomefield, 1744-1822, of Attleborough, Norfolk, General and Colonel-Commandant of Royal Artillery. In 1789 appointed inspector of artillery and superintendent of the Royal Brass Foundry. (DNB).

(25) David Emanuel Musly, *A treatise of artillery*, (1760-66) quoted in Carel de Beer, *The art of gun-founding*, p.155.

originally passed inspection, may have had similar defects which had not yet been detected. He requested permission to examine and test them all again over a four-day period at the end of July. The board granted Blomefield's request to re-test the guns and immediately ordered that Tanner be made aware 'that the attempt to impose upon the board a gun so faulty and the consequences of using which, might have been so dangerous and destructive, is very highly displeasing to the Master General & Board who will on no account ever receive another gun from him'.⁽²⁶⁾ The board issued the warrant of justification due to Tanner on 2 August.⁽²⁷⁾

It appears to have been the deception practised by Tanner which prompted the board to review their contracts with all gunfounders early the following year. They issued a policy declaration that all future contacts with gunfounders would include a clause that would allow the board to enforce rigidly the right to condemn the whole of a supplier's consignment if any concealed defect were to be discovered. At the same meeting they ordered that the defective guns received from Tanner should be returned to him. They also ordered that the faulty batch be replaced with guns of Tanner's that were lying unproofed at Woolwich.⁽²⁸⁾

Tanner still had 44 guns which he wanted the board to accept and his case was again discussed in March. The board urgently required guns for ships that were due to be launched later that year but again refused to accept any more cannon from Tanner. Major Blomefield was directed to re-examine all the guns which had been accepted from Tanner and which had not yet been put into service. Any of the guns found to be defective were to be returned to Tanner.⁽²⁹⁾

Two years later, there were still 50 of Tanner's 24 pdr guns lying in London which had not been proofed. Thirty-eight of them had been at Woolwich for three years and the other twelve were lying at the wharf at the Tower in London.

In June 1786 Richard Crawshay decided to intervene on behalf of Tanner. Crawshay was partly successful. The board agreed to request a report from Major Blomefield on the condition of the guns held at Woolwich Warren. They specifically asked him to ascertain whether they were part of the consignment that Tanner had delivered in 1781, some of which had been condemned.⁽³⁰⁾⁽³¹⁾

Blomefield reported back to the board on 29 June. He informed them that the 38 guns were part of two consignments, totalling 44 guns, which had been delivered by Tanner in January 1783 and February 1784. The guns had not been tested because of the board's orders of 17

(26) PRO, WO 47/102, 17 July 1783.

(27) PRO, WO 47/102, 2 Aug.1783.

(28) PRO, WO 47/103, 25 Feb.1784.

(29) PRO, WO 47/103, 22 Mar.1784.

(30) Both the Verbruggens were dead by March 1786, (de Beer, *The art of gunfounding*. p.24.).

(31) PRO, WO 47/107, 21 Jun.1786.

July 1783 and 22 March 1784 which had been issued because of the discovery of the five screws concealing defects in one of the 24 pdr guns.

Another nine 24 pdr and five 18 pdr cannon had also been discovered with the same defects. The guns should have been returned to Tanner in accordance with the board's instructions but the order had never been executed. Despite this apparently damning report, the board informed Crawshay that they would be willing to consider accepting the 50 guns if Tanner would accept the conditions laid out in Crawshay's letter. The board also insisted that Tanner was to confirm the offer to them in writing.⁽³²⁾ Tanner made the offer to the board, as requested, on 19 July. He also informed them that all 50 guns had been cast by him prior to their order to stop. The board referred Tanner's offer and a copy of their minute on the subject to the Master General for his consideration.⁽³³⁾ The Master General referred the matter back to Major Blomefield who was requested to report whether or not the guns were required. Blomefield was also asked to give his opinion on whether the guns should be accepted for service even if they passed proof testing in line with the Walkers' contract.⁽³⁴⁾

Major Blomefield must have assured the board that the guns would be acceptable if they passed proof for, on 13 February 1787, the board informed Tanner that they were willing to have the guns proved. Their willingness was subject to Crawshay's recommendation, and Tanner's own assurance, that the guns were made from a different cast of better metal than that of those found to be defective.

The board were obviously wary of Tanner, and so insisted that a new contract be issued to him to prevent misunderstandings and future mistakes.

The twelve guns which had been lying at the wharf were accepted at Woolwich on 26 March and the extra gun of Tanner's that Crawshay had requested the board to take was delivered there on 3 April.⁽³⁵⁾

By 22 April Major Blomefield had tested all Tanner's 50 guns and reported that he suspected that there were screws and plugs covering defects in the bore of three of them. He could not prove his suspicions without cutting up the guns to examine them properly and was unwilling to do this without the board's authority.⁽³⁶⁾ Blomefield was requested to attend the next board meeting to discuss the matter. At that meeting, he confirmed that a visual inspection of the guns had led him to believe that three of them contained screws. The defective guns all

(32) PRO, WO 47/108, 4 July 1786.

(33) PRO, WO 47/108, 19 July 1786.

(34) PRO, WO 47/108, 17 Aug.1786.

(35) PRO, WO 47/109, 3 Apr.1787.

(36) PRO, WO 47/109, 5 Apr.1787.

(37) PRO, WO 47/109, 27 Apr.1787.

appear to have been from the batch of twelve that had lain at the wharf in London and the extra gun that they had accepted at Crawshay's request. The board did not go to the trouble of confirming Blomefield's suspicions about the three guns but simply informed Tanner that they contained screws, rejected all 51 guns and requested him to remove them.

On 2 October Richard Crawshay again appealed to the board on Tanner's behalf. He informed them that he thought it 'rather severe' that all Tanner's guns had been rejected just because of defects in three of them. He asked the board to reconsider their decision and allow the remainder to be accepted. This the board refused to do and added in their statement that their reasons for rejecting them had already been fully explained to him and they were sure that he would understand that it was unnecessary to repeat them.⁽³⁸⁾

The board's rejection of Tanner as a gunfounder did not seem to diminish his optimism or his opportunism, for on 7 December 1787 Major Blomefield reported to the board that another letter had been received from Tanner. In it he requested that all the guns that had been rejected be stamped with the Crown symbol. Since this would have symbolised that the guns had passed proof when they actually had not, the board refused Tanner's request.⁽³⁹⁾

Method of Manufacture

David Tanner's methods of manufacturing cannon were described by John Bedford of Cefn Cribwr Ironworks in 1781 and again in 1788, although it is not clear from his notes whether or not he had actually observed the processes involved. In his notes written in 1781, Bedford describes the making of a malleable iron cannon by a Mr Tamplin, a smith employed by Tanner. Tamplin was forging cannon from part-forged bars rather than by casting them and this may explain why no cannon pits were found at Tintern by Pickin during the archaeological investigation of the site.

The cannon was constructed from four or five half-blooms which were forged together lengthways into one long solid piece at a smith's hearth using a walking bellows. A side-note alternatively described the process as 'made from faggot iron turned and welded as gun barrels over this way they bored'. The description of the method of forging would appear to imply that the separate bars were twisted together by the rotative action of the forging process, in many ways analogous to the making of thick wire rope.

The gross weight of the forged cannon blank was estimated to be around 5 cwt which was

(38) PRO, WO 47/110, 9 Oct.1787.

(39) PRO, WO 47/110, 12 Dec.1787.

reduced to a finished weight of about 2 cwt after the bore and external surface had been machined. There were difficulties in handling the resulting blank because of its weight and shape. There were also difficulties in drilling the bore of the cannon, which was probably harder to drill than a normal solid cast iron cannon blank. The granular nature of cast iron makes it relatively easy to cut, whereas boring cannon of this design would have been more difficult, partly because of the added strength of the metal induced during the forging process and partly because the tool would have been passing through different bars from different casts. The forging of half-blooms would almost certainly have meant a higher proportion of slag inclusions being dispersed throughout the unbored cannon which were probably harder than the cutting tools employed. The problem was overcome by boring the cannon first to the calibre of a one pounder and then increasing the diameter to that of a two pounder and so on in one pounder steps until the desired calibre for a six pounder cannon was reached. Indeed, Bedford described the process as taking a long time. His comment that 'they found by their water mill that they could bore one a day at one spindle', which would have meant that the full cycle of boring operations would have taken six working days to complete. The full manufacturing cost for the gun that Bedford described was claimed by Tanner to be more than £20.

The cannon was tested by firing it with charges of up to and including 6lb of powder with a 6lb cannon-ball. Although the cannon withstood the tests carried out by Tanner's men, it was still rejected by the arsenal at Woolwich because of the test failure of a cannon supplied by Tanner eighteen months before. ⁽⁴⁰⁾ (Between 1776 and 1778, the Verbruggens had been making 6 pdr bronze cannon at Woolwich under the directions of General Desaguliers; the 6 pdr guns cast by the Verbruggens were used by Captain Congreve attached to carriages.) ⁽⁴¹⁾

In 1788 Bedford wrote down another of his recollections of Tanner's methods of cannon manufacture at Tintern which, in this case, he refers to as 'Abbey Tintern Gun Foundry'. Bedford's description this time refers to what was by this date the more usual method of casting guns solid and then boring them out.

Tanner's success as a gunfounder

It is difficult to assess Tanner's true success as a gunmaker. Major Thomas Blomefield was appointed as inspector of artillery between Tanner's his first approach to the Board of Ordnance and his first delivery of cannon. In the year before Blomefield took over the post, serious

(40) NLW, John Bedford Papers, 3 Nov.1781.

(41) de Beer, *The art of gunfounding*. p.19.

complaints had been made to the board about the quality of powder and guns by Admiral Barrington. Blomefield's appointment seems to have heralded a new and concerted attempt to improve the quality of ordnance supplied to the board. In his first year in office Blomefield condemned 496 pieces of ordnance.

Tanner's move to Merthyr showed an apparent will to succeed in the manufacture of cannon by leasing premises with a proven record for making guns acceptable to the Board of Ordnance. The facilities at Merthyr and Tintern would have given Tanner the capacity to manufacture cannon on a much larger scale than is evident from the Board of Ordnance records. Also, all the board's gunfounding contractors would have been aware that the 6 pdr forged cannon described by Bedford was of a type not apparently acceptable to the board. Thus the possibility exists that in the eight-year period of Tanner's known involvement with cannon, he was making them for sale to customers other than the Board of Ordnance.

Although the quality of Tanner's guns was generally very poor and he was certainly the worst supplier of cannon to the board during the period of his first deliveries, it is difficult to assess just how poor the quality really was. The figures for the failure of Tanner's guns in the Board of Ordnance minutes and the proof records for the initial period of 1780-1 show a 100 per cent rejection of the 42 12 pdrs and a 75 per cent failure rate for the 70 18 pdrs he delivered⁽⁴²⁾. The board's refusal to accept the form of deceit practised by Tanner meant that many of these cannon were not subject to full testing. The whole batch was condemned because of the screws found in some of them. Other gunfounders achieved failure rates of 44 per cent and nearly 67 per cent on comparable ranges of guns during the same period. The average overall failure rate during the same period was 10 per cent. The weight of guns supplied by Tanner was, however, more consistent than that of guns supplied by his rival gunfounders during the same period. The guns were weighed to the nearest half stone and an analysis of the weight variation for 9 ft 18 pdr guns show that Tanner could consistently manufacture them at around 40 cwt.

Abbreviations

<i>DNB</i>	Dictionary of National Biography
<i>DWB</i>	Dictionary of Welsh Biography
<i>GwRO</i>	Gwent Record Office
<i>PRO</i>	Public Record Office

(42) Brown, 'The Woolwich proof registers', *International Journal of Nautical Archaeology and Underwater Exploration* (1988) p.107.

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Synopsis

Cannon making In Tintern In The Eighteenth Century.

Britain was almost continually at war through out the eighteenth century. In the 1770s the growing demand for armaments by the Board of Ordnance encouraged ironmasters to manufacture cannon on a growing scale. This included a few ironmasters in South Wales where most of the iron produced was sold as bar iron. The making of cannon was one of the few methods attempted in the region to add value by producing a finished saleable product.

This period of manufacture was accompanied by the Board of Ordnance's attempt to introduce stricter quality control. This paper attempts to explore the production and methods of manufacture employed at Tintern Ironworks by David Tanner, the last of the great charcoal ironmasters in South Wales, and to examine his degree of success as a gunfounder and some of the technical problems that he had to attempt to overcome.

It also briefly examines the changing attitude of the Board of Ordnance to aspects of quality control in gunmaking and the comparative success of other gunmakers in Britain at that time.