NEWSLETTER NO 41 SPRING 2005

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WINTER MEETING

The Winter Meeting of the Group was held at 2.30pm on Saturday, 22nd January at the Nutley Memorial Hall

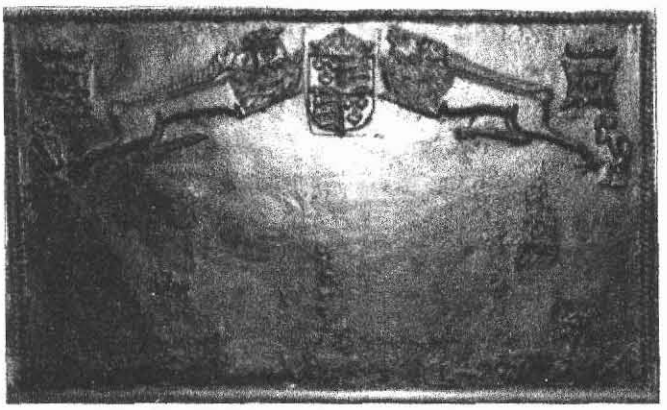
The meeting was well attended and members heard an interesting and well-illustrated talk by Jeremy Hodgkinson, WIRG Chairman, "Cast-Iron Firebacks – some observations on their evolution, design and provenance". Jeremy's interest was kindled when he inherited a fireback, cast at Ashburnham Furnace, which his parents had bought for £2 from an old cottage in Bexhill that was being renovated. His aim has been to record as many firebacks as possible, building a collection of photographs that has enabled him to find recurring patterns and series.

The earliest firebacks date from the mid to late 16th century, a period when the building of many new smoke bays and chimneys caused a high demand for protection of the back of the fireplaces. These early firebacks were wider than they were high, matching the shape of the fireplace. During the 17th and 18th centuries fireplaces became narrower and firebacks gradually became narrower and taller to suit.

Manufacture of a fireback involves the preparation of a bed of sand into which objects or moulds can be pressed to leave an imprint before molten iron is poured on top. Generalised types of design can be observed. The most simple involve patterns made by rope or carved wooden mouldings. There is also the use of prepared symbols such as heraldic motifs. The same motif may be used in differing arrangements on different firebacks and letters and numbers may also be used. Heraldic designs are also used, including the Royal coat of arms that, because it changes according to the monarch, may aid in dating. Some firebacks use personal designs, such as the Pelham buckle or the well-known Lenard fireback, showing the iron founder, his furnace, dog and tools of his trade. Historic events may be commemorated, such as the Lewes Martyrs or the Royal Oak at Boscobel. Finally, biblical and classical designs appear, many from abroad.

Through some impressive detective work, Jeremy has identified several specific series of firebacks, which contain clues about their origin. Some – the Anne Forster and Fowle series - had been identified by earlier researchers.

The Royal series is based on a huge fireback in Anne of Cleves House, crammed with Tudor motifs including the coat of arms, a rose and crown and fleurs de lys. The existence of similar firebacks using some of the same motifs, suggests that they may all have come from the same furnace; they could have had a variety of carved motifs in stock that were used to make up designs for the requirements of individual customers. Jeremy suggested that the use of Royal motifs might suggest that the source was one of the Crown furnaces, such as Newbridge or Worth.



Fireback from Hastings Museum

The Fowle series is a set of detailed firebacks with a 'fowl' motif, all of similar size, and using wooden mouldings. A connection with the Fowle family has been suggested although this is not certain. Recurring motifs are a sunburst rose and crown, ropework and wooden mouldings.

A grave slab (Lewes)

The Anne Forster series is based on her graveslab at Crowhurst Church, Surrey, which includes an inscription, two coats of arms, children, a shroud and a grape motif around the edge. This series is odd because there are at least four copies, all firebacks, two of which are in churches (at East Grinstead and Ardingly), one in the Six Bells, Billingshurst and one at the Sussex Archaeological Society. Jeremy speculated that the reason for making copies might have been that it was making use of an expensive carving in a time when most people could not read the inscription, or to reinforce the stated claim of the graveslab that Anne's children were their grandfather's heirs.

The Lenard Fireback

The Brede series contains the Lenard fireback, which is signed and dated, a naïve figure representing the 'Ogre of Brede', and a fireback showing three Biblical scenes. The last, and best, of these is at Squerries Court, Westerham, and it shows crude figures dressed in the style of the 17th century. A curly bracket in the design matches one in the Lenard fireback.

The Ayloffe series contains six firebacks that show a geometric pattern using shields of Sir W. Ayloffe, with varied inscriptions and dates from 1603 to 1630 and often the initials 'CT'.

Following the Restoration, the Netherlands influence is seen in several series, which incorporate biblical and classical scenes. Many of the designs show Dutch history and tend to be repeated although the borders vary. This suggests that border and design were available as separate pattern piece

Fireback from Petworth (Dutch influence)

The designs of the Ashburnham series are similar to the Netherland designs, showing classical subjects in a more elaborately shaped fireback, and with the monogram 'AN'. The last of these, showing the Ashburnham coronet and dated 1813, was made just before the furnace finally blew out.

Jeremy followed this fascinating and detailed talk by showing a film, made by Dot and Tony Meades, of firebacks being cast at Rye Foundry.

ANOTHER MAYFIELD GUN

A phone call from Wessex Archaeology last year alerted us to the finding of another cannon that had been taken from the wreck of a late 16th century merchant ship in the Thames estuary. It bears the initials and grasshopper family crest of Sir Thomas Gresham, who cast guns for Queen Elizabeth I at Mayfield furnace; this demi-culverin has been described as the most significant gun found since the recovery of the Mary Rose.

Sir Thomas was no mere ironmaster; he was both a courtier and the Queen's financial agent, raising money on the Antwerp money market and buying large quantities of arms for the English army.

After the Spanish crushed a Calvinist revolt in 1567, Gresham came to Mayfield where his family owned the Old Palace. In his time, Mayfield Palace was splendidly furnished, fit for Queen Elizabeth to visit him there; he even built a private staircase to the Queen's apartments so that she would not have to share with other guests.

He is referred to in Hogge's Complaint of 1573 as casting guns (see Straker, Ernest p 150-152). As a result of this Complaint, many ironmasters had to appear and sign a bond to ensure that they would not export guns without a licence. Although Gresham was excused this duty, he was licensed to export cannon in 1574 and in 1578 and was listed as the owner of Mayfield furnace in 1574. He died in 1579.

Further details of Mayfield Furnace may be found in *Wealden Iron* by Ernest Straker, p 292, 293 and in *The Iron Industry of the Weald* p 344 by Cleere and Crossley. Hogge's Complaint appears in *Wealden Iron* p 150-15.

DMM

PRINCE RUPERT'S PATENT GUNS

Jeremy Greenwood has kindly responded to the report in our last newsletter with the following information.

The recent publicity surrounding the recovery of one of these guns from the Stirling does not give the full story. It is one of 39 demi-cannon of 9 ½ft. delivered in June 1690 to the Board of Ordnance by Thomas Westerne noted as 'neiled and turned iron ordnance'. (R Brown. 'Thomas Westerne: The great Ironmonger'. *J. Ordnance Soc.* 13. 2001, 39-54 : PRO WO 51/41 f.13)
It was cast by John Browne (died 1677) or his widow at Brenchley or Hawkhurst in 1677-8, 'on spec', as no orders for such expensive (£60 a ton) guns were made by the Ordnance Board. Although the Brownes supplied many 'rough iron' guns for

the 'Thirty New ships' programme of the navy during 1678-80, they were only paid the normal £16-18 a ton. Heavily in debt, Mary Browne and her partners, Alexander Courthope and William Dyke, borrowed from many sources including the Thomas Westernes (father and son). The latter eventually obtained judgement against the partnership and in 1642 the Sheriff of Kent seized guns lying at Maidstone and Hawkhurst, in settlement of the uncleared debt. These guns included the ones sold by the Westernes in 1690. (Barter Bailey, S. *Prince Rupert's patent guns*. 2000. Leeds: PRO C 9/119/24)

JG

FORAY REPORTS

An invited foray to Hendall Wood, Maresfield, TQ475249; 7/12/04

Landowners are always asked for permission to search their land. Occasionally, however, a landowner invites us to visit an interesting feature, which makes arranging a foray easier and is much appreciated. This happened in November last, when Mr Duncan Ferns, the new owner of Hendall Wood contacted us. The land in question was not part of the Hendal blast furnace and forge site but further downsteam. The mention of large pits in the woodland and a stream flowing through it seemed promising.

In fact, two of the pits turned out to be very large and exactly on the junction of the Tunbridge Wells Sand and Wadhurst Clay, whilst at the east end of one pit a level area may indicate the site of a former building. A little further "down" the Wadhurst Clay there were a further three, smaller pits. By one of these pits, now named "Hendall Wood West", at approximately TQ47652496, there was a bloomery site about 15m in diameter. A second, smaller site was found at approximately TQ47752499 (Hendall Wood East). Other finds were two nice pieces of nodular iron ore.

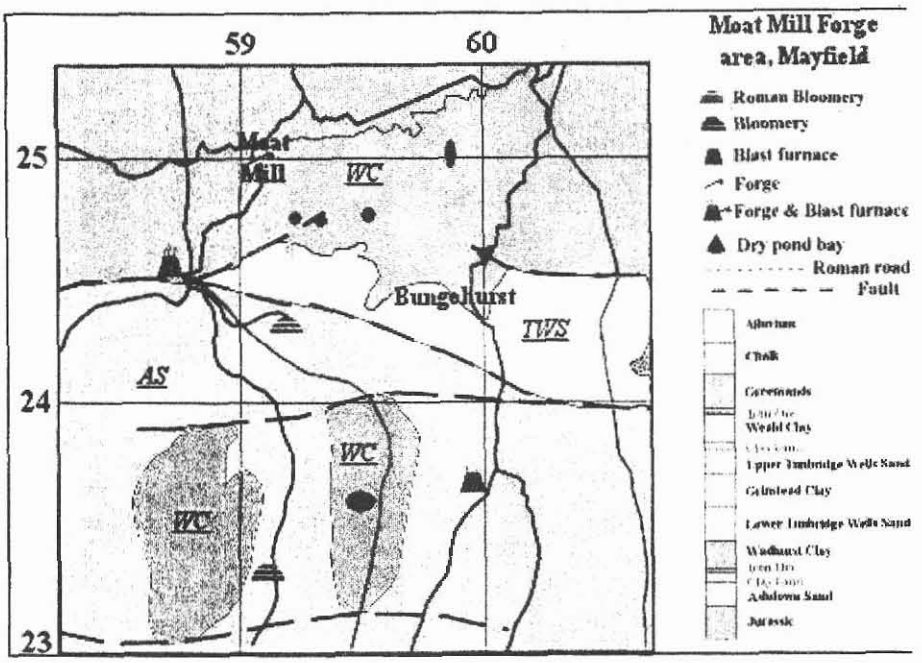
During the 2005-2006 foray season it is hoped to search the wood more thoroughly and also to organize a small excavation to search for dating material

BH and DMM

Another foray to the search area, now in south Mayfield

After the exciting discovery, and excavation of the Roman bloomery furnace site at Little Furnace Wood, Mayfield, Sussex, we searched the next valley to the south. We found one very small bloomery site beside the stream and an area of slag in a field, high up on th north bank.. It was hoped that the next valley north might be more productive but this was not to be.

A sketch of the geology for the area is shown in the map below, where strata initials have been added to help identification.



Starting at the valley between TQ59052469 and TQ59352465, two large, water-filled pits were noted. No definite clues could be found as to their origin although a few small pieces of sandstone were seen lying around . They had both been dug close to the to of the Wadhurst Clay. The width of the valley seems to have been considerably enlarged when the pits wer dug and the top-most pit extended to the end of the valley, culminating in very steep edge up to the footpath at the top.

These two pits may have well been dug for marl (calcareous material used to improve sandy farm land), perhaps with a lucky find of iron ore at some level, this would account for the lack of overburden to be seen as this would have been considerable if only iron ore had been removed from them.

There was no obvious track away from the valley by which marl or ore could have been transported, although the latter might have been taken down the valley in the direction of Old Mill blast furnace. So, could these pits have provided iron ore from the top levels of the Wadhurst Clay? [Pits lying in a similar position were noted in the foray to Hendall Wood as reported above.]

A dry quarry in the field to the south, at TQ59152458, had a sandstone face some six to nine metres deep in the Tunbridge Wells Sand, at a slightly higher level that the two pits.

Continuing east, over the ridge and to the next valley from TQ59462457 to TQ59522477, this was followed, north, down towards the R. Rother. Here, we came across another water-filled pit, at exactly the same height and geology as the two previous pits, leading to similar conclusions, although in this case the ore might have gone to Bungehurst blast furnace. However, there is a definite and closer source of iron ore on the ridge road to the west.

As an aside, the 2.5"/mile map marked a gap in the stream where this pit had been dug; did the cartographer forget to paint-in the blue blob? Strangely, the stream petered out after about 100m at TQ59522477, causing the foray to be rather shorter than expected. It may be that this stream was man-made, or widened, to partially drain this pit.

Towards the edge of the Rother valley we crossed the man-cut tailrace for Moat Mill Forge (later a corn mill). Later on, it was noticed that this tailrace had meanders further down the race; so this part was definitely not man-cut. Also here, the course of the R. Rother, to the east, is very straight, so this is definitely man-cut. These points may easily be seen on the 2.5in/mile map and it is intended to investigate these features on our next foray.

Recently, on speaking to the farmer who owns the two water-filled pits in the valley, he said that the pits are/were known for their "puddling clay", although we were not sure if this was different from just common "clay", but it was obviously used for sealing the bottom of ponds.

BH

Bloomery site (1) approx TQ47652496

Bloomery slag had already been found on the left bank of the stream some 100m east of the Weald Way footpath. The slaggy area was approximately 15m in diameter, up a slight bank, although a patch of slag was found within the roots of a fallen tree a few metres further south; in the hole made by the roots there are some sandstones that should be carefully investigated.

Very little of the visible slag seemed to be typically Roman, although small pieces might indicate tapping. The site would be very easy to dig for dating material. One of the lower-level pits was adjacent to this bloomery site.

BH

Bloomery site (2) approx TQ47752499

Again, bloomery slag was found had already been found on the bank where the two previously mentioned streams met. [On the right bank of the E-W stream and the left bank of the south-flowing stream]. This scatter was about 10m in diameter and the slag looked to be very similar. The site would be very easy to dig for dating material. [Bloomery furnace sites have been noted before on a bank between two meeting streams; this being a well-drained situation.]

The neck of woodland to the north was not searched [owner unknown] but this is on the Ashdown Sand.

Not all the E-W stream has been searched for sites, but the owner would allow us to visit the area, providing that we let him know in advance.

BH

In search of Bournemill Furnace

This foray, scheduled for January 2005, was brought forward to the previous November, and was sparked off by the assertion, in a recent paper written by Dr Christopher Chalklin in *Archaeologia Cantiana*, that, contrary to what had been written in *The Iron Industry of the Weald*, Bournemill furnace and Vauxhall furnace were not synonymous (see Recent Publications below, p 7).

Bournemill is situated in a quiet corner of the Weald, south east of Tonbridge, virtually encircled by main roads and railway lines. The name, however, is old, dating back to the 14th century at least. Dr Chalklin's article located the site of the putative Bournemill furnace about 200 metres downstream of Vauxhall furnace, at a point where a footpath crosses the Hastings-London railway line. It did not take long to discover that this had not been the furnace site. Despite what must have been considerable disturbance to the ground when the railway embankment, and the culvert taking the stream beneath it, were made in the 1840s, the whole layout of the ground as well as the almost total absence of slag made it clear that this was not the site it had been suspected of being.

The group moved on, over the railway line, and followed the stream towards Bournemill Farm. Nothing in the stream or on its banks suggested that a furnace had been in the vicinity. We were not able to look in the grounds of the former farm, but might try to find the opportunity to return at a later date. Instead we retraced our steps to the railway but, instead of re-crossing, we continued uphill towards Minepit Wood. This turned out to be a slightly disappointing detour as, although a small number of pits were noted, the wood did not really live up to its name.

Returning to the other side of the railway line, we visited the site of Vauxhall furnace. This is a 'rare bird' – an open-field, blast furnace site – where it is possible to see most of the features normally associated with such a site, but without the trees that usually intervene.

A slightly disappointing foray, in that we did not achieve what we set out to do, but interesting in that a new area was explored, and the chance to see a site that many who attended had not seen before.

JSH

In search of Iping Furnace

Our knowledge of the existence of Iping furnace, which is listed by neither Straker nor Cleere & Crossley, is, in part, due to a tragic accident. While it was only just light in early February 1629 (which would have been 1630 had the calendar been changed before then, instead of in 1752), Richard Heather, a husbandman from Iping in western Sussex, was riding along the road which formed the bay of the furnace. His horse must have been of a more than usually nervous disposition for it took fright at the noise of the water cascading over the water wheel which powered the furnace bellows, and at the gasping of the bellows themselves. Leaping sideways off the narrow road and into the furnace pond, it drowned itself and its hapless rider. The coroner's inquest, held at Easebourne a few days later, made it clear that the accident had occurred in Iping parish – more specifically, in Iping Marsh, an area of common in the central part of the parish – and that the road across the bay was newly constructed.

So the purpose of the foray was to find the site of the furnace. Apart from Chithurst Hammer, in the south of the parish, where it borders Chithurst, no other iron sites are known in Iping. Milland furnace lies just to the north in what used to be Trotton, and to the east is Inholmes Copse furnace, in Stedham, a site with no known association with any ironmaster or any particular historical period. Parishes in this part of West Sussex quite commonly had detached portions of other parishes within their boundaries, and Iping was no exception, although it did not appear to have any such outliers in any of the neighbouring parishes – according to the 1st edition of the 25" Ordnance Survey map at any rate. The first problem was 'where to look?' The preliminary drawings for the 1st edition of the OS one-inch map, which in the case of Iping date from 1808-9, show Iping Marsh as covering the middle of the parish, with other, so called, marshes – Milland Marsh and Wardley Marsh – further to the north. Iping Marsh, paradoxically, is mainly high ground with only one stream running across it on which a

furnace could have stood. However, in West Sussex Record Office, in Chichester is a beautifully drawn, large-scale map showing the extent of Iping Marsh in 1857, at the time when it was being enclosed. This map includes Milland and Wardley Marshes, or at least those parts which then lay in Iping. Could the furnace have been in one of those areas?

The foray began with a walk across rather wet ground alongside the Hammer Stream (it leads to Chithurst Hammer eventually), going north, towards Milland mill. Passing the mill, we found two other pond bays upstream, but no slag at any of the sites. Beyond these sites lies Milland furnace, but we did not go that far. Back at Milland, we looked in the copse that lies on the south side of the local road between Milland and Fernhurst, opposite a pond called Durrant's Pond. With a road passing across the bay, in the area formerly called Milland Marsh, this site was certainly a candidate, but no evidence was found to suggest it had been a furnace. There was no slag, except a small amount where the stream emerged into the field, the area was too narrow, and there was insufficient change in the level of the ground to have caused enough fall of water to turn a water wheel.

We carried on along the banks of the Hammer Stream to Lyford Bridge, where the stream passes under the local road leading from Milland to Iping. Here we were in what had been called Iping Marsh, but there was nothing to suggest there had been any ironworks. We then walked up a side stream, in the direction of Inholmes Copse furnace. Here we were in more familiar terrain, in a small wooded valley. We were climbing gently uphill, but still on the ubiquitous Weald Clay. As we neared the parish boundary, several minepits were noticed – not surprising given the nearness of Inholmes. But when were they in use? We walked back along Lambourne Lane, which forms the parish boundary - our mission had failed!

So where is Iping furnace? There is one other part of Iping Marsh still to explore, but all the other likely locations lie outside the parish. Frustratingly, iron slag appears with monotonous regularity in most parts of the parish, though this probably comes from its widespread use for road metalling. Could Inholmes be the missing furnace? Perhaps in the 17th century it occupied a detached portion of Iping within Stedham, which has since been incorporated into its adopted parish. The quest goes on.

JSH

RECENT PUBLICATIONS

C. Chalklin, 'Iron manufacture in Tonbridge parish, with special reference to Barden furnace c.1552-1771', *Archæologia Cantiana*, 124 (2004), 95-115.

Without detailed studies such as this, general understanding of the development of the iron industry in the Weald would be based on broad assumptions. That said, the subjective selection of sites to study based on their proximity to a particular urban centre may not, in itself, reveal patterns upon which informed assumptions about the industry in general can be founded.

The paper commences with a general survey of the state of the iron industry from the 16th to 18th century, drawn from the main secondary sources, after which the author examines the historiography of those sources, although the endnotes indicate that he has not looked at some of the most recent studies.

Significant features of the land adjacent to Tonbridge in the 16th century were four large estates: Southfrith, Northfrith, Postern and the Cage, all of which had extensive woodland, and which provided the fuel for a cluster of iron mills. Southfrith, which in the 14th century had supported well-documented ironworks (curiously not mentioned in this article), supplied Vauxhall furnace and Old Forge towards Southborough, which were in the hands of George Harper and Thomas Culpepper in 1552, although they sub-leased the works to Davy Willard. Within 20 years, the timber resources of Southfrith were nearly exhausted. The woodland of the other three estates was being drawn upon for the forge erected at Postern by the same tenants. With little other evidence for the operation of these works, a Star Chamber case of 1610 sheds some interesting light on the workforce and tenancy at the time.

The existence of Bournemill furnace, a short distance to the north of Vauxhall, has been known from the lists of 1574, but its common tenancy with Vauxhall and the uncertainty of an allegation of 1563 that Sir Thomas Fane, the then owner, owned Vauxhall, Old Forge and two other ironworks, has led to the assumption that it and Vauxhall were one and the same. Dr Chalklin asserts that they are two separate furnaces, and that Bournemill was specifically referred to as 'the Old Furnace' when the eponymous estate was sold in 1615. The closeness of the two sites would probably have led to water supply difficulties for the lower works.

Barden furnace did not draw its fuel supplies from the sources used by the other works in the Tonbridge area, but was able to make use of the resources of the nearby Penshurst estate. The history of the site is well documented from 1549/50, passing through several owners and tenants including the Willard family who operated the other Tonbridge works. It was mainly used for gun casting in the 16th century, but in the early part of the next century cooking pots were among its products. Guns were again being made when the furnace came under the control of the Browne family during and after the Civil War, and it was described by Sir John Hope after his visit in 1646. Laid off after the first Dutch war, it was revived in the next decade but was in the hands of Edward Herbert by 1670, in whose family's hands it stayed until 1729 when it was taken over by William Bowen. The information available about Bowen is considerably more than Dr Chalklin seems to have found out, particularly in the records of the Board of Ordnance, and its omission somewhat diminishes the paper. Nor is there any comment on evidence of a forge at Barden.

The activities of the ironmasters referred to, and their positions in local society, are discussed more fully in the closing section. Evidence of their wealth is described, as are some details of the skilled labour force they employed. Finally, the author comments on the supplies of wood for the furnaces, although sources of ore are not mentioned.

There is much useful information in this paper, although it is not exhaustive. There is a basic map of the area, showing the positions of the ironworks, but the courses of the waterways would have been a useful addition, and there are illustrations taken from Straker's Wealden Iron, showing contemporary drawings of Horsmonden and Lamberhurst furnaces, with the latter erroneously described as the exterior of the furnace.

JSH

TEBBUTT RESEARCH FUND

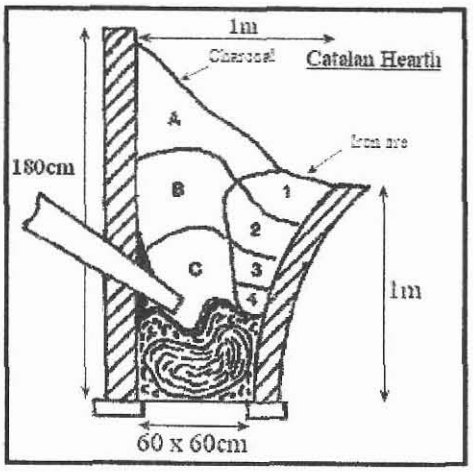
Applications for grants from this fund are welcome. They are available for expenses relating to any research into the Wealden Iron Industry. Further details from our secretary, Ann Callow (address at the end of this newsletter). Applications should be submitted before the end of April 2005 for consideration this year.

BLOOMERY SMELTING USING A CERAMIC TUYERE EXTENDING INTO THE CHARGE

With all our experiments, so far, we have stopped the (mild steel) tuyere pipe at the inside surface of the furnace wall; unfortunately, about 10-mm of the pipe becomes oxidised during each smelt, so necessitating its removal to re-shape and then re-fit it into the furnace. Although a practical scheme, it has now been abandoned; iron pipes might have been very difficult to make in the Roman period and difficult in the mediaeval period, although it was possible to make iron pipes for the Wealden glass blowers working on the Surrey/Sussex border between 1330 to 1618 [1]. They were about 4 to 5 feet long but no mention of their diameter can be found.

The air inlet pipe (still metal) is now stopped half way through the furnace wall and an in-line air hole is continued through the furnace material of Ashdown Sand. Although it is still necessary to repair the "hole" after every smelt, it is now a far more realistic arrangement. The "hole" must be in-line so that the inside of the furnace may be inspected to allow any molten slag that rises to tuyere level to be rodded-out.

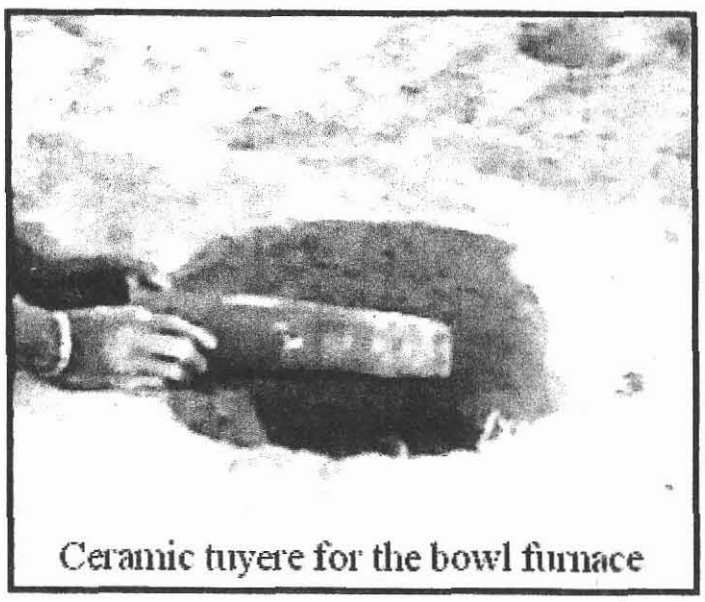
A further modification to the tuyere system can be envisaged, where it is allowed protrude into the charge; but for obvious reasons it could not be metallic. There are reports of its use in the literature [2], one type being called the "Catalan Hearth"; the diagram below shows that the resulting bloom is not attached to the furnace wall and so does not damage it when removed.



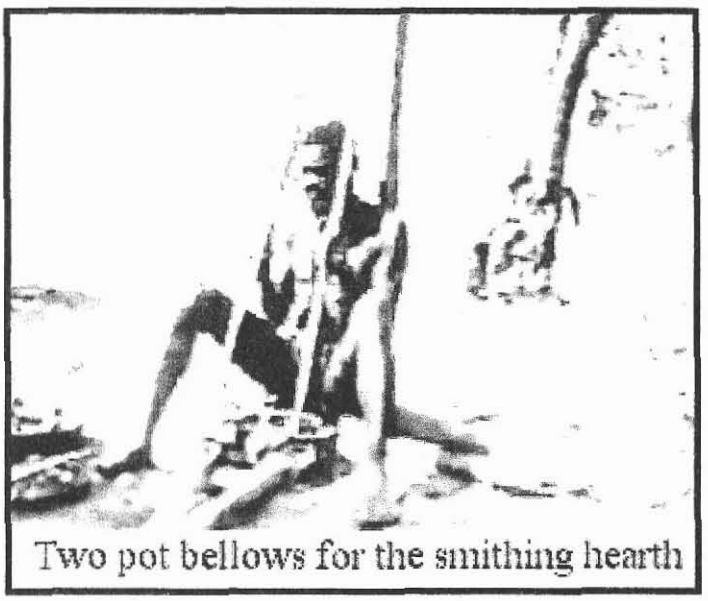
Another, more modern, source of information comes from the web sites [3,4,5], and is primarily a film from 1936-7 taken of the Kwanyama Ovambo tribe of southern Angola. Part of the film is concerned with the operation of an iron smelting, bowl furnace and was taken by Major Powell-Cotton's daughters, Diana and Antoinette, on 16mm film. There is a wealth of information on these sites including an interesting Bibliography and information on a museum at Quex House, on the Isle of Thanet.

The three pictures below have been taken from the 16mm film (via the web); although the quality may seem poor, this is probably due to picture compression for the web. Also, it must be remembered that the camera would have been clockwork powered!

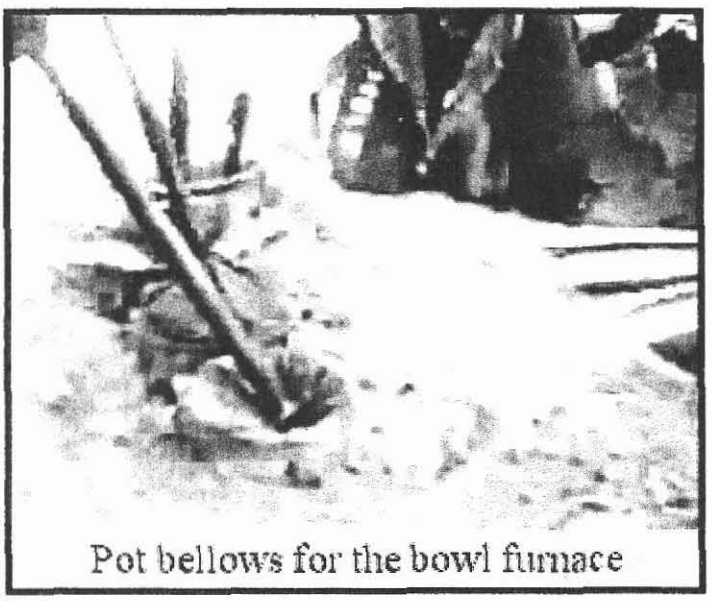
From the film, the tuyere seems to be between 40 and 50-cm long and about 10-cm OD.



Ceramic tuyere for the bowl furnace



Two pot bellows for the smithing hearth



Pot bellows for the bowl furnace

For WIRG, the problem really concerns the material that the tuyere should be made from, bearing in mind the high temperature involved, 1500 – 1600°C and the aggressive nature of hot tap slag, which, we are warned, will attack almost anything by dissolving it, whereupon it becomes part of the slag. ***[Note the very high temperature, 1500 – 1600°C, directly in front of the tuyere hole. This has been measured using a non-intrusive, optical pyrometer, and probably represents the temperature of localised hot charcoal directly in front of the tuyere. At this temperature, the heat will be efficiently radiated to the surrounding ore, charcoal and the iron bloom, producing a very steep temperature gradient].***

After discussion with a very useful shop selling all things pottery-orientated, "The Clay Cellar", in Parson's

Green, Brenchley, Kent, TN12 7DE, they recommended "Molochite" as being a suitably high temperature, silica-based clay. After asking numerous questions at the shop, it became clear that although the basic problems were appreciated, the actual "numbers" were unknown.

For example: -

There is the tuyere-strength problem...an unfired tuyere cannot be put into the furnace and be expected to survive; it must be biscuit fired, at least, to give it some strength and remove most of the water. Also, clay shrinks during firing by 10 to 20%; so arriving at a desired ID would be guesswork. Fortunately, one of the smelting team had an oven just large enough to take one tuyere, but he was hesitant to take it to 1200°C for complete firing, when it had previously only been used to 120°C. So it was decided to fire the tuyere to 750°C.

At this low temperature, 750°C, the tuyere would shrink further during smelting, so fixing it over the metal air-inlet pipe could be difficult. Also, the oven temperature must be raised very slowly to eliminate cracking, necessitating an oven "temperature controller".

So, an 8" long tuyere, 28mm ID and 35mm OD, was duly made from a sheet of clay placed around a former and joined along the seam and allowed to air dry for 2 weeks, then biscuit fired at 750°C over a period of 24 hours using a 1°C/min temperature increase; then decrease.

To couple air into the ceramic tuyere, a thin-walled iron pipe (slightly smaller than the ceramic tuyere hole) was inserted into the tuyere by about 30mm and an iron fixing-wire passed through a pair of holes on opposite sides of the tuyere (made before firing) and matching holes in the iron pipe. This loosely held the two pipes in position, hopefully allowing for any thermal expansion. To thermally test the tuyere, it was fixed into the furnace and heated using just charcoal; no iron ore was used, so no slag. The ceramic tuyere survived intact with the bellows pumping at 10-l/sec for over an hour. The end of the tuyere must have been fired to well over 1000°C, and had shrunk slightly, although the other, cooler, end at the furnace wall was unchanged.

A first experimental smelt, No.26, was carried out using this ceramic tuyere and successfully made a small amount of iron, some 1.5 kg, but about half the usual efficiency. Early on in the smelt we realised that it would now be dangerous to tap the slag for fear of breaking the ceramic tuyere. In our experience, the iron bloom is surrounded by molten slag that is, itself, surrounded by a thin crust of solidified slag hanging to the furnace wall, just below the tuyere and about 300-mm above the floor of the furnace. Our usual procedure is to puncture the outer solidified slag, towards the bottom, whereupon the molten slag flows from the bloom and runs out of the furnace, becoming tap slag. Unfortunately, when the bloom was retrieved, the tuyere had disappeared, so it was not known how long it had survived during the smelt.

A second smelt, No.27, was carried out but with the tuyere having only been baked to 750°C, [for the first experiment it had been well-baked in the furnace using only charcoal]. During this smelt it survived only about 15 minutes from the start of the smelt. This fact was discovered by utilising a long, thin wire, of known length, having a hooked end. After removing the air pipe from the iron pipe into the furnace wall and inserting this wire, it would "catch" over the end of the tuyere and be difficult to withdraw. It is not known whether the ceramic tuyere broke-off or the molten slag dissolved it, but there was no sign of it amongst the slag, at the end of the smelt.

No further experiments are envisaged using a ceramic tuyere projecting into the bloomery furnace burden, although it is known to be a practical proposition. If further research is carried out, three possible improvements come to mind: -

The outside diameter of the ceramic tuyere should be made much larger, 50 to 75mm say, but still keeping the hole diameter at about 22mm. This would make it much stronger and allow it to survive longer whilst it is being dissolved by hot slag.

Use an ideal mix of clay, having better proportions of silica and alumina, to reducing the hot, slag attack. First fire the ceramic tuyere at about 750°C in an oven, then in the smelting furnace with the tuyere being used to supply air to the charcoal fuel (only), as if smelting.

References

The Glass Industry of the Weald; G H Kenyon; Leicester University Press, 1967.
The Early History of Metallurgy; R. F. Tylecote; The Institute of Materials, London; 1992.

All web pages available from [but not very user friendly]: -
http://www.era.anthropology.ac.uk/Era_Resources/Era/P-C_Museum/smelt_index.html

Notes on the film are available from: -
http://www.era.anthropology.ac.uk/Era_Resources/Era/P-C_Museum/P_C_Fieldnotes_TOC.html

Bibliography and museum: -
http://www.era.anthropology.ac.uk/Era_Resources/Era/P-C_Museum/Intro.html

BH

WEALDEN TUYERES

Henry Cleere, writing on tuyeres p 43, *The Iron Industry of the Weald*, says, "The simplest type was a clay cone, with an internal diameter of 20-30mm. However, a more elaborate type is known only from the Weald, a double tuyere with twin outlets...two examples from Bardown, and others have been found at Beauport Park and Chitcombe. These would have been inserted through the blocked-up tapping aperture on the slag-tapping shaft furnace and jets of air would have spread around the restricted hearth area, creating high turbulence and uniformly high temperatures across the whole combustion zone; they would have been more effective than the single-vent tuyeres, which would have tended to create a single hot zone on the back wall of the furnace facing the blast." There is further interesting information on tuyeres in this chapter.

Roger Adams, who carried out many bloomery-smelting experiments put forward another possible explanation for these double tuyeres. This was that the double tuyere allowed a bellows nozzle to blow air into one opening whilst the other opening enabled the blower to look into the furnace. Through this he could see if the blowing nozzle was becoming choked with slag and if necessary insert a rod to clear the slag away.

DMM

WORDSMITH!

Recently, in the Daily Telegraph's letters, it was thought that the Spanish did not have an equivalent for "taking coals to Newcastle". This was corrected by the expression "taking iron to Bilbao" [1].

History of the Manufacture of Iron in all ages; James M Swank; Burt Franklin, New York; pp 21-26. Originally published in 1892.

BH

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FORTHCOMING EVENTS

16-17 April and 30 April - 1 May 2005 Further excavations at Little Furnace Wood, Mayfield; 16-17 April and 30
Apr-1 May 2005

28th-30th April, 2005 A three day international archaeometallurgy conference to be held at the British Museum to celebrate Paul Craddock's contributions to the study of historical metallurgy. See the website for registration form and information (www.thebritishmuseum.ac.uk/whatson/events/conferences.html) £130 (£145 after 25th March 2005)

11th-13th May 2005 Palaeosiderurgy and Industrial Heritage Recovery. San Sebastian, Spain.
This conference will examine iron technologies from their origin to the development of modern ferrous industries, as well as the ways in which the remains of such industries can be preserved for tourism and other purposes. The conference fee is €200 for registration between 31st January and 11th May 2005. Further details from INASMET - Marketing Dept., Ana Olaizola, Mikeletegi Pasealekua 2, Parque Tecnológico, E-20009 Donostia San Sebastián, Gipuzkoa - Spain. Tel: +34 943 00 36 78. E-mail: paleosiderurgia@inasmet.es Web: www.inasmet.es/paleosiderurgia.

9th-11th September 2005. HMS Conference based in Middleham. All lectures and meals will be at the Key Centre in the middle of the township which provides a wide range of accommodation. However, the area can be busy in September and early booking is advisable.

The conference theme will focus on lead/silver smelting and refining. With the opportunity to review work done since the *Boles and Smeltmills* conference in Swaledale in 1992, but we are also looking for papers on iron metallurgy, and associated subjects, related to the Yorkshire Dales area.

For details of accommodation on the Internet go to http://www.middlehamonline.com where you will also find information on the conference venue.

Offers of papers, help in organizing field trips or any enquiries regarding the conference should be sent to: Dr Peter Claughton, Blaenpant Morfil, Clynderwen, Pembrokeshire, Wales SA66 7RE. Email: P F Claughton@exeter.ac.uk

17th-21st October 2005 The 2nd International Conference on Ancient Greek Technology will be held in Athens from the 17th to the 21st October 2005. This conference will cover ancient technology from prehistoric times to the Byzantine period. The conference includes sessions on a wide range of organic and inorganic materials (including metals and mining). Further details from Secretariat of the 2nd International Conference on Ancient Greek Technology, Technical Chamber of Greece (408), 4, Kar.Servias, 10562, Athens, Greece Tel: =30 210 32 91 291. Email: email@central.tee.gr

The Iron Industry of the Weald; 10 weeks starting Thursday, **22nd September 2005** at **Oathall Community College**, Haywards Heath; tutor: **Jeremy Hodgkinson**. Details from Sussex University CCE, 01273 877888.

COPY DATES, APOLOGIES AND THANKS

The Editor apologizes for the lateness of this newsletter (the agreement is that we issue a newsletter in March and November). A large factor in this was that copy dates were not met

Contributors may not realize the various stages that their much-valued contributions have to go through before appearing in print.

Firstly, there is the initial reading through, editing and saving/copying onto the computer. Then the copy has to be arranged into the ready-prepared template, so that it fits suitably and logically into the newsletter. Pictures must be included, arranged and captioned. This cannot be properly achieved unless everything has arrived.

Next, there is proof-reading, corrections, more proof-reading and the result is sent to David Brown who improves the illustrations, etc. where necessary and then sends the completed newsletter to the printer.

Finally, the newsletter is printed and ready for distribution, for which another few days must be allowed.

My thanks, as always, for your contributions; judging by comments from members, our work *is* appreciated.

So please, the Editor welcomes contributions and will be greatly helped by receiving copy by the following dates:

February 14th for the **Spring (March) issue**
October 15th for the **Autumn (November) newsletter**.

DMM