Joseph Harris in Bristol, 1748

Peter Wakelin and Joan Day

Introduction

A flew short extracts from a manuscript ‘Journal of Two Visits to Wales in I746 and 1748‘ written by Joseph Harris, visitor to Bristol, are worth noting for their references to industrial enterprise. Although brief, the comments depict activities which were rarely encountered by the traveller of Harris's time, enabling him to give an unusual view of the contemporary scene as he was passing through the city. The manuscript which is held in the Ynysfor Collection at the National Library of Wales, Aberystwyth ,was investigated and the relevant part transcribed by Peter Wakelin of Keble College, Oxford, with the permission of Major U E B Roche, the depositor. Peter Wakelin later compiled the biographical details to be found below, and brought the extracts to the attention of **BIAS Journal** editor, who has added the local and technical commentary.

Joseph Harris

Joseph Harris was born c.1703 in Breconshire, the oldest of three famous brothers (the others were Thomas, who made his fortune from army contracts as a London clothier, and Howell, the influential religious reformer). His one sister, Anne, died at the age of sixteen. Given both a practical background and a sophisticated education, Harris must have been a reliable witness of the changing technology of industry. After working as a teenager at his uncle's blacksmith's shop he moved to London where, under Edmund Halley, he began a distinguished scientific career, making two voyages to the West Indies testing navigational instruments. Then, for a few years he seems to have taken up research in his own right, publishing important papers on astronomy and magnetic observations in the **Philosophical Transactions**. In 1737 he took a post at the Royal Mint where he must have developed a practical knowledge of chemistry and metallurgy before becoming Assay-Master in 1748, the year of his visit to Bristol.

Several of his technical and philosophical treatises, most particularly those on navigation, optics and money, were of widespread and lasting influence. His work with the Pioneering Breconshire Agricultural Society and in the standardization of weights and measures was of considerable importance in his day. He died in the Tower of London (his residence as Assay~Master) in 1764. His monument at Talgarth Church states that ‘he invented many mathematical instruments’ and that his political talents were well known to the ministers of the day, to whom he freely communicated many 'wise and learned ideas'.[1]

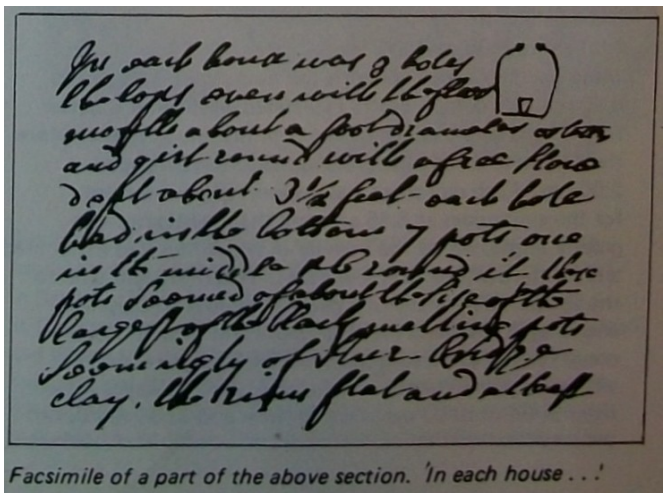
It was not until late August, 1748 that Joseph Harris was passing through Bristol, recording experiences on journal pages headed *Hot well[s]*. His entry of 25 August described a visit to Bristol Cathedral and included some rather un-complimentary remarks. The following day his itinerary started, conventionally enough, at ‘the finest parochial' church of St Mary Redcliff.

29th August, 1748

’Ferry’d over the river and rode round to Radcliff church which is without the town and was founded in 1298, and is reckond only a cheppel of ease to a Small church in a neighbouring village. . .

From Redcliff, the day's journey lay in the direction of Lawford’s Gate, (in the area of Old Market Street) and, less conventionally, on towards an un-named brass works. This could only have been Baptist Mills, founded in I702 and the main works of the Bristol brass company, where brass metal was actually produced. Possible remains of this site were obliterated by construction of the M32 junction 3 and its approaches. From Baptist Mills, brass was distributed to other water-powered works of the company at Weston near Bath, Woodborough near Woollard, Saltford or Keynsham, for working up into finished wares[2]. Details of these finishing operations can be derived from several fragmentary sources but a dearth of information on metal production at Baptist Mills has prevented similar representation. Therefore, this early account made by Joseph Harris, describing an updated Bristol version of the ancient **cementation** brass-making technique, although more obscure than one would wish, is all the more valuable and worthy of careful interpretation.

From hence led our horses, it being too dangerous to ride, thro ’a great part of the Town to Lawfords gate and from thence rid about a mile to the brass works, where is a village of a great many houses all doing as we were informed the very Same work. In each house was 3 holes [illustration] the tops even with the floor mouth about a foot diameter or better and girt round with a free Stone dept [?] about 3½ feet. each hole had in the bottom 7 pots one in the middle & 6 round it these pots Seemed of about the Size of the largest of the black smelting pots Seemingly of Stur-Bridge clay, the rims flat and at least an inch thick. these Stayed in the fire about 12 hours, but the furnace kept continually hot. The air holes came from a back yard.



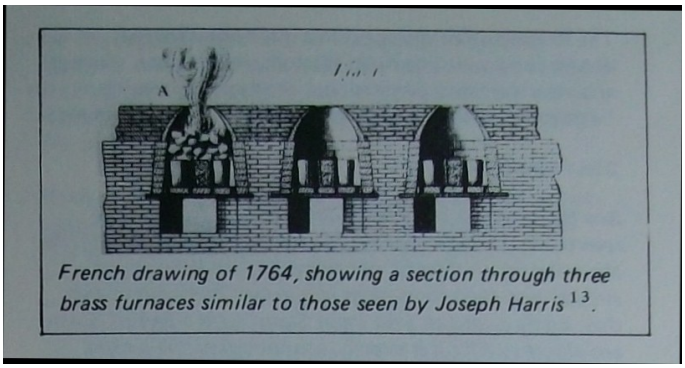
Facsimile of a part of the above section. ’In each house . . .’

The three holes, or furnace mouths, in the floor of each individual furnace-house which Harris visited, probably correspond to one half of an actual brasshouse. Back in 1724 the Swedish traveller, Henric Kahlmeter[3], had reported that there had been 36 brass-making furnaces distributed between six brasshouses at Baptist Mills, leading to the assumption that each house was divided, probably beck to back, into two banks of three furnaces each[4]. This arrangement would correspond with similar interior layouts illustrated by continental drawings published just a few years later. The observations by Joseph Harris appear to support this view.

The usual cementation-brass furnace, as described in other areas, was divided horizontally into upper and lower chambers by a cast-iron bedplate[5] .This plate was pierced by a ring of holes to allow air access from the ashpit below, which was connected by a large duct to the outside of the building; the 'back yard' that Harris saw. The duct allowed a draught to be induced through the furnace which could be controlled by a cast-iron cover at the mouth, in the floor of the furnace-house. It was from this viewpoint that Joseph Harris looked down, through the mouth which he estimated to be 12 ins diameter, to a depth of about 3½ feet, to the bedplate below. There he saw the six Stourbridge-clay crucibles in a circle, with an extra one in the centre. Such crucibles elsewhere have been estimated to be from 12 to 16 ins deep and, scaling such measurements with contemporary drawings of a brass furnace, makes Harris's estimate of 3½ ft quite feasible for the depth of the chamber. A century later, John Percy described a cementation brass furnace of similar dimensions[6].

*To 30 of granulated Copper 56 of Lapis Calaminaris fuwnded [? or forwarded][7] from Mendip hills but the best from flint Shire. this mixed with charcoal dust. The mold for the brass plates which Seemed at 40 Inches long and about 18 wide was between two huge Stones ground flat, the upper most lifting as upon a hinge by a pully and tackle fixed over it. and the lid confined by 3 Iron bars of the proper thickness. These two Stones were afterwards bound together very firm by a Stout leaver across and * Screwed at one end. These Massy Stones turned very easy upon an axis to a proper activity for receiving the metal, and the Same plate took [?] the pots were hot [?]!*

The crucible contents noted were proportions of **granulated** copper and Lapis Calaminaris[8] (or calamine, the zinc ore, $ZnCO_3$), mixed with charcoal dust. The granulation of copper for brass making was a Bristol innovation, patented by Nehemiah Champion in 1723, Patent No 454, and said to be a great improvement on the former practice of incorporating broken copper pieces[9]. When Harris visited Baptist Mills the process would probably still have been confined to Bristol as efforts were made to keep it secret. It was still being described as an innovation when the French rnetallurgist, Gabriel Jars, visited the city in 1764 and apparently saw it then for the first time[10]. The process, which later became common practice, enabled the



French drawing of 1764, showing a section through three brass furnaces similar to those seen by Joseph Harris [13].

zinc vapour to permeate the greater surface area of the copper granules more efficiently. The furnace temperature, approaching l000°C, was kept carefully below the melting point of copper to allow the granules to remain distributed throughout the mass in the crucible. Granulation improved the yield because less zinc vapour was wasted to the atmosphere.

The proportion of copper to calamine mentioned by Harris would have been variable according to the quality of zinc ore being used and its method of preparation, as well as the ultimate quality of brass required. Elsewhere, a proportion of scrap metal was often mentioned in the formula or, especially on the continent, a quantity of arco, or arcos. This was the 'raw brass' from the first melting of the brass-making process, which apparently needed remelting to make it workable[11] This second melting does not appear normally to have been necessary at Bristol even though the best grades of malleable brass were required for the **battery** finishing process. It has been suggested that the high quality of the available calamine made the extra melting unnecessary[12].

There has been no known early eighteenth-century description of the Bristol method of pouring brass metal into moulds until the observations made here by Joseph Harris. One could only have tentatively assumed that the method followed the old continental practice of making plate by pouring metal between a large pair of flat stones[13]. The correct spacing of the required cavity was achieved by placing iron bars of suitable depth between the upper and lower stones and then clamping the whole assembly together. Some kind of mechanism was then required to haul the stones up to an angle to enable the metal to be poured. This operation was also illustrated by continental drawings and it is clear that, apart from stones of much smaller dimensions, Harris witnessed something very similar at Baptist Mills. During the nineteenth century at Bristol, the use of cast-iron moulds superseded this traditional operation but, throughout its history, the company practice usually was to cast metal into plate or slabs for further working. The production of finished cast wares was a trade which developed later in Birmingham and the Midlands although the Bristol company produced brass for casting for that market. Most of the Baptist Mills foundry products, however, were distributed to the rolling and battery mills elsewhere in the Avon Valley[14].

The last few words of Harris's entry for 29 August remain cryptic. Perhaps they signified something to the writer or, possibly, they merely indicate a lapse at the end of a long day.

** See the cover drawing for an illustration of this operation from Diderot's L'Enctclopédie. . . des Arts, 1763, showing also the tops of three furnaces. (Massy means massive here.)*

The Following day was spent in a more usual tourist occupation by visiting Kings Weston, where house, grounds and view were duly admired, but the next day's entry records further observations on Bristol's non-ferrous metal Industry.

31st August. 1748

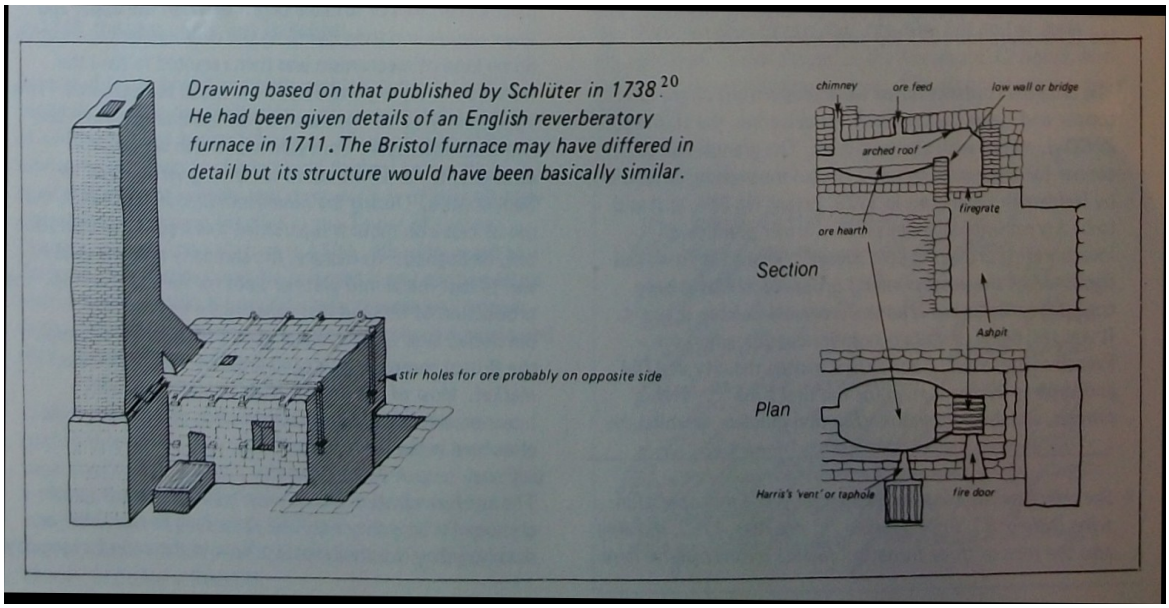
Saw the Lead works opposite the wells. This is a large reverbatory furnace haveing 3 holes on each side for Stirring the metal which they let out every ¼ of an hour into a circular iron tubb fixed close to the vent hole, out of this they laddle it into an Iron Ingot Standing in a pair of Scales, and as they fill till it exactly counterpoises the weight (1¼ C) at the other end. The hearth where the metal is and on which the [illustration] flame plays has a gentle declivity every way towards the middle that the metal may run down which they often Stir. 8 men attended this work. Some in grinding the oar which is done by a large Stone turned round by a horse like a Cyder mill. Others are employed in Washing, &c. They use no flux but Quick lime, and Smelt about 10 tun of Oar per week which is as much as they have a vent[15] for, and this produces about ¾ as much lead. The oar they have from flint Shire, and of different prices from £4: 10^{S} to 9$^{£}$ per tun, this last being the black Shining oar and contains about 9/10 of lead. A great deal of Calamy [16] comes mixed [? or mined] with the oar which they Sell at a cheap rate to the brass works.

There had been some kind of activity in the smelting of lead from at least 1655 on the banks of the river opposite Hotwells [17]. By 1678, George, Viscount Grandison was attempting to counter rising costs in wood fuels by developing a coal-fired reverberatory furnace for the smelting of lead on this site. Such a furnace lessened the risk of contamination by coal impurities by separating the fuel from the ore chamber by a low wall, over which furnace gases were drawn to follow the line of an arched roof. The roof was designed to reflect, or 'reverberate', heat to the ore hearth below, hence the name **reverberatory**, often mis-spelt, as with Harris's version. The early structure of this type was often called a cupilo, as was the case in Bristol, because the roof was domed. When this was modified in later years the name, cupilo, dropped out of use gradually.

During the 1680s, one of Grandison's former assistants Sir Clement Clerke established an additional works near the original site, smelting lead with similar furnaces, until litigation forced him to stop. Clerke then turned to experimenting with the smelting of copper using a similar kind of coal-fired furnace, and by the early 1690s was achieving technical success but financial disaster [18]. In a few years his site was under new ownership and lead smelting resumed for a short period. There has been some confusion between these two early smelting sites ,both more-or-less opposite Hotwells. The earliest, occupied by Grandison, is now thought to have been at the bottom of Stockley Vale, known today as Nightingale Valley, the other site of Sir Clement Clerke was probably below Rownham Hill [19] , but both appear to have been involved in lead smelting from time to time during the eighteenth century. Thus, it is not at all clear which site was visited by Joseph Harris. Both places, however, have a claim to an important part in the initial development of the coal-fired reverberatory furnace, although this has not been widely recognised.

The German metallurgist, Schlüter, writing in 1739, gave credit to a Dr Wright for the development, and these details were translated and reprinted by John Percy in his *Metallurgy of Lead* in 1870. They have been widely accepted ever since, claiming that Wright's furnace was invented in 1698 for use in lead smelting in Flintshire [20]. However, documentary sources confirm that the Bristol furnace was in production well before this time and, indeed had been successfully adapted to the smelting of copper by the early 1690s. Its use was extended to other sites in Redbrook on the River Wye, and to Conham, two miles above Bristol by 1696. By the time of Harris's visit the reverberatory furnace had been widely accepted in the smelting of both lead and copper ores and, undoubtedly, would have been of great interest to him.

Harris took some advice about his health after his leadworks visit, with the result that he spent the following day at the Cold bath at Jacob's Wells. By 2nd September, however, he was travelling round Bristol once again, this time to the Kingswood area.



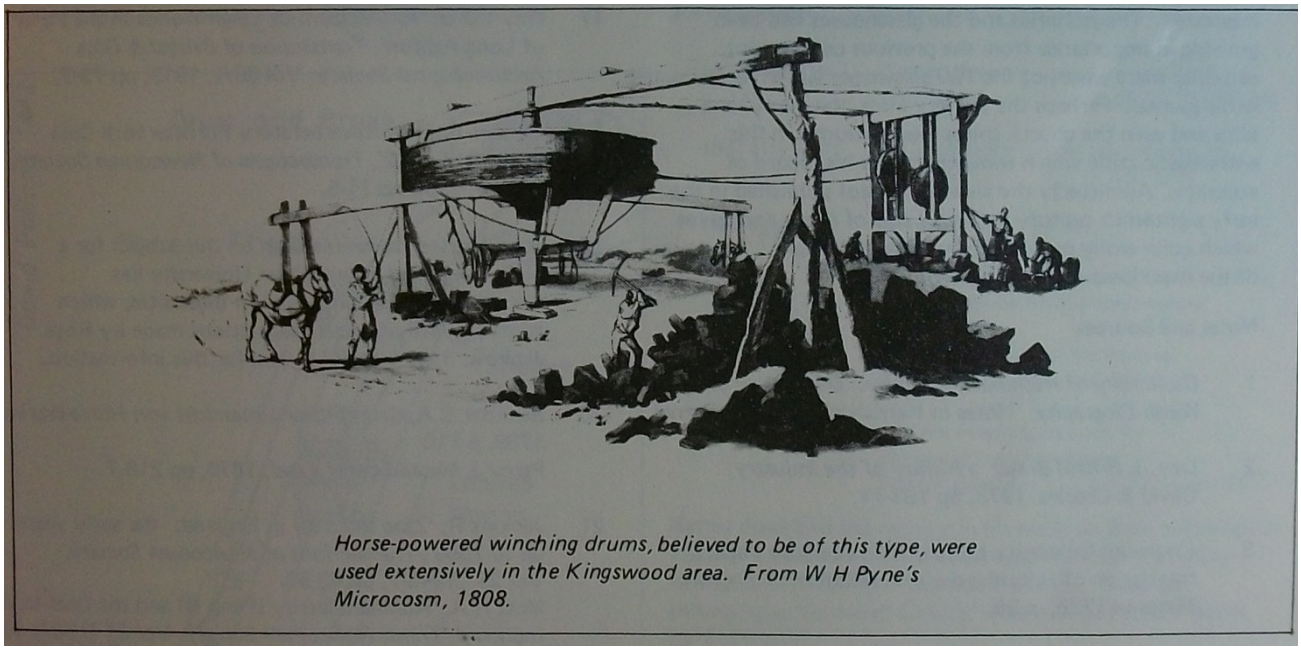
2nd September, 1748

Kings wood begins about a mile from Bristow from whence an incredible quantity of coals are daily carried to the town from whence much is transported to other places. The Shafts are about 4 or 5 [?] foot Square and Some 30 fathoms deep, perpendicular the earth he/'ng Supported by timber work and Sometimes they follow a vein to a considerable distance over each Shaft is a windlass turned by two men and one basket ascends while another descends. In some places they drain the water with horses, and within these 20 years many fire engines have been erected.

Clearly, Harris was impressed by the 'incredible quantity' of coal being extracted from Kingswood and it was this ready availability of several different grades of coal, including good quality low-sulphur smiths' coal, which gave impetus to Bristol innovation in the coal-fired smelting of metals. In the seventeenth century there had been several attempts to smelt iron with coal at Bristol ,and in Kingswood itself. John Copley and also Dud Dudley were just two of those involved but few facts are known of their work . Shortly after Abraham Darby had become involved in establishing the brassworks at Baptist Mills his interest turned to the working of iron. His 1707 patent for producing bellied iron pots describes him as a Bristol smith. Darby is thought by many to have carried out the pioneer experimental work on smelting iron with coke at his Cheese Lane works in Bristol before leaving for Coalbrookdale. At the time of Harris's visit William Champion was in the process of setting up his Warmlev works and initiating the first commercial process of zinc smelting in Europe, using large stocks of coal to lire his furnaces[21]. Coal had been mined at Kingswood for many centuries and the easily-won stocks were diminishing. Prior to the eighteenth century the area was being drained by a system of levels which allowed greater depths to be worked[22]. Harris's estimation of 30 fathoms, or 180 ft. for the depth of the shafts he saw appear to be quite feasible. It has been calculated that a depth of up to 250 ft could have been worked on the high ground drained by the ten-mile system of levels which had been excavated by the time of his visit [23].

Shafts extending below these levels, or outside the system, were forced to adopt other types of drainage. Methods operated by horses and waterwheels are mentioned in contemporary records for the area, even plans to use windmills, but it is not known if these were actually erected. Authentic sources which record pumping by means of **fire engine**, the atmospheric Newcomen engine mentioned in Harris's journal are more difficult to find before the mid-century. Kenneth Rogers in *The Newcomen Engine in the West of England*, refers to more eighteenth-century engines than previously had been thought to exist but most of these were installed after the time of Harris's visit. There were exceptions, however, including, possibly, the unknown colliery near Bristol which ordered parts of an engine in 1747 and which may have been working by his time. More certainly, the engine erected by Richard Chester at Kingswood Forest would qualify for inclusion. This installation which had cost over £400 led to Chester being granted the coaling rights of the site in 1735[24].
At Clink Close coalworks, in the Longwell Green area of Bitton Parish the partners agreed in 1741 to have their 'ffire engine' value[25]. But an earlier source, of 1724. referring to a 'nue lngen . . to be worked with oute Horses', which in the past has been assumed to refer to a Newcomen pump, can be eliminated by studying the relevant Patent Specification, No 469, which specifically excludes the use of fire[26] . This installation is more likely to have been operated by waterpower. Such devices were commonly referred to as 'engines' in the early eighteenth century.

Thus, the present early records of 'fire' engines which can be verified hardly add up to the 'many' which, according



Horse-powered winching drums, believed to be of this type, were used extensively in the Kingswood area. From W H Pyne's Microcosm, 1808.

to Harris' had been erected within the last 20 years. Had he men given information which was greatly exaggerated or were there more Newcomen engines installed than the present known sources indicate? His observation suggests that further research in this field may possibly produce some worthwhile results.

When one considers the vast advantages of these coal pits, the nearness of the Severn, and the tides bringing very large vessels into the heart of the Town, one cannot help admiring the excellency of the Situation of Bristol for trade, and vast Sorts are here carrying on, especially Such as require fires and particularly here are a vast number of Glass houses. I should imagine not less than a 100 from the prospect one has of them.

The easy availability of coal, linked with the resources of the second most important port in the country, gave a great impetus to the trade and industry of Bristol during the early half of the eighteenth century, as Harris and many other writers have so rightly remarked. A growing number of processes were dependent on coal at this time, apart from the metallurgical industries in which Harris was professionally interested. The potteries and the glasshouses had been growing in importance from the previous century but, certainly there were not the 100 glasscones which he estimated in his journal. Perhaps the pottery kilns, the many lime kilns and even the church spires were included in this enthusiastic aside which somewhat mars his record of accuracy, Admittedly the views of Bristol published in the early eighteenth century showed a city of cones and spires which quite easily could have confused a visitor [27], even one of the experience of Joseph Harris.

Notes and Sources

1 *Dictionary of National Biography: Dictionary of Welsh Biography.* Notes in Harris's manuscript journal.

2 Day, J, *Bristol Brass: a history of the industry*, David 8&Charles, 1973, pp 153-71.

3 Liverpool University Library, Rhys Jenkins Papers, translation of H Kahlmeter's 'A Relation of English Mines in I725', p 56.

4 This was the arrangement that Hatchett saw in Birmingham brassworks of the 1790s. *The Hatchett Diary*, edited by Raistrick, Bradford Barton, 1967, p 53.

5 Galon J, *L'Art de Convetire /e Cuivre Rouge ou le Cuivre Rosette en Laiton ou Cuivre Jaune*, 1764.
Percy J, *Metallurgy. "Fuels: F ireclays: Copper: Zinc: Brass, etc*, 1861, p 613.

6 Ibid.

7 This could be *fownded, pownded*, or even *forwarded*. The writing is not clear enough to transcribe with any certainty.

8 Lapis Calaminaris was the latinised form of calamine quite often used in the seventeenth and eighteenth centuries.

9 Watson R, *Chemical Essays*, Vol 4, 1786, pp 45-50: Watson stated that most English brassworks used granulated copper by the time he was writing. He claimed that its use, together with 'the superior excellence of our calamine' produced a greater yield than was achieved by any foreign brassworks.

10 Jars G, *Voyages Métallurgiques*, Vol 3, 1781 p 223.

11 Rees's *Manufacturing Industry*, Vol 1, edited by Neil Cossons, David & Charles, 1972, p 222.

12 Tylecote R F; I am grateful to Professor Tylecote for discussions on this subject.

13 Galon J ,L'Art de Convetire /e Cuivre Rouge. . .

14 Day J, Bristol Brass, . .

15 Sales outlet

16 Abbreviation of Calamine

17 Way L J U, 'An Account of Leigh Woods in the Parish of Long Ashton', *Transaction of Bristol & Glos Archaeological Society*, Vol 36/1, 1913, pp 72-3.

18 Jenkins R, 'The Reverberatory Furnace with Coal Fuel 1612-1712', *Transactions of Newcomen Society*, Vol 14,1935 pp 71-5.

19 John Morton, in his research on this subject for a higher degree at Birmingham University has discovered new information on these sites, which conflicts with previous assumptions made by Rhys Jenkins. I am grateful to him for this information.

20 Schlüter C A, *Gründlicher Unterricht von Hütte-Werken . . .* 1739, p 110;
Percy J, *Metallurgy of Lead*, 1870, pp 216-7.

21 Jenkins R, 'Zinc Industry in England: the early years up to 1850', *Transactions of Newcomen Society*, Vol 25 , 1945-7, pp 43-50-
Mott R A, 'Abraham Darby (I and II) and the Coal-Iron industry', Trans: *Newcomen Society,* Vol 21 (1967) 49-57

22 Ellacombe H T, *History of the Parish of Bitton*, 1883, pl XI.

23 Southway M J H, '*Kingswood Coal*', *BIAS Journal 4*, 1971, p 15.

24 Rogers K, *The Newcomen Engine in the West of England*, Moonraker Press, 1976, pp 28-40.

25 Southway M J H, '*Kingswood Coal*', *BIAS Journal 4*, 1971, p 16.

26 Vinter D, *Some Coalpits in the Neighbourhood of . Bristol and Kingswood,* 1964, p 5;
Southway, '*Kingswood Coal*', p 16;
Rogers K, The Newcomen Engine. . . p 28.

27 Buck N and S, *Prospects of Bristol*, 1734.