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**The Costers: Copper-Smelters and
Manufacturers**

by

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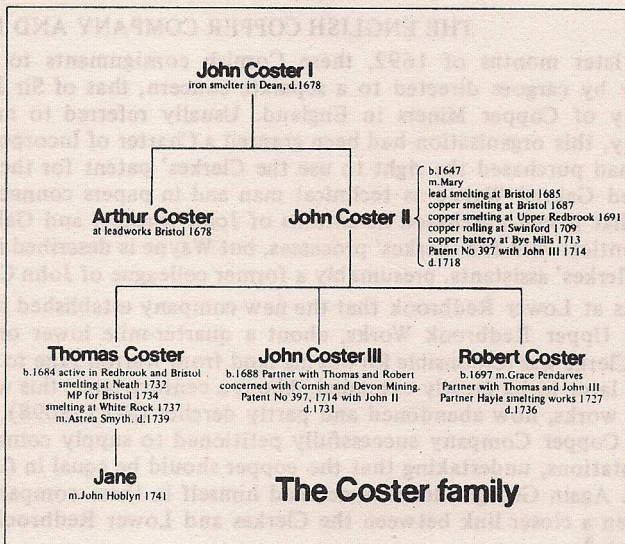
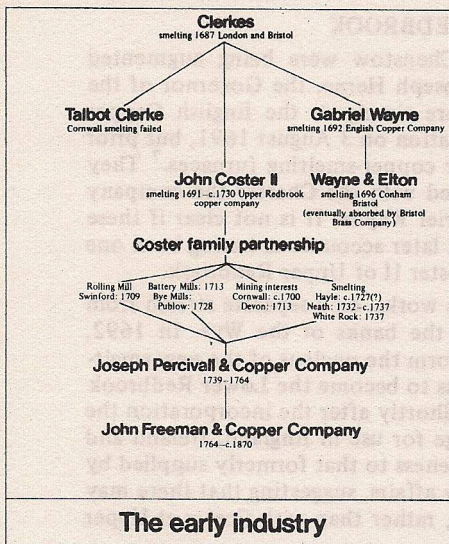
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INTRODUCTION

The copper industry of England received a stimulus in 1689 with the passing of the Mines Royal Act. Additional legislation reinforcing the Act some four years later came at a time when considerable progress had been achieved in the use of coal fuel in reverberatory furnaces and the improved techniques for copper smelting had become commercially possible. These combined factors produced a revival of the English industry after the long period of gradual deterioration earlier in the seventeenth century.

The introduction of coal-fired furnaces to Lord Grandison's lead works in Bristol was followed by experiments at a nearby site which led to copper being smelted in similar furnaces, as described in detail by the late Rhys Jenkins.¹ John Coster was first mentioned in 1685 as a lead smelter at 'the Cupilo in Bristol' under Sir Clement Clerke and his son Talbot, being their 'Chief agent and workman and a sharer therein'. Arthur Coster, brother to John, had been associated with the Clerkes from at least 1678 at 'the Cupilo', the Stockley Vale lead works, in an area now known as Nightingale Valley near Clifton Suspension Bridge. Experiments in smelting copper and other metals in a coal-fired reverberatory furnace began here when the Clerkes were forced by Grandison to abandon their production of lead. He had brought a Chancery action in 1685 for infringement of his patent for lead smelting, in spite of an earlier patent under which the Clerkes were working.

By January 1687/8, the Clerkes had progressed far enough in their new undertaking of copper smelting to be granted Patent No. 253, for 'A new invention, being severall sorts of furnaces, vessels, wayes and meanes that never before were knowne'. The successful application of the new furnaces to the technique of copper smelting is believed to have been largely the responsibility of John Coster, the chief technical man of their concern.² (We shall refer to him as John Coster II)



During 1688, small supplies of rose copper were made available for sale by the Clerkes, possibly produced on an experimental scale in the London area, but later consignments were produced elsewhere. What little evidence there is suggests that this copper was most likely to have been smelted at the Bristol cupilo. The Clerkes still had possession of this site and Cornish ore was being delivered to George Clerke, brother to Talbot, at Bristol as late as 1691. With a reappraisal of available documents, it seems unlikely that the Clerkes were responsible for copper production at a new site at Upper Redbrook as had been previously assumed.³

JOHN COSTER II AND UPPER REDBROOK

The Copper Works of Upper Redbrook was quite separate from the Clerkes' concern, being a joint-stock company whose ten trustees had no names in common with the Clerkes' eight partners. From 1691, John Coster II was responsible for this new works on the banks of the Wye in Gloucestershire, bordering on the Forest of Dean. An earlier John Coster I, probably the father of the copper-smelter, had been involved in iron smelting in the forest from 1657-76, and died there in 1678. Possibly the family had local knowledge which influenced the siting of the new works, as according to Eric Odelstierna writing in 1692, old copper mines had recently been re-opened in the Forest of Dean.⁴

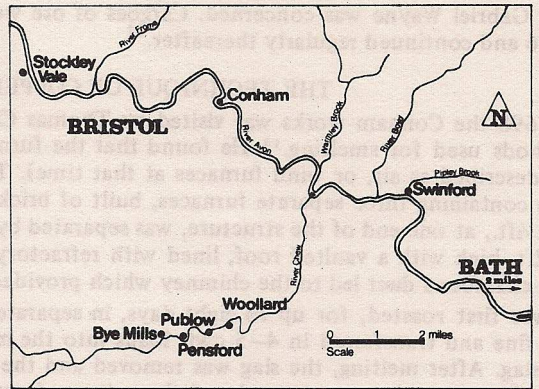
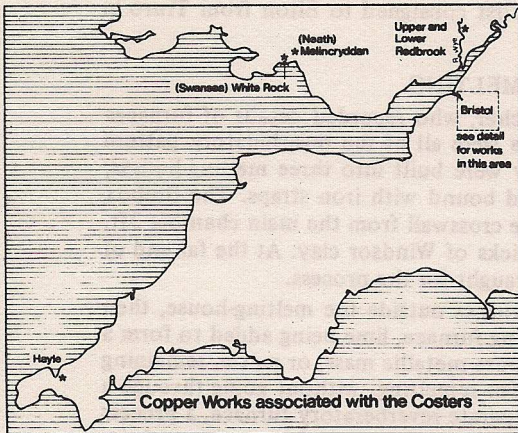
The earliest document connecting Coster II and Upper Redbrook refers to an indenture dated 16 July 1691 when he leased a mill, formerly a paper mill, from Benedict Hall of High Meadow.⁵ An area of about one acre surrounding the mill 'with all ways, waters, watercourses, ditches, stankes and millwheels and passages', was converted to a copperworks. In present-day terms it was situated on the river side of the old tramway arch over the Redbrook-to-Coleford Road, B.4231; between that road and the tramway track as it leads to Lower Redbrook at approximately SO 537102. The area is now occupied by houses and their gardens through which an open watercourse still runs. The garden soil and banks are littered with copper-slag fragments but copper-slag blocks in surrounding walls are probably of a much later date.

The lease had been back-dated to take effect from 25 March 1691, for three score years at £20 per annum. There is no reliable evidence of earlier copper smelting at Redbrook, although some 50 tons of Cornish ore had already been consigned through Thomas Treluddra, a Chepstow agent, as early as July 1690. Cornish ore cargoes followed regularly after the lease had taken effect.⁶

THE ENGLISH COPPER COMPANY AND REDBROOK

By the later months of 1692, these Cornish consignments to Chepstow were being augmented regularly by cargoes directed to a separate concern, that of Sir Joseph Herne, the Governor of the Company of Copper Miners in England. Usually referred to more simply as the English Copper Company, this organisation had been granted a Charter of Incorporation on 3 August 1691, but prior to this had purchased the right to use the Clerkes' patent for their copper-smelting furnaces.⁷ They employed Gabriel Wayne as technical man and in papers connected with the Charter the company stated that it had purchased inventions of John Duckett and Gabriel Wayne. It is not clear if these were identical with the Clerkes' processes, but Wayne is described in later accounts as having been one of the Clerkes' assistants, presumably a former colleague of John Coster II of Upper Redbrook.

It was at Lower Redbrook that the new company established its works, on a separate stream from Coster's Upper Redbrook Works, about a quarter-mile lower on the banks of the Wye. In 1692, George Clerke was responsible for buying land from Warren Jane to form the nucleus of the new smelting site, later to be greatly extended. About a century later, this was to become the Lower Redbrook tinplate works, now abandoned and partly derelict (SO 538098). Shortly after the incorporation the English Copper Company successfully petitioned to supply coinage for use in England, Ireland and the Plantations, undertaking that the copper should be equal in fineness to that formerly supplied by Sweden. Again George Clerke concerned himself in these company affairs, suggesting that there may have been a closer link between the Clerkes and Lower Redbrook, rather than with Coster at Upper Redbrook.⁸



Copper Works in the Bristol area associated with the Costers

The Clerkes' Bristol connections did not flourish for long after the Redbrook works were established. Following repeated financial difficulties, the Stockley Vale site was relinquished in 1692 and after the death of his father in the following year, Sir Talbot later became interested in copper smelting in Cornwall, a venture which was eventually abandoned. Although he also regained control of the site at Stockley Vale, it is unlikely that he ever resumed smelting there in more than a desultory fashion. In the early years of the new century Sir Talbot complained that he had not 'made the hoped-for advantage' from the new process, although the nation had received great advantage from the new invention of the furnaces.⁹

THE GROWTH OF THE INDUSTRY

During the 1690s, the country's revitalised copper industry established its main centre at Redbrook in Gloucestershire. In the last few years of this decade, the two Redbrook companies were importing almost 1000 tons of copper ore from Cornwall per annum, but other smaller companies had been formed elsewhere after the passing of the Mines Royal Act. Writing in 1697, John Houghton referred to five existing organisations under the names of Dockwra, Hern, Derby, Welsh and Cumberland. At the time, the last three of these companies were mainly concerned with mining. Of the first two, the main smelting companies, Hern was Sir Joseph Herne of Redbrook's English Copper Company and Dockwra was a leading proprietor listed in the earliest indenture of the Upper Redbrook works.¹⁰ Better known for his connection with the Esher brass works of the 1690's, Dockwra's involvement with copper smelting has usually been discounted. He later became financially embarrassed and took no further part in the Redbrook company. The same Houghton account goes on to state that the Dockwra company alone had produced 80 tons of copper per year, worth £100 per ton, and the remaining companies were thought to have a similar joint output; a total production for the whole country of 160 tons per annum. The following year, however, Thomas Cletscher, a Swedish mining expert, estimated the country's output at 400 tons per annum. It is difficult to assess the accuracy of these figures, but they suggest a rapidly increasing output at Redbrook.

If the earlier Houghton estimate is correct, it is not surprising that the English Copper Company had its difficulties in keeping to the terms of its coinage agreement to supply 100 tons of copper per year. During 1696, the Treasury received information about large sums its contractor was losing in an attempt to obtain supplies from other companies. Permission was sought to use Swedish copper when necessary.¹¹

Perhaps it was these production and financial difficulties which persuaded Gabriel Wayne, the technical man of Lower Redbrook, to establish his new enterprise during 1696. At Conham on the Avon, two miles above Bristol, he set up a new smelting works in partnership with Abraham Elton, a successful Bristol merchant. Elton petitioned the Lords of the Treasury that same year, offering to coin farthings and halfpence at the Bristol Mint, but his petition was not successful. The works went ahead, however, receiving some of its copper ore from the North Downs area in Cornwall from mines

in which Gabriel Wayne was concerned. Cargoes of ore were first consigned to Elton from Truro in May 1696 and continued regularly thereafter.¹²

THE TECHNIQUE OF COPPER SMELTING

During 1698 the Conham works was visited by Thomas Cletscher, who recorded details of furnaces and methods used for smelting.¹³ He found that the furnaces were all of the reverberatory pattern (usually described as air, or wind furnaces at that time). They were built into three melting-houses, each one containing three separate furnaces, built of brick and bound with iron straps. The firebox 3ft. by 1½ft., at one end of the structure, was separated by the crosswall from the main chamber 3ft. square, 2ft. high with a vaulted roof, lined with refractory bricks of Windsor clay. At the far end of the main chamber a duct led to the chimney which provided draught for the process.

Ore was first roasted, for up to eight days, in separate furnaces outside the melting-house, then stamped fine and transferred in 4–5 cwt. loads into the melting furnace, lime being added to form a suitable slag. After melting, the slag was removed and the impure metallic mass, or matte, remaining after this first operation was tapped and then stamped again for remelting, without going through a roasting process. It was then converted to black copper in a separate reverberatory furnace, a process involving oxidation of part of the sulphide, and double-decomposition between this portion and the unoxidised part. Refining was then carried out in smaller reverberatory furnaces.

Cletscher gave no details of the fuel used in the various stages but in his criticism of the technique, implied that coal was used throughout. He described the resulting copper as fragile, [or brittle], compared with the Swedish product and not suitable for making brass. This fault he attributed to the sulphurous coal fumes and suggested that this could be remedied by using charcoal in the refining stages. Many improvements were made later at Conham and copper for brass-making was produced in quantity.

The Forest of Dean ores were worked out by this time, according to Thomas Cletscher, but as he referred only very briefly to the two large smelting works in the area, no reliable comparison is possible between the early stages of the Redbrook works at that date, and the newly constructed Conham smelter which he described in detail. (Writing in 1734, Swedenborg implies that one part of his retrospective account of Redbrook is valid for c1700, but a careful comparison with descriptions made by Swedish official Henric Kahlmeter at the time of his visit, 1724/5, suggests that Swedenborg based his Redbrook details on those of Kahlmeter. In doing so, he appears to have made topographical and chronological errors, confusing Upper and Lower Redbrook. Similar confusion arises in the same writer's descriptions of the plant and techniques at Conham, which appear to have been based on accounts of Cletscher and Kahlmeter).¹⁴

By the time of Henric Kahlmeter's visit to Redbrook in 1724/5, both the Upper and Lower works had been considerably enlarged. The property of the Upper Redbrook works comprised some 26 smelting furnaces to accommodate various stages of the process which he saw being employed at the site. This has been described by Dr. R. F. Tylecote as less technically advanced than that of Lower Redbrook, or even of Conham when Cletscher described it in the late 1690s, but comparable in some aspects with the earlier methods of the seventeenth-century Keswick works, where small blast furnaces were utilised.¹⁵ The explanation may be found in the fact that the Upper Redbrook works was the earliest of the late seventeenth-century smelters to be established and, at its formation, John Coster may have been inhibited by the Clerkes' patent, which had been purchased to build the Lower Redbrook works of the English Copper Company.

At Upper Redbrook there were ten reverberatory melting furnaces and after the matte had been produced in these, it was stamped to a very small particle size in preparation for roasting. For this stage, there were six reverberatories which could each take 400 lb. of matte and used a mixture of coal and coke as fuel. Clotting then took place, again in reverberatory furnaces, four of which were available. Sand was added to the melt producing a lump material which could be dealt with conveniently at the next phase of the process.¹⁶

There were two small blast furnaces for this, the penultimate stage. Kahlmeter described them as breast furnaces, in which the totally oxidised material was smelted with coke, one load of coke to two loads of matte. These stone-built furnaces had interior measurements of 1 ft. 10 ins. by 2 ft., were lined with Stourbridge clay, and topped with a 14–15 ft. stack. When ready, the slag was run

off for use as a flux in the next melting process and the remaining black copper was then tapped. There were four reverberatory furnaces for the last refining stages. The coke used as fuel in the various phases of the process was produced on the site at Upper Redbrook. Although this works could not be described as in the forefront of contemporary technology, it was said by Kahlmeter to produce the best grade of copper, the most malleable quality obtainable in the country. This property was of greatest importance to the production of the Coster's manufacturing business, which was being developed as a separate organisation from the Upper Redbrook Company.

FURTHER EXPANSION AND EXTENSION

The English Copper Company had been making use of additional land from 1703 onwards. Thomas Chambers, who had assumed control of the works, had personally acquired properties adjacent to the original site at Lower Redbrook and appears to have rented them to his company. John Coster was involved to a smaller extent in similar transactions. From 1711, he leased Kings Mill, an old watermill to the north of the Upper Redbrook site. He acquired additional land extending up the valley just short of the 'upper stampers', an old ore-crushing site at its northern extremity. (Approximately SO 537107.)

At his death in 1718, John Coster II left this property to his two elder sons, with power to assign part of it to the trustees of the Upper Redbrook Company, to discharge a £336 debt to them. The remaining local property was to be retained by the family, together with his dwelling house situated near 'the upper stampers'.¹⁷

Kahlmeter referred to two copper mills at Upper Redbrook in 1724/5, presumably on this property. Both were probably hammer mills, as one site produced copper plate and 'bottoms', the bases of large industrial hollow-ware vessels produced by hammering at the time. The other mill made 'staffs', or 'negroes', the decorative rods for winding round arms and legs, sent for sale to African natives on the Guinea coast. These were also formed by hammering.

By the time that this additional property had been acquired at Upper Redbrook in 1711, John Coster II was already occupying an old tucking-mill site at Swinford (ST 691689), on the River Avon, six miles above Bristol. He had leased this mill in 1709 and adapted it as a rolling mill to produce sheet copper, possibly the second such mill in the copper industry.¹⁸ Dockwra is believed to have introduced the technique at Esher in the 1690s. In 1713, Coster leased his second site in the Bristol area, eight miles to the south of the River Chew, a tributary of the Avon. Near Pensford, Bye Mills (ST 610638) had been used as a hammer mill, producing iron battery from at least 1668, and possibly from the early 1600s.¹⁹ When the Coster family business acquired the property, it was adapted to produce copper batteryware, hollow-ware beaten into shape by means of water-powered hammers. Undoubtedly it would have utilised the rolled sheet prepared at Swinford Mill.

There had been further developments in the Bristol non-ferrous metal industries in the intervening years. In addition to the Conham copper smelter established in 1696, a brass works was started in 1702 making brass battery, or hollow-ware, as its main end-product. By 1708, an additional mill to the original Baptist Mills site was opened at Keynsham, five miles east of Bristol. In 1709 a title was first mentioned, the Company for Brass and Battery at Bristol, but over the years many different names were used, a source of some confusion. The company had expanded to such an extent by 1710 that it had acquired its own copper-smelting works at Crew's Hole, half a mile downstream from Conham on the banks of the Avon. It also continued to take much of the Conham output.²⁰

Thus, during the early years of the eighteenth century, the main focus of the industry had established itself at Bristol and this development must have precipitated the Coster move to the area. It can be assumed that much of the output from the Upper Redbrook Copper Company which Kahlmeter estimated as 200 tons per annum found its way to Bristol for the production of the separate Coster family business. In 1728, it was said that £15,000 worth of copper batteryware was marketed at Bristol, where the port and centre of West Country commerce was at hand to facilitate this new-found industry.²¹

It has often been assumed that both John Coster II and his son Thomas were responsible for copper smelting at the Bristol brass works and became active partners of the company, but no real evidence has been discovered to support this idea of such close liaison. John Coster left no shares of

the brass company in his will and there is no mention of the family in the few brass company documents. During the 1720s, however, the Coster family business provided supplies of Cornish ores to all of the Bristol and Redbrook companies and possibly also offered them some form of technical service.

THE COSTERS IN DEVON AND CORNWALL

By this time the Bristol and Redbrook companies were widely known to be 'united and confederated' in a trade association but prior to this, the Costers had been developing extensive interests in the mines of both Devon and Cornwall. William Pryce in his *Mineralogia Cornubiensis* (1778) implied that they had been an active force in Cornish mining from the early years of the century, although he gave no precise dates. From at least 1713, documentary evidence is available of the Costers' concern in Devon mines. In that year, John Coster III, Thomas's younger brother, then dwelling at Redruth, leased, from the Trustees of the Bedford Estate, the right to mine copper in a Sett at Morwelldown near Tavistock, on behalf of the Upper Redbrook Copper Company.²²

The following year, 27 May 1714, John III, of Redruth, together with John II of Redbrook, were jointly responsible for Patent No. 397, an 'Engine for Draining Mines', which they claimed was capable of raising water, greater in quantity by one-third, or from a depth one-third greater, than the water wheels currently in use. It involved some new form of water-powered pump worked by cranks on each side of 'a peculiar sort of wheel', which alternately raised and lowered the ends of two arms, counterweighted by balance bobs. Chains were suspended from the arms which held pistons moving up and down in cylinders of brass or cast iron, drawing the water by means of 'sucking plumps, chaine plumps and forcing plumps'. Apart from this introduction of a new drainage 'engine', the Costers are credited generally with the improved use of drainage adits as well as the adoption of a new system of ore dressing and assaying.

They were also said to have been responsible for the introduction of horse-whims to Cornwall, enabling a simple temporary or portable structure to be used for the drawing of water or ore from far greater depths than was practicable by manpower. It has not been possible to find evidence to verify these extensive claims. For instance, William Pryce attributed the introduction to Cornwall of the large 30 ft.—40 ft. diameter waterwheel to the work of John Coster in the early years of the eighteenth century. His statement has been questioned in an earlier Newcomen paper by T. R. Harris who claimed that Francis Scobell had introduced the use of large diameter wheels to Cornwall by his Patent No. 467 of 1724. However, large wheels were being used in North Somerset coalmines in the first decade of the eighteenth century, one 30 ft. wheel being recorded in a parish neighbouring the Bye Mill site which John Coster II occupied.²³ Thus he might well have introduced the same technique to Cornwall. There is no doubt, however, that the name of Coster was revered in Cornish mining by the end of that century and that members of the family were responsible for much development which occurred in the early years. So much so, that John Coster II was acknowledged as 'the father of Cornish copper mining'.

Mines in which the Costers are known to have been directly concerned were Impham and the William and Mary Mine, both near Tavistock, Frenches Work near Helston and Relistia near Gwinear,²⁴ but one of the areas in which they were active over a long period was at Lord Falmouth's North Downs in the parish of Blanchland. At the time there were several small workings within a small area, including Great, Middle and Little Pittsdown [sic], which later became known as Wheal Busy, as well as Metalwork and Chasewater, which were being run by the Bristol brass company. On the southern bank of the nearby River Blackwater, John Coster III leased several stamping mills which had existed from the 1670s. During 1716, he undertook to replace the Roswithy North 'engine', a waterwheel system which was no longer able to cope with the drainage of the North Downs mines.²⁵ He thus enabled the area to be worked at far greater depths than previously.

When John Coster II died in 1718, his will, made two years earlier, directed that all his shares and interests in the tin and copper mines of Cornwall, together with all his water engines, tin ore, iron, bell metal, cylinders and brasses and all other engine materials, should be left as a joint stock to his wife and three sons. Mary Coster was to hold 12 shares, Thomas and John nine shares each, and Robert, a minor when the will was made was left six shares. John III continued to care for the family

interest in Cornwall and in September 1722, he leased a house in Pider [sic] Street, Truro, 'with the liberty of building an essay [sic] office for trying copper oar on the premises or of converting one of the outhouses into such an office'.²⁶

By 1727 John Coster III was buying copper ore on behalf of the two large Bristol businesses and both companies at Redbrook. Possibly he had held this responsibility for some years previously. The companies had long been suspected of working together to depress ore prices and to raise costs of their finished goods. During 1729 the joint purchases amounted to 627 tons; in 1730, 1,198 tons 18 cwt. 0 qrs.²⁷ In 1732 the purchases dropped and afterwards ceased, following the death of John Coster III. During this time the companies had also purchased batches of varying size, as well as receiving direct supplies from mining sites which they owned.

Possibly it was through the youngest son, Robert, that the Coster family concern became involved in the Hayle smelting works. Smelting had been started at Penpol near Phillack, Hayle, about 1714 by Gideon Cosier, who was still in charge in the early 1720s.²⁸ After his death, the works was continued by a partnership between Robert Corker, MP for Tintagel and Sir William Pendarves. Robert Coster married Grace Pendarves, possibly the daughter of Sir William, and Coster was described as a partner after the death of Sir William in 1727. It was suggested to Corker that the works might be relinquished to Coster at a valuation of £660 if the smelter was to be closed to prevent further competition, but at £927 for the going concern.²⁹ Copper smelting in Cornwall had not proved successful, as some 3 tons of coal were needed to smelt each ton of ore. In a county which had no coal resources, it was cheaper to transport the ore to Bristol or the coast of South Wales, where coal supplies were abundant.

It has not been discovered if the Costers did, in fact, discontinue smelting at Hayle on taking over the works, but in partnership deeds of Coster property made in 1734, Hayle Mills only was referred to with no mention of a smelting site.³⁰ By the 1740s, it was said that the works were in ruins and partly converted to other uses.

THE COSTERS IN SOUTH WALES

In December 1732, the Costers leased another smelting site, this time in the South Wales area, at Melincryddan near Neath. Sir Humphrey Mackworth had established a small smelting works for copper in 1695, not far from the earlier Mines Royal smelter near Neath. Kahlmeter had described these Neath works as having about 10 or 12 furnaces each, with a production not comparable with the centres at Redbrook and Bristol. Following repeated losses in the Mackworth organisation, the Coster concern took over the site, consisting of:

'Building formerly used for smelting and refining of copper and brass and lead, with warehouses, furnaces, wheels, stamping mills, comthinghouse, stable and smithy, with the liberty of dumping slag on nearby waste land, and the benefit of using the River Crythan when not needed by the Coalworks for drainage purposes'.

This was leased for 20 years at a rent of £105 per annum.³¹ The nearby Crythan Mill was also leased in 1735 for an additional rent of £5 per annum.

This interest in acquiring a smelting works in the family was a new departure for the Costers. In earlier times, the smelting of copper had been the concern of the quite separate joint-stock company, the Upper Redbrook Copper Works. Old John Coster II had bequeathed some 78 shares of this organisation to various members of his family, probably the largest part of the company stock. It is possible that the Costers acquired the remaining shares in the years that followed, but the Redbrook works does not appear in any references to their family property. Certainly by about 1730, the joint-stock company no longer existed and the Costers had vacated the site and had assigned it to the Bristol brass company.

THE DECLINE OF COPPER SMELTING AT REDBROOK

This sub-letting was later to become an important factor in prolonged litigation initiated by the landowner, involving the Costers as well as the brass company. In 1735, the new occupiers were accused of having taken the site merely to prevent its use by any possible competitor, destroying most of the buildings and taking useful equipment to Bristol.³² As the Redbrook techniques and

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some of the furnaces had long been outdated by Bristol methods, this charge appears to be well-founded. Viscount Gage, the landowner, claimed that £980 would be necessary to put the works into working order but this was contested by Thomas Coster. Details of a later repair estimate of 1739, made on behalf of Viscount Gage, provide information on the extent of the works:

	£. s. d.
The repair of 25 furnaces for melting copper will cost	1125. 0. 0.
The repair of four wheels, shafts, bellows, trows [mill-races], ^{32a} sluices and other necessaries, with timber and iron and other materials	220. 0. 0.
The repair of the several chimneys or stacks with materials and iron cramps for the same and other mason work will cost at least	250. 0. 0.
The repair of the timber work in the roofs and other timber work with timber, nails and other materials	5. 0. 0.
The repair of the dwelling house will cost	25. 0. 0.
Other repairs not above specifically mentioned	10. 0. 0.
Iron work, viz, cast plates for flooring and other cast iron taken away about 40 ton at £7 per ton	280. 0. 0.
Repairs of the lower hammer house	10. 0. 0.
	£2025. 0. 0.

The lawsuit was not settled until 1744 when £500 was paid to the heirs of Viscount Gage. Later when Reinhold Angerstein visited Redbrook in 1754, he discovered that the works was occupied by a new partnership which had installed fourteen smelting furnaces but they were not in operation at that time.³³ Neither does there appear to have been much further activity at the site in the smelting industry. Eventually, in the 1790s, the works was leased to a tinplate manufacturer.

LATER HISTORY OF THE COSTER BUSINESS

After their loss of smelting facilities at Upper Redbrook, the Costers must have relied heavily on the output at Melincryddan but the occupation of this works proved only a short-term measure. By 1739, they had no further use for the works, which they allowed to pass into the hands of the English Copper Company, the former neighbouring company at Redbrook. Thomas Coster had already taken occupation of lands near Swansea, called Craigraplath, White Rock, Morva Carw and Knaploth Hill, east of the River Tawe. The new lease from the Hon. Bussey Mansell in 1737 enabled the building of a smelting works, which was to be known as White Rock, established as the permanent smelting site of the Coster family business.³⁴ The entire concern continued to be run from the Bristol area where the capacity to manufacture wares in copper had been greatly extended.

An additional site had been leased from the Popham estate, downstream of Bye Mills, on the River Chew at Publow (ST 625642), where formerly frying-pans had been manufactured with water-powered battery hammers.³⁵ Thomas Coster had leased land nearby in March 1728, and erected a new mill building, but by 1731 had taken over the old iron-mill with its 'watercourses, rivers, millponds, sluices, weirs and all apurtnances'.³⁶ The last stages of copper refining and battery production in two separate mills were to be developed on the overall site.³⁷

The intervening Pensford Mill (ST 618637), which separated Publow and Bye Mills, was also leased from the estate, for the life of Jane Coster, only child of Thomas. This property, 'two water grist mills under one roof with Millhouse, Stable and Garden', was not converted to the manufacturing purposes of the copper business. It remained a grist mill to be sub-let to a local miller, although the millhouse was converted much later for use as a copper warehouse. By gaining control of this mill site, the Costers had obtained command of the whole two-mile stretch of river between Bye Mills and Publow and this was presumably the main reason for the acquisition.

This period of development in the Bristol area could not have been an easy one for Thomas as head of the family and of the Coster copper business. His brother John III of Truro, died in June 1731 aged 43 years. His mother Mary, wife of John II and a partner in the business, died in 1734. The youngest brother, Robert, of Pendarves in Camborne, died in Bristol in March 1736 at the age of 39. During 1734, Thomas Coster was elected as Tory Member of Parliament for Bristol, in company with

Sir Abraham Elton, son of the Conham copper smelter. A petition from Whig supporters, stating that Coster's return was due to invalid votes, was presented on the opening of Parliament, only to be withdrawn later when the charges could not be substantiated. He continued to represent Bristol until his death five years later on 30 September 1739, 'when the great bell of every parish church tolled in the city an entire day'.³⁸ The plaque from his monument can still be seen in Bristol Cathedral.

Thomas Coster had been married to Astrea, daughter of Sir John Smyth of Long Ashton and their only daughter Jane, who appears to have been the sole heir of the three brothers, is said to have inherited the family fortune of £40,000. In 1741, she married John Hoblyn of Cornwall, who was elected Member of Parliament for Bristol during the following year. Jane Coster was not called upon to bear the full responsibility of the business on the death of her father. In 1734, the year of Thomas's election to Parliament and of his mother's death, he and Robert had taken Joseph Percivall into partnership, admitting him to a third share of properties at Hayle, Melincryddan, Swinford, Pensford, Bye Mills and Publow. During the following year additional minor partners were taken into the business and yet further articles of co-partnership in 1742 are referred to in a later minute book. This latter phase of re-organisation may indicate the date from which Jane Hoblyn gave up her inherited share in the business. However, some of the business premises had been leased for her life, prior to the death of her father and her name appears on property documents until at least 1758.³⁹ This has been the cause of some confusion about the name of the company during this period, but following the death of Thomas, the last of the Coster brothers, the whole concern came to be known as Joseph Percivall and Copper Company.

The new White Rock smelting works was drawn in ink by Joseph Lightfoot in 1744, and its buildings named and described as fully completed, and owned by Joseph Percivall. The drawing was reproduced in Grant-Francis's *The Smelting of Copper in the Swansea District* (1867). The features there detailed included: Mansell's field; and old mill; the pond; the slag bank; the great coal road; the great calciner; four new smelters; four new calciners; the great work house; compting house; storehouse; quay; manilla house and pay office; carpenter's shop; the clay mill and stamps; the entrance to the dock; Mansell's coalyard; the quarry; Edward Jones's house.

Production figures for the whole concern are available for the period shortly following the date of the drawing when, undoubtedly, some residual influence of the Costers was still being felt. In the year ending June 1750, some 2,566 tons of ore was smelted at White Rock and 343 tons of copper produced. During this same period, the copper rolled at Swinford Mill amounted to 1312 cwt. At Publow, 1028 cwt. of copper was refined, whilst 647 cwt. rolled copper was made into batteryware and 628 cwt. of other battery products were made. At Bye Mills, 801 cwt. of copper was made into batteryware.⁴⁰

Joseph Percivall remained in charge until his death on 29 June 1764, when one of the senior partners gave his name to the business.⁴¹ The new John Freeman and Copper Company was still essentially the same concern as that established by John Coster II and so it remained for almost another century. In the 1790s Woollard Mill, an old tinplate mill, was added to the River Chew sites and developed as a rolling mill, and later, Swinford Mill was extended and partly rebuilt. From early in the nineteenth century prolonged squabbles developed between the descendants of early partners and their managers, which led to several legal battles.⁴² In consequence, the company declined until, by mid-century, it was a shadow of its former self. Swinford Mill was relinquished and all its equipment auctioned in 1859. The same fate overtook the Chew mill sites during the following year, bringing the business's long connection with the Bristol area to an end.⁴³ White Rock smelter continued for a few years, possibly until 1868, and the company appears to have existed in some form, still buying ore, until 1870.⁴⁴ The final years of the company still remain to be recorded but it appears to have quietly faded away. The buildings constructed in the Freeman era still remain at Swinford and fragmentary traces of buildings and water courses can still be seen at the Chew sites; survivals of the copper industry built by the Costers.

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NOTES

1. Jenkins, Rhys. 'Copper Works at Redbrook and Bristol', *Trans. Bristol & Gloucestershire Archaeological Society*, 63, (1943), 145-54; 'Copper Smelting in England: Revival at the end of the Seventeenth Century', *Trans. Newc. Soc.*, 24 (1943-4), 73-80; 'The Reverberatory Furnace with Coal Fuel', *Trans. Newc. Soc.* 14 (1934), 67-81.
2. Liverpool University Library (LUL), Rhys Jenkins Papers, translation of H. Kahlmeter's 'A relation of the English Mines in 1725', 12.
3. Jenkins, 'Copper Works at Redbrook and Bristol', 150-6; 'Copper Smelting in England', 75. Rose copper was a commercial grade of metal with a distinctive red hue formed by immersing the ingots in water whilst still hot.
4. Liverpool University Library, Rhys Jenkins Papers, translation of Eric Odelstierna's 'Travelling Description over the Foreign Mines', (1691-3), 2. His statement has been queried on geological grounds but, four years later, Cletscher referred to the closure of the mining.
5. Gloucestershire CRO. D1677 GG1092, Indenture of 1709; National Library of Wales, Mynde MSS 1923.
6. Science Museum Library (SML), Rhys Jenkins Papers, Box 22; Exchequer Port Book extracts.
7. *House of Commons Journal*, 17 June 1715.
8. Jenkins, 'Copper Works at Redbrook and Bristol', 156-8.
9. Raistrick, A. 'The London Lead Company', *Trans. Newc. Soc.*, 14 (1933-4), 120-5; *HoC Journal*, 17 June 1715, 178.
10. Houghton, John. *Husbandry and Trade Improv'd*, (July 1697); Glos. CRO. D1677 GG1352-7, 1709.
11. *Calendar of Treasury Papers*, Vol. 37, (May 1696), 509. The contractors were reported to be losing £87 per week.
12. SML, Rhys Jenkins Papers, Exchequer Port Book extracts.
13. LUL, Rhys Jenkins Papers, translation of Thomas Cletscher's 'Relation of European Mines in 1696'.
14. Swedenborg, Emanuel. *de Cupro*, (1734), English translation, Searle, A. H., British Non-ferrous Metals Research Association, Misc. Pub. 333.
15. Private communication to author, from Dr. R. F. Tylecote, who kindly gave his guidance in the interpretation of these techniques.
16. LUL, Kahlmeter, pp. 52-6.
17. NLW, Mynde MSS, 1269; SML Rhys Jenkins Papers, Will of John Coster.
18. Glamorgan CRO, D/DXhr/9, Abstract of Title.
19. Somerset CRO, DD/OB.103 (i) - 105.
20. Day, J. *Bristol Brass*, (1973), 29-47.
21. University College of Swansea Library (UCSL), Robert Morris MSS, 'A History of the Copper Concern', 22.
22. Devon CRO, Records of Bedford Estate, by courtesy of R. Stiles.
23. Borlase, W. *Natural History of Cornwall*, 205, (1758).
24. Barton, D. B. *A History of Copper Mining in Cornwall* (1968), 13-14.
25. Harris, T. R. 'Engineering in Cornwall before 1775', *Trans. Newc. Soc.*, 25 (1946-7), 112-3.
26. Bulley, John A. 'To Mendip for Coal', Pt. I, *Proceedings of Somersetshire Arch. & Nat. Hist. Society*, 97, (1952), 71.
27. LUL, Kahlmeter, 7, 9, 18 and 24.
28. Public Record Office, C33/352.
29. Cornwall CRO, Enys - 29.9.1722.
30. UCSL, 'A History of the Copper Concern', 9.
31. Royal Institution of Cornwall Library, Tonkin MSS (Phillips MS 13495), 199.
32. UCSL, 'A History of the Copper Concern', 93.
33. Glam CRO, D/DXhr. 1.
34. *ibid.*
35. Glos CRO, D1677 GG1352-7.
36. 'Thorow' or 'throw', sometimes pronounced 'trow', is a local term in the Bristol district for a mill-race running through a building.
37. LUL, translation of Reinhold Angerstein's 'Journal of a Journey through England in the years 1753-4-5'.
38. Glam CRO, D/DXhr 37.
39. Som CRO, DD/SH 108, Strachey Papers, by courtesy of Dr. R. W. Dunning.
40. Glam CRO, D/DXhr 1.
41. Bristol Archives Office, Vaughan Papers 12171, Account book of White Rock Copper Refinery.
42. Commemorative stone of family in Newland Parish Church; of Thomas Coster in Bristol Cathedral; Latimer, John. *Annals of Bristol, 18th century* (1893).
43. Glam CRO, D/DXhr 1-93.

40. BAO, Vaughan Papers, Account Book.
41. Bristol Reference Library, MS B 4771, Committee Book of the Joseph Percivall and Copper Company.
42. Glam CRO D/DXhr 107-110; Som CRO, DD/OB 106.
43. Glam CRO D/DXhr 104/1-42 and 105.
44. Roberts, R. O. 'The Non-Ferrous Smelting Industries in South Wales', *Cymrodorion Society Transactions*, (1956) reprinted in *Industrial South Wales, 1750-1914*, (ed. W. E. Michinton), 121-160, (1969), also in details of an unpublished paper on Swansea Copper Smelting, kindly disclosed to author by Mr. Roberts in private communication.

DISCUSSION

Mr. LAW opened the discussion by asking what the lettering was on the Swansea building. Mrs. Day replied that she had only seen the engraving of White Rock in Grant-Francis's book and, apart from the caption to this, detailed in the paper, had no further information about Mr. Law's query.

Mr. J. G. B. HILLS asked what metals, other than copper, had been processed by the Costers. Mrs. Day said that the Clerke patent, 1687/253 covered the processing of gold, silver, copper, lead and tin from ores or minerals and had probably been drafted to cover as wide a field as possible. The Costers, however, were mainly interested in copper.

Mr. T. BERG wondered whether the Coster family had come from Sweden where there was still a family of that name. He reported that Angerstein had said there was a colour mill near the present Clifton Suspension Bridge where the colour grinder was paid 10/- a week with two baths a day when the tide was in. Mrs. Day was interested to hear Mr. Berg's suggestion about the name and referred to the Rhys Jenkins papers where the same possibility was discussed. More recently, others had suggested to her that the Costers may have come from Holland where the surname (spelt with a K) was common. Rhys Jenkins had also referred to a number of Swedish workers being employed at the Redbrook Works. She did not know of the colour mill (or mill for crushing ochre, as she understood the term) but it may have been connected with the logwood dye-processing mill (Red Mill) which was situated almost beneath the present Suspension Bridge.

Professor D. G. TUCKER said that the Redbrook site was somewhat unusual; David Bick had searched the area but could find no traces of copper, and Cyril Hart had made no mention of copper deposits there. Why should a copper-smelting works be set up in an area so far from raw materials? Mrs. Day replied that in the Odelstierna papers of 1691-3 there was a reference to copper mines in the Forest, which she had included in her paper. There was a possibility that this may have been the result of a misunderstanding in translation but, in 1696, Cletscher reported that these copper mines had been closed, thus corroborating their earlier existence. Admittedly, the probability of copper deposits has been questioned on geological grounds but their existence is not impossible. However, copper ore was imported from Cornwall from the earliest years of the Redbrook industry but the same applied to Bristol. With regard to other raw materials, the early copper reverberatory furnaces used coal, not charcoal; the first reliable references to coke in reverberatory and blast furnaces occurred in the Kahlmeter papers, 1724/5, although it may have been used earlier.

Dr. EARL asked when the mills were started; tithe records showed that the area had been an industrial area with mills of various types. Mrs. Day had no evidence on these dates. As far as copper smelting was concerned Redbrook was a virgin site but some grist mills, and the paper mill mentioned, were then already established. Dr. EARL further asked whether the choice of the Redbrook site might have been influenced by the convenience of obtaining ready supplies of both copper ore and coal. Mrs. Day agreed and added that another influence may have been that the site was available in an area already industrialised, and that there may have been no similar site available then in the Bristol area.

Mr. REX WAILES wondered whether the Costers might have gone to Sweden instead of coming from there. A tide mill at Hayle had its pond wall built with slag blocks from the Copperhouse foundry. He also asked whether there was any connection between the Harveys of Bristol and Hayle. Mrs. Day replied that she did not know of any connection between the two Harvey families, that she knew of the slag blocks at Hayle but had no information on them, or on the travels of the Coster family.

Mr. CLOUSTON said there had been gunfounders called Costers in Amsterdam and he also noted that there was no record of bells being made by the Costers at Redbrook. He knew of no bellfounders in England at that time and remarked that it was the usual practice to melt the copper and then add the tin. A remelting of solidified bell metal would result in the vaporisation of some of the tin so that the re-cast bell metal would not have the desired copper-tin proportion. Mrs. Day had no further information on the re-melting of bell metal other than the reference by Kahlmeter, 1724/5; a brief note on the Cornish ores used at Bristol which were said often to contain appreciable amounts of tin. This must have caused a high-tin bronze to liquate to the bottom of the refining furnace which was sold to foundries for the production of bell metal, and there were several well-known bellfounders in the surrounding area of Bristol.

Mr. BUTLER congratulated Mrs. Day on the lucid presentation of the paper and of the slides which illustrated it. He queried the use of the reverberatory furnace which required a fuel that burned with a long flame. He also queried whether coke would have been available at the date of the first reverberatory furnaces at Redbrook. Regarding the slide of the White House, he said that this had been described as the house of the manager of the tinplate works. Mrs. Day replied that the period covered by the paper pre-dated that occupancy of the house. She suggested that the metallurgical use of coke might possibly have been learned at Bristol during the early copper-smelting experiments. Dr. R. A. Mott had suggested this in several of his papers and had also put forward the theory that Abraham Darby had learned the metallurgical use of coke in the early years of brassmaking at Bristol before going to Coalbrookdale. Immediately after leaving Bristol in 1708-9, he had used coke for smelting iron at Coalbrookdale. The use of low sulphur-content coal (for example from Shropshire) might also have been the answer.

Mr. J. G. B. HILLS said that coke had been used by maltsters before it had been used for iron-smelting at Coalbrookdale. Mr. BERG said that sulphur was not important in copper smelting whereas it was in iron smelting; dirt or tar contaminants would have been much more deleterious. Mrs. Day commented that it was possible that coke was used in the early copper furnaces but confirmation from the sources available at present was not possible until 1724/5.

Mr. ROBINSON said that Swinford mills used a large waterwheel as a flywheel, might the same have been done at Redbrook? Mrs. Day replied that when the Swinford and Chew Valley mills closed in 1859/60 the sales catalogues listed separate flywheels. Such details were not available for the much earlier era at Redbrook.

Mr. WATKINS said that there were probably four undershot wheels at Exley. He also remarked that a long-flaming coal would have been very useful in a reverberatory furnace; normal coal or coke would not provide this facility. Mrs. Day accepted the comment but could not add to it.

Mr. WRIGHT commented on the brittle nature of the early copper produced at Redbrook. London trumpet-makers used a 'springy' metal in their manufacture of their instruments. Commenting on the Redbrook metal, Mrs. Day said that the refined copper would still have contained sulphur which would have embrittled the metal. The processes evolved later used charcoal instead of coal, in the last stages of refining, to overcome this difficulty. Mr. BERG agreed.

Mr. PALLETT said that the Romans had mined lead on Mendip; was this the reason for the continuance of the industry in the Redbrook area? Mrs. Day replied that Mendip leadmining was partly responsible for the lead-smelting industry of Bristol, from which copper smelting evolved, so it could be said to be one of the reasons for the development of the Redbrook industry.

Mr. DARLING proposed the vote of thanks. He congratulated Mrs. Day on the presentation of a well-rounded and complete account of copper production in the areas where John Coster II had built up an empire which remained in existence for some 150 years after his death. The account of the Costers had been presented in a most informative way. The vote of thanks was passed with acclamation.