Appendix 3

The Coalbrookdale Accounts:

a description of the records and their use

In chapter 5, calculations have been made, based on the accounts of the Coalbrookdale ironworks. The history and topography of the works is dealt with elsewhere,[1] but something needs to be said here to provide a context for the accounts.[2] As mentioned in chapter 2, the furnace was leased by Abraham Darby I, who successfully used it with coke as fuel to produce pots and other cast iron goods. About 1715 he built a second blast furnace to expand his trade, but died in May 1717 followed soon after by his widow. Before her death Mary Darby disposed of her husband's interest in Vale Royal Furnace in Cheshire and probably also that at Dolgûn near Dolgellau where another furnace was planned. Mary Darby also transferred six of her husband's shares in the Coalbrookdale Company outright to Thomas Goldney II, a Bristol merchant, who held a mortgage over Darby's shares. Mary died soon after, leaving a family of young orphans. There then followed conflict over the administration of the Darby estates, and Thomas Baylies, who had been a partner in the Coalbrookdale Company took out Letters of Administration as a creditor. This was ultimately resolved by an uncle of the Darby orphans satisfying Baylies claim and acquiring the remaining Darby shares in the company to hold in trust for the orphans.[3] As part of the arrangements between Mary Darby and Thomas Goldney, the latter's son, Thomas Goldney III, was appointed to keep the firm's accounts, and he was later made a partner in the works. Having been trained as a merchant, the son was well qualified for this and the accounts have been kept to a high standard.

The surviving Coalbrookdale account books consist of one kept by Abraham Darby starting in 1709 (of which little use has been made here) and two journals and two cash books covering the period from July 1718, when the new company in which Goldneys were partners was formed, until September 1738. The second cash book then continues with a new pagination until 1748. The journals are usually (but possibly incorrectly) known as 'Stock Books', but are in the form frequently found in merchants accounts of the period and also in ironworks accounts at Backbarrow and Sheffield.[4] The one respect in which the accounts are different is that entries

---

[1]. Raistrick 1953; Mott 1957a; 1957b; 1957c; 1958; Trinder 1973; Trinder 1974; Cox 1989; Hayman *et al.* 1999; Thomas 1999.

[2]. The accounts are Shrops. R.O., 6001/329-331 and Ironbridge Gorge Museum, Coalbrookdale ms.1.

[3]. King 1993, 7-9; Stembridge 1998, 17-20. The descriptions of these events by Raistrick (1953, 43-8) and Mott (1957a) is somewhat incomplete. After leaving Coalbrookdale, Baylies pursued his interest in the Vale Royal ironworks: King 1993, 8-10. Baylies was imprisoned in 'Worster' [Worcester] Castle for debt in 1727, at which time the Company gave him a guinea: Shrops. R.O. 6001/329, 156. Subsequently he was manager of the York Buildings Company's ironworks at Abernethy in Scotland, an affair that collapsed in a morass of debt and then in 1737 emigrated to Massachusetts, where he and his son managed ironworks: King 1993, 10 18; information from Mr Bob White of Huntsville, North Carolina quoting Mary R.B. Allen, *Reminiscences of the Baylies and Richmond families* (privately, U.S.A., n.d. c.1880), 5-9.

[4]. BB a/c; SIR a/c; cf. Prankard a/c. If the description 'Stock Book' is correct, this may be to contrast it with the Cash Book, since it recorded all transactions other than those involving the receipt or payment of cash.

relating to the receipt and payment of cash do not appear in the journal but in a separate cash book.[5] These journals and cash books together record all the commercial transactions of the business, but there were nevertheless other books that have not survived. Firstly there was a waste book, which is mentioned in the journal from time to time as containing further details that were not entered in the journal. The waste book can be regarded as a rough draft of the journal, but it may well have been based in turn on other books kept by the stocktakers for the two blast furnaces, the air furnaces, the forge and the warehouse.[6] Furthermore there may have been a separate book recording monies advanced to workmen. That was probably treated as private transactions between the accountant and the workmen.[7] Thirdly (and most importantly), there was a ledger, which, with the journal and cash book, was an integral part of the main accounting system, to which the waste and other books were merely preliminary. Though no ledger survives, the journal and cash book contain the usual references to the folios of the ledger and have all the information necessary to reconstruct the ledger. Every journal entry has two corresponding ledger entries and a full reconstruction could be achieved by posting those entries in just the way that the original accountant did. However, a complete reconstruction has only been undertaken in respect of a relatively short period at the beginning of the accounts, merely sufficient to ensure that the workings of the system had been correctly understood and to demonstrate that reconstruction was possible.[8] A partial reconstruction for the whole period 1718-38 (limited to those ledger pages that dealt with operations at each productive section of the works) has been undertaken, and this forms the basis of the figures provided in chapter 5. Even this limited reconstruction has been a very substantial undertaking. The resultant full compilations are too large to print, but will be found on the accompanying CD-ROM disc.

The Coalbrookdale works consisted of a number of productive units. The Old Blast Furnace (OBF) was built by Sir Basil Brooke in 1638 (or by some one else in 1658).[9] At that stage it was a traditional charcoal furnace making pig iron for consumption in several forges in the Dale and perhaps elsewhere. However it was this furnace that was used by Shadrach Fox to make cast iron shot and grenado shells in the 1690s and then by Abraham Darby for his potfounding business from 1709.[10] The New Blast

---

[5]. Elsewhere the cash entries were inserted in the journal in a group every month or quarter, the total being posted to a ledger folio entitled 'cash' or '[name]'s cash'.

[6]. The waste book is mentioned periodically as containing further details not written into the journal. An 'iron waste book' probably concerned with the forge is also mentioned occasionally, *e.g.* Shrops. R.O., 6001/330, 385. A waste book from the 1770s and a blast furnace record book from the 1790s book survive for Horsehay ironworks (HH a/c). The surviving Prankard accounts (relating to a mercantile business), comprising waste books, journals and ledgers, provide an indication of what the complete system consisted of.

[7]. Such workmen's debts were taken into account when the cash book was balanced and the cash was handed over to a new accountant.

[8]. This reconstruction is a manuscript account book in my possession. This exercise influenced the way in which data was subsequently collected from the journals.

[9]. The date depends solely on what appears in relief on the furnace lintel. Hayman et al. (1999, 11-2) have suggested from a photograph taken in the 1950s and earlier descriptions of it that this date was 1658. However, they do not appear to have undertaken any fresh investigation as what the correct reading of the number is, merely suggesting that it was changed when the lintel was repainted. Nevertheless, the question does not concern a superficial layer of paint, but the underlying metal where the date stands (or stood) proud. Sir Basil Brooke died in 1646 and his estate was sequestrated during the Civil War because he was a recusant. It did return to his family until the Restoration. This makes 1658 a rather improbable date for the construction of the furnace. Sir Basil was a partner in farming the King's Ironworks in the Forest of Dean until 1633 and the wireworks at Tintern until his sequestration. He was also concerned in a monopoly in the production of steel in the 1610s and had a forge at Bromley (Shrops.) in the same period. A date such as 1638, a few years after his loss of ironworks in the Forest, is therefore (unlike 1658) not an improbable one for the construction of the furnace. It is noteworthy that A. Raistrick believed in the earlier date in 1989 (Raistrick 1953 (1989 edn, publisher's note facing first title page, author's corrigenda for p.102). It does not seem now to be known why the date was painted as 1638. Perhaps some new examination of the lintels is needed. See also Trinder 2000, 20-1.

[10]. For Shadrach Fox see chapter 3 and King 2002a.

Furnace (NBF) was built by Darby in about 1715 on the site of the Upper Forge. Further down the Dale were the Middle Forge (which was occupied by Thomas Stanley until taken over by the Company in 1720) and the Lower Forge, which was occupied, usually as the Company's subtenants, until the 1780s by members of the Hallen family, who used it to make frying pans. From the 1780s it was used for the potting and stamping process.[11]

In addition to these water-powered works there were several air furnaces, the earliest of which was built by Shadrach Fox.[12] By 1718 there were three of these, known as the Upper Air Furnace (UAF), New Air Furnace (AFN), and Lower Air Furnace (LAF).[13] The Upper Air Furnace probably adjoined the Old Blast Furnace and presumably dates back to Fox' time. This was in almost continuous use throughout the period of the two journals. The other two air furnaces enjoyed only intermittent use, mostly when one of the blast furnaces was out of blast and so not available to provide molten iron to fill the moulds. Of these the New Air Furnace received some use in most years, whereas the Lower Air Furnace was not used at all after 1722. After 1738 the cash book contains a reference to Upper, New, Lower, and Old Air Furnaces in successive entries,[14] but the accounts do not make their precise locations clear. The moulders were employed at both blast furnaces (while in blast) and those air furnaces that were in use, being paid for pots and such like at piece-rates. However they seem to have been paid for 'castware' (miscellaneous cast iron goods) in other ways.

Each of these sections of the works is dealt with separately in the journal and the cash book and each had its own series of pages in the ledger, which recorded its consumption of raw materials and other input costs together with the quantity of products made. It is these pages on which the reconstruction has focused. The pages of the journal are mostly of a small number of content types. One such type relates to sales to customers from the warehouse. These form part of the basis of a detailed study of the marketing of pots and pans, which K. Dannehl has been undertaking. No detailed examination of these sales records has therefore been undertaken. Most of the remaining pages are concerned with the production of the works, as far as the point at which pig iron was 'weighed off' to the pig yard and other goods to the warehouse. Cost figures were usually entered up every four weeks and have been systematically extracted from such pages, in order to calculate the total production costs of the business. However, marketing costs charged to the warehouse and pig yard have not been extracted, including that of transport to (or towards) customers.

One of these page types deals with the supply of coal, specifying the royalty paid to the mine owner (either the landowner or a coalmaster who was a tenant under a mining lease such as Richard Hartshorne), the cost of carriage to the furnace, and (where the mines were operated by the Company themselves), the cost of 'getting coal', that is a payment to a charter master covering the miners wages. These are broken down for each mine

---

[11]. Mott 1959b.

[12]. Woodward, 'Observations', f.101; King 2002a.

[13]. Certain authors have been confused by the presence of two air furnaces in the Copper House (Raistrick 1953 (1989 edn), 306). These were probably for smelting copper and related to a separate business, which evidently ceased before 1718, since both the copper house and copper warehouse were being used to store stock for the iron business. For the copper business see Cox 1989, 130-1.

[14]. Shrops. R.O., 6001/331, part ii, 41.

and also (in the case of carriage) each carrier.[15] Another series of pages is concerned the costs and output of each section of the works. These 'various charges' included the quantity of coal coked and the cost of this, the royalty and carriage of limestone and the moulders' wages. Certain other items, which appear on the same pages such as repairs and the royalty and carriage of sand, have not been extracted individually because they are quite small. Instead such minor items have been taken into account by calculating the difference between the items specifically extracted and the total. These charges are specified separately for each section of the works and are followed by expenses for the warehouse (which have not been extracted) and certain other minor items. Towards the foot of such 'various charges' pages is the quantity (in *cwt.*) of goods made at each blast or air furnace. The entry of all these expenses is extremely systematic and extraction of figures has presented no difficulty, other than that of their sheer quantity. The entry of certain other costs was somewhat less systematic. The cost of ironstone ('mine') and other miscellaneous entries sometimes appear at the foot of other pages (if there was room) and sometimes on separate pages. This also applies to most entries concerning the forge. The main forge entries usually appear together, but at irregular intervals (sometimes once a quarter), but some entries appear in spaces at the bottom of pages or are combined with other transactions with the same supplier.[16]

The figures extracted from the journals and cash books were entered into an EXCEL spreadsheet with each type of quantity always appearing in the same column (as in an analysed cash book), but the same column could be used for more than one kind of entry, the particular type of entry (such as coal royalty, coal carriage, mine royalty and coking) and the unit (such as stacks, dozens, and tons) being indicated by text appearing in columns to its left. These quantities were then decimalised. By this means a number of cost items comprised in a single total could appear (along with the total) on the same line. A similar procedure was used (but with a different layout) in respect of the cash book.[17] Entries in the journal relating to the forge (FOR) were extracted in a separate exercise and placed in another workbook. A separate worksheet in this was used for sales from the forge warehouse, which included 'uses', iron supplied for the use of the works themselves. These uses were then extracted from the full list of sales, so that they could be charged to the appropriate section of the works.

All this amounted to over 7000 lines of data and over 20000 quantities of money or material, and was then processed in a number of stages, using macros written for the purpose. First the various source files were combined so as to place all the data set out in a single file approximately in date order. In the course of this further entries were added relating to goods (principally scrap from air furnaces) transferred from one section of the works to another, these having previously only appeared as products and not as raw materials. More importantly, cashbook entries were rearranged to have the same layout as those from the journal. The next stage was to segregate the entries according to the section of the works to which they related, so that each of

---

[15]. Details of individual carriers have not been extracted.

[16]. For example Richard Baldwin & Co. of Willey Furnace appear as suppliers pig iron and also timber and cordwood.

[17]. The layouts were chosen primarily for ease of entry, according to the form of the book the data came from.

the two blast furnaces, the three air furnaces, the forge, and also 'General Charges' (GEN) (overheads for the works as a whole) had its own worksheet. After that the decimalised figures were extracted and placed in a further workbook, in which each quantity had a column of its own, whether this was a measure of volume or weight of raw material or product or a sum of money for its value. At that stage pig iron and scrap transferred between sections of the works remained unpriced. Accordingly, in the next stage a price was added for these using values found in the accounts, ranging from £2 per ton for sculls (a steely crust from foundry ladles) to £9 per ton for pig iron, the latter varying from time to time according to the price charged to third parties. The final major stage of the process then consisted of totalling the data for each year (or other period). For the blast and air furnaces the period chosen was years starting on 1 July, because the accounts had started on that date in 1718, but almost any other date would have been as satisfactory because entries were made so regularly. However entries for the forge, though largely complete, appear at less frequent intervals. While similar annual figures have been calculated for it, it was found more satisfactory to use periods ending on the dates when iron was recorded as weighed into the forge warehouse (see below).

Throughout the period the accounts were meticulously kept and are neatly written except during a few months when they were kept by Ben Wall, whose handwriting (but not accountancy) was less neat. There is however (as mentioned in chapter 5) an inherent problem in using the accounts to advance any general case, in that there are no inventories of stock in hand, apart from an initial inventory at the beginning of the account and one for the forge when it was bought. For the products this does not matter, since their transfer to a warehouse (or the pig yard is recorded), but the only record of the consumption of raw materials is of the quantity received. Even this probably does not matter much for fuel the blast furnaces, since the accounts show deliveries of coal to them ceasing while they were out of blast, suggesting that the stock was not usually substantial. This also applies to the air furnaces. However, the absence of inventories is significant in relation to the forge, where there was probably a significant stock of charcoal, and perhaps also of charcoal pig iron during the period while that was being used.

Processing the entries relating to the blast furnaces and air furnaces generally presented few difficulties other than that of devising instructions that actually dealt with every different permutation of the data that might appear on a line. Writing these instructions (in Visual Basic), and testing them, was also extremely time-consuming, as the number of permutations that existed was considerable. However in dealing with the data from the forge, a number of more specific difficulties were encountered, partly as a result of the rather smaller and more varied nature of the data. These have been dealt with as follows:

1. Due to the lack of inventories it has been necessary to define accounting periods for the forge according to the dates when entries were made for bar iron 'weighed into' the forge warehouse. The absence of such inventories means that the accounts have to be analysed on something more on a 'receipts and payments' basis than an 'income and expenditure' basis. This does not apply to the bar iron made, as its quantity is known and

can be priced according to the price achieved for contemporary sales. However the impossibility of estimating the stock at the end of one period and beginning of the next means that the estimate has had to be made (with one exception) as if it was constant, which is evidently not correct. This is certainly a problem when estimating its fuel cost and also the pig iron cost while charcoal pig iron was being purchased from nearby charcoal furnaces. However when coke pig iron was in use, the entries for (coke) pig transferred from the pig yard are likely approximately to match actual consumption.

2. In December 1726 30 tons of pig iron were entered as carried from Leighton (at 2s. 6d. per ton),[18] but no entry has been found recording payment for this. It has been assumed that this was a real transaction and a price of £9 has been assumed, based on preceding purchases of Leighton pig.

3. In the winter of 1725-6 a quantity of old guns was purchased. These were melted in the New Air Furnace and apparently cast into pigs before being taken to the forge. However the accounts record the carriage of pigs from the New Blast Furnace. This probably merely indicates that the New Air Furnace adjoined the New Blast Furnace, but it might possibly refer to an otherwise unrecorded transfer of pig iron from that blast furnace to the forge.

4. Fuel costs have presented a considerable challenge: separate payments were made for wood, for cutting and cording it, for coaling it, and for carriage. Some of the payments relate to more than one of these or to an unspecified quantity. It has not proved possible to reconcile the payments for the wood and for the different operations that it underwent. Estimates of quantity have been built on purchases of wood.

5. There are a number of pages missing at the beginning of the second Journal.[19] This is not a severe problem in respect of the blast and air furnaces, since most of their entries were made monthly and what survives is probably a representative sample of the period. However, entries concerning the forge were made somewhat irregularly, about once a quarter. Considerable data has been lost that must have appeared on the missing pages. This includes a figure for iron weighed off about 25 July 1728.[20]

6. In the half year following that date virtually nothing was paid for fuel and the fuel cost has to be estimated at £5 based on those for the preceding and succeeding periods. Figures calculated for this period must therefore also be regarded as unreliable.

7. During the period when the second journal was in use figures concerning the forge were only rarely entered up, but when a set of forge entries were made, they do cover the whole period since the previous set. Accordingly, nothing is missing. However the infrequency with which the entries were made means that the

[18]. Shrops. R.O., 6001/330 (Journal i), 424.
[19]. Ironbridge Gorge Museum, Coalbrookdale ms.1.
[20]. The following entry (in December 1728) runs from 25 July (Journal ii, 40).

figures can only be analysed for a period of 2½ years from December 1728 to July 1731 and then 7¼ years from then to the end of the Journal.

8. Classification of production of bar iron between that using of charcoal pigs and that using coke pigs has to depend primarily on the wages paid to the finers. They were paid 15s. for making blooms from coke, but for charcoal blooms only 10s. (for 'ordinary' or 'mill') 11s. (for 'tuff' or 'merchant'). Differentiation presents no difficulty in the early years when the forge wages were entered in the journal with other forge entries, but from 1723 payment was made directly via the cash book often at dates other than when iron was weighed off into the forge warehouse. This means that when short periods are examined the quantities made by the forgemen and those weighed are not the same. One reason for this is that the hammerman often succeeded in making more than a ton of iron (of 20 *cwt.*) out of a ton of blooms (of 22 *cwt.*),[21] and was paid a bonus for his 'overyield',[22] details of which have not been extracted. However over longer periods there is sufficiently good correlation between the finers wages and actual output for this to present little difficulty. In one case (in summer 1731) it has been found useful to alter the date of payment to the finer for 2½ years work from August 1731 to the preceding July in order to bring it into the accounting period to which it (or most of it) relates.

9. Sales of raw materials and by-products also provided a minor difficulty. Sales of wood and charcoal and also charcoal pig iron (and their cost) have been dealt with by deducting them from the purchases. Other such minor sales have been deducted from a class of expenditure described as 'other expenses'. In a few cases it has been necessary to price such items: for example the transfer of a ton of charcoal pig iron to another part of the works in order to cast 'bushes' (probably bearings for vehicles) has been assumed to be part of a parcel of pig iron bought from Kemberton Furnace and priced accordingly.

---

[21]. Carlisle R.O., DDX/46 BRA 93/5; SIR Y a/c, 1717 journal, 19; 1719 journal, 45; 1716/21 ledger, 161.

[22]. This 'overyield' appears frequently in forge accounts, *e.g.* SW a/c.