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**ACCOUNTING FOR STEAM: THE ACCOUNTS OF THE
SOHO FACTORY**

by

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ACCOUNTING FOR STEAM: THE ACCOUNTS OF THE SOHO FOUNDRY

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Abstract

The accounting records of the Soho Foundry, an organisation set up in the late eighteenth century display a close similarity to modern accounting processes. This paper discusses the organisation of the foundry and its ledger, as a reflection of that organisation, during the early years of operation. The Soho Foundry was unique in as much as it was the first factory built to solely manufacture steam engines and as may be expected the organisation of the foundry reflected the innovation of the design of its product. The accounting system employed also reflected a high degree of sophistication.

November 1995

Accounting for Steam: The Accounts of the Soho Foundry

Introduction

The accounting procedures employed by James Watt jnr at the Soho Foundry bear a striking similarity to modern accounting processes. This paper is concerned with an examination of the organisation of the accounting records that were established when the Foundry was built in the late eighteenth century. The flow of accounting entries reflected the flow of product through the operating departments of the Foundry and provides an early example of the treatment of these operating departments as profit centres.

The first part of the paper provides background to the establishment of the Foundry and the second section is concerned with the organisation of the ledger and provides an example of its output.

The Steam Engine Business

The original partnership of Boulton and Watt, formed in 1775 was established to act as consulting engineers in the erection of steam engines [Roll, 1930; Dickenson, 1935; Tann, 1981; Law, 1990]. The steam engine developed by James Watt was more efficient and economical than the other engines then available. As most of the engine parts were made by subcontractors, Matthew Boulton and James Watt selected appropriate specialists for particular pieces, and because of a concern for the firm's

reputation these subcontractors were selected more on the basis of the quality of their work than cost [Tann, 1981]. However as time went by, in order to maintain the high quality of the product, more and more parts were made in Boulton's Soho Manufactory, until by the early 1790's over 50% of the value of the engines was made by the partners [Tann, 1981]. The nature of the business was changing as well, with customers being more interested in purchasing a complete engine rather than being bothered with the close involvement in its construction that had been necessary to this point [Dickenson, 1936]. Other incentives that inclined the partners towards manufacture in their own right included the attraction of a greater share of the profits, hitherto being taken by the sub-contractors. There were problems too with quality control and lack of standardisation, together with the difficulties in coordinating the sub-contractors [Tann, 1981]. Sub-contracting did have some benefits though. The major one being that all the engines were custom built and the sub-contractors bore a large part of the risk.

By late 1794 Boulton and Watt had come to the view that they would have to manufacture complete steam engines and not depend on subcontractors. In October a new partnership under the name of Boulton, Watt & Sons was formed [Roll, 1930; Dickenson, 1935; Tann, 1981]. The partners were Matthew Boulton and his son Matthew Robinson Boulton, James Watt and his sons James Watt jnr and Gregory Watt¹. The purpose of the new partnership was the manufacture of steam engines,

¹ Gregory Watt (1777-1804) was a half-brother to James jnr. Always suffering poor health, he died of consumption at the age of 27 [Rolt, 1962].

thus completing Boulton's promise of 1769 to build a factory for this purpose [Dickenson, 1935; Tann, 1978]. Roll [1930] suggests four reasons for the establishment of the factory, to be known as the Soho Foundry, in 1795:

1. The steam engine patent as extended by the Act of 1775 was due to expire in 1800 and the mounting incidences of piracy of their engine design indicated that there would be intense competition after the monopoly was removed. This impending competition meant that the firm would have to concentrate on efficient methods of production and competitiveness.
2. Success had ensured an adequate supply of capital to finance a new production facility. There was also available a pool of workmen skilled in the production of the various parts of steam engines.
3. Matthew Boulton was 66 years old and James Watt was 58 and both, wishing to pursue other interests, were ready to hand over to their sons.
4. Perhaps the most immediate reason was the disagreement between John Wilkinson and his brother William² resulting in a court order to close the Bersham Ironworks, a situation which was potentially disastrous as Wilkinson was the major supplier of cast iron cylinders and other castings. Other foundries³ could not match the quality of Wilkinson's work.

² Matthew Robinson Boulton married William Wilkinson's daughter. William Wilkinson gave advice on the setting up of Soho Foundry [Roll, 1930; Rolt, 1962; Gale, 1962].

³ Cylinders cast and bored by the Coalbrookdale Company were reasonably satisfactory but they were unable to meet the demand and cylinders produced elsewhere were unsatisfactory [Rolt, 1962].

There was no formal legal agreement for the establishment of the 1794 partnership so it is not possible to determine how it was intended to operate [Gale, 1962]. It is obvious from the way that the business was conducted that the sons were to be given freedom in their management of this new direction. The elder Watt was not involved apart from advancing finance to buy land and giving advice, he being more concerned with his scientific pursuits [Dickenson, 1935]. Once the new partnership had been formed the first step of note

... was to decide on the building of a completely new works solely for the manufacture of engines and, having decided, to set about the task with a speed and energy which was entirely characteristic of the younger partners. It was a most important decision. Engines had, of course, been built for years, both by Boulton and Watt and latterly by numerous others, but nobody had, so far, put down a factory designed, built and equipped with that one end in view. Here, then, was a new conception. It could reasonably be called the world's first purely engineering works.

[Gale, 1962, p. 76]

Soho Foundry

The name given to the new works was the Soho Foundry and it was intended from the outset to be run as a separate business by Matthew Robinson Boulton, James Watt jnr, and Gregory Watt. The opening of the foundry meant that they would be complete engine manufacturers. Construction began in 1795 and was complete in 1796 [Roll, 1930; Dickenson, 1935; Gale, 1962; Tann, 1981].

The Foundry was sited on 18½ acres in Smethwick, next to the Birmingham and Wolverhampton Canal. The layout of the works received close attention being

designed to take advantage of the natural fall in the land. Following the advice of experienced engineers such as Peter Ewart and William Wilkinson the buildings were “extensive and included a foundry with air furnace and core-drying kiln, forging shop, smith’s shop, boring mill, turning shop, fitting shop and carpenter’s shop” [Rolt, 1962, p 119]. This establishment was important because it was the first facility ever built for the purpose of building steam engines and offered greater efficiency of production over other manufactories that had been adapted for the purpose. The Soho Foundry was a product of remarkable skill and foresight [Gale, 1962].

The buildings were designed to take account of the natural fall in the land which assisted in the removal of the cylinders from the casting pit down a slope to the boring mill “(h)ere was a natural flow-line process, with no unnecessary material movement, in 1795!” [Gale, 1962, p 79]. Similar attention was paid to the siting of the other items of equipment and ancillary buildings, with the aim of achieving efficient production.

The foresight and planning that had gone into the building of the Soho Foundry is evident from a description of the Foundry by Shaw in his *History of Staffordshire* (1798-1801) who observed that

... Messers. Boulton & Watt found it necessary to erect and establish an iron foundry for that purpose [manufacture of steam engines] and they have accordingly in partnership with their sons (to whose activity, genius, and judgement it must be attributed, that this great work was begun and finished in the course of three winter months) erected at a convenient place and contiguous to the same stream at Smethwick a great and complete manufactory and foundry into which a branch from the Birmingham Canal enters and thereby the coals, pig iron,

bricks, sand, &c. are brought and their engines or other heavy goods are transported to every part of the kingdom, their being a wet dock within their walls for four boats to lie.

[quoted in Roll, 1930, p 161]

The Soho Foundry was opened in January 1796, an occasion celebrated by a luncheon for 200 guests [Roll, 1930; Rolt, 1962]. Many former Bersham employees were engaged to work in the new factory including Abraham Storey who was appointed the foundry foreman [Dickenson, 1935; Rolt, 1962]. The new factory did not manufacture all of the engines that the firm sold as the records indicate that Boulton's Soho Manufactory continued to assemble engines and make parts of engines for a number of years even though the Soho Foundry was manufacturing complete engines. In its first year of operation the Soho Foundry accepted orders for 31 engines and by 1800 had produced 169 engines [Tann, 1981].

Matthew Robinson Boulton seems to have been very much involved in the initial planning for the Foundry while James Watt jnr, judging from the amount of calculations and costings in his handwriting, seems to have been more concerned with the daily organisation and running of the business [Dickenson, 1936]. In a letter to a friend on 14 April 1797, Matthew Robinson Boulton said:

You will (not be a) little surprised to find that I am a very regular attendant in the counting house & immersed in business. Like a person hesitating on the brink of a cold bath I found that the only means of conquering my aversion was to plunge in; my experiment has so far succeeded. Mr. J.W. jun^r. & myself with the occasional advice of the old gentlemen have the entire Management of the Engine business & for the last 12 mos. I have not had respite from it as you will judge from the epitome of our labours.

[Tann, 1981, p 235]

The Organisation of the Soho Foundry

The Soho Foundry had three main operating departments. The Foundry Department was responsible for the casting of engine parts, the Smithy Department was responsible for the manufacture of parts from wrought iron and the Fitting Department was responsible for machining the parts and fitting the engine together. As mentioned above, engines continued to be built at the Manufactory, with the products of both establishments being sold by the one organisation, however, the records make a distinction between the products of each. The Soho Foundry was operated as an independent entity and was expected to make a profit; as were each of its operating departments which were treated as profit centres.

The Accounting System of the Soho Foundry

The accounting records employed in the Foundry exhibit the same attention to detail and system that is obvious throughout the whole Boulton and Watt organisation. The ledger was set up so that it reflected the work flow through the operating departments. The accounting system was designed to play a central role in keeping the partners informed of the economic progress of the enterprise because the Foundry was only one of several businesses they were interested in. On a number of occasions the partners demonstrated their awareness of accounting issues and their familiarity with the accounting process will be illustrated in the discussion that follows covering the period from the inception of Soho Foundry in 1795 to about 1804 by which time production had settled down into a routine.

The Soho Foundry was part of a wider group of businesses overseen by the Boultons and the Watts and as such it is reasonable to assume a similarity of accounting processes in each of the individual ventures. To this end it is useful to pay some consideration to the instructions given to Mr. Foreman, the accountant/book-keeper for the Engine Manufactory - an enterprise which predated the Foundry but continued to build engines alongside the Foundry. The engines produced by the Manufactory and the Foundry were for all intents and purposes identical, however it was necessary for the Manufactory to obtain some of the parts it needed elsewhere. The existing records indicate that the accounting processes followed a similar pattern in both organisations. Extracts from these instructions show:

Memorandum for M^r Foreman Nov 5th 1799

Mess^{rs} B & W wish M^r Foreman to understand that the Books kept by him were instuted for the purpose of ascertaining the following objects

1st The collective Profit & Loss of the Engine Manufactory in general

2. The Profit & Loss of the Different branches of the Engine Manufactory viz

1. of the Smithy department
2. of the Fitting department
3. of the Brass foundry
4. of the Pattern making
5. of the Boiler acct
6. of the Pneumatic acct
3. The Amount of raw Materials used
 1. viz of Wrt Iron & Steel +
 2. of Copper & Brass
 3. of Timber +
 4. of Coals +
 5. of Stores +
4. The Amount of Manufact^d goods
 1. in Cast Iron
 2. Wr^t Iron & Steel
 3. Copper &c

5. The Amount p^d for labour
 1. wages paid to workmen in the yard
 2. do to Engine Erectors - & Contra
6. The Amount of Disbursemt in Const of Manufactory
 1. Experiments
 2. Repairs
 3. Gen^l Expences - Int of money, Rents
Salaries
Decrease in value of
Build^s & Machinery &c
Salaries, Incid^l Exps
 4. Carriage, freight &c
 7. The amount of goods sold
 - in 1. Cast Iron
 - in 2. Wrt Iron
 3. Copper & Brass
 4. Miscellaneous

[B&W 285/47]

The partners were interested in knowing the performance of each operating department, as well as the cost of their product, so the ledger was set up to provide this information. The instructions then proceed to detail the accounts required with the procedure to debit and credit those accounts. These rules also provide for the ascertainment of depreciation, referred to as decrease in value of buildings and machinery, which is to be debited to the various operating departments. The arrangement also requires departmental operating expenses to be determined and allocated. As well, quantities are to be recorded where appropriate. Perhaps the most interesting paragraph of these instructions is the last one, which outlines the purpose of keeping the accounts in this way and states that it

... may be proper to repeat that the more explicit & detailed the Accts are kept & the more the wishes of B & W are likely to be fulfilled, their chief aims being to have a distinct view of the total ann^l accts of each item of disbursement & receipt, & not simply to know the state of the concern generally, the latter point being shown already by M^r

Pearson's⁴ books - Where therefore the articles included under one head as stores &c can be distinguished in the entries with^t [obscured] complication, it will be very desirable to have it done as B & W will be enabled to collect annually the Am^{ts} of any article with^t a troublesome investigation.

[B&W 285/47]

These instructions highlight the general importance placed on accounting by the Boulton & Watt organisation, a view which was held by the junior as well as the elder partners. They had an interest in detail as well as the broad overview. Documents left by Watt jnr illustrate this interest in the detail revealed by the accounts.

The Organisation of the Accounting Records at the Soho Foundry

The list of the accounting records kept at the Foundry was extensive. The number of books kept seems high in comparison to the size of the business, but the detail recorded was probably a requirement stemming from the partners involvement in other businesses, as well as the fact that they were often away from Birmingham and had many other interests. It is reasonable to assume that the records that were kept were designed to keep them fully informed of the happenings at the Foundry. A list of the accounting records kept by the Foundry includes:

1. Rough time books and pay notes.
2. General Time Book.
3. Piece Workman's Ledger.
4. Ledger of Personal Accounts.
5. Foundry Men's Ledger.

⁴ Pearson was the Cashier or accountant, who joined the Boulton & Watt in 1783 and remained with them until his death in 1817 [Roll, 1930].

6. Forgers' Book.
7. Distribution Register - to record the transfer of goods from one department to another.
8. Ledger of Materials.
9. Packing Books.
10. Engine Books - the cost of each engine was recorded in this book.
11. Fitting Books - used to calculate the cost of fitting the engine.
12. Pattern Books - used to record the cost of patterns used.
13. Carriage Book.
14. Building and Machinery Book.
15. Sales Book or Day Book.
16. Order Book.
17. Bill Book.
18. Houses Rent Ledger.
19. Account Book.
20. Timber Book - cost of timber used.
21. Inventory Book.
22. Cash Book.
23. Journals.
24. Ledger.

[B&W 37/2]

The document containing the above list is not dated but from other evidence it would appear to relate to the period after 1811 and before 1816. The document has notations in Watt jnr's handwriting assigning clerks to the responsibility for the keeping of the various records. There were some eight people involved in keeping these books.

The financial year ran from the 1st October to the end of September, in line with the other enterprises of the Boulton and Watt empire.

The Ledger

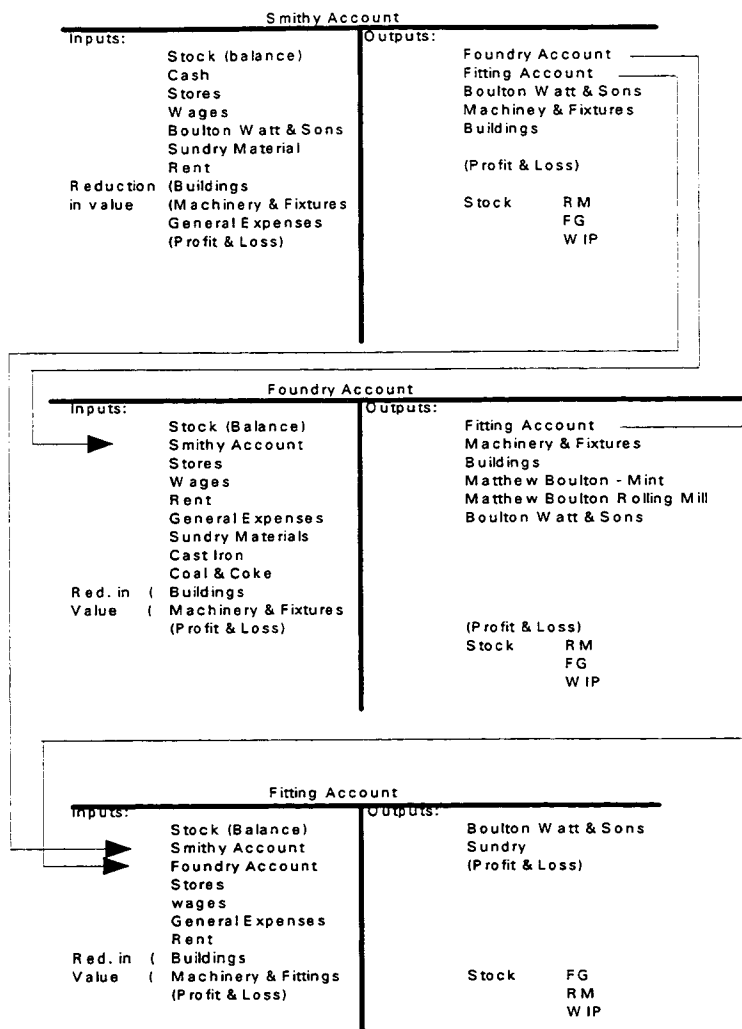
The ledger of Soho Foundry was set up on a double entry basis with a journal for all entries. Information for the journal came from the Day Book and the Distribution Register. The accounts for the operating departments of the Foundry were set up as

profit centres with the profit or loss for the year in these departments being transferred to the general profit and loss account. Transfers between departments took place and were recorded as such with sales being recorded as transfers to Boulton, Watt & Sons. At the end of the year the inventory was determined by inspection, and the existing inventory records indicate the detail of this procedure. There was, however, no separation of the different items of inventory and the inventory recorded for each department included tools and utilities, goods and materials as well as finished goods and work in progress. All of these items were taken into account when determining the departmental profit.

The Operating Departments

As has been mentioned, the major operating departments at the Foundry were the Smithy, the Foundry and the Fitting Department. The flow of entries through these accounts was as is shown in the following diagram:

Soho Foundry
Ledger Accounts - Showing Profit centres and Transfers between them



At the end of each year these departments were debited with an amount equal to 5% of the value of the buildings they used, as well as 8% of the value of machinery at the beginning of the year. General expenses were apportioned between the departments and contained an interest charge for floating capital, calculated as 5%⁵ of the debt owing to Boulton & Watt at the beginning of the year. In the early years rent was

⁵ The Usury law limited the amount of interest that could be charged on a loan to 5% [Shapiro, 1967]. It was common to allow for interest on capital and in this instance the debt owing represented the capital employed in the business.

debited to these accounts, although this seems to have disappeared by 1799, the rent being a charge for the use of the facilities of the Foundry. This charge was eventually included in the interest charge as the value of machinery and buildings became established. The rent on this fixed capital was equivalent to 5% of the cost of the buildings and machinery [B&W 295].

The debit for machinery and buildings was termed "reduction in value" and is obviously depreciation. Those assets were written down by this amount and there was no attempt to create a provision for depreciation. When the operating departments were involved in building machinery and buildings for use in the Foundry, the cost of these was transferred from the various department accounts to the Building Account and to the Machinery and Fixtures Account.

Transfers from the Smithy Account to the Foundry Account and Fitting Account, and from the Foundry Account to the Fitting Account, appear from the Day Book to have been made at a price per ton for some items and at an individual price for other items. This was a pre-determined price based on cost. Transfers to Boulton, Watt & Sons, that is, sales were made at the contract or selling price, hence the surplus or deficit on the account. Whether these accounts were used during the year, for management purposes, is not obvious, what is obvious is that they were prepared and the book-keeper was obviously familiar with the principles involved in the concept of a profit centre.

The Profit and Loss Account [MBP 285/27] for 1798, in James Watt jnr's handwriting, shows the inputs and outputs of the Foundry classified according to the nature of the input and sub classified according to operating department. The document shows an analysis by department, as well as, a reconciliation with the books of account which apparently included a mistake due to the misallocation of interest on capital [B&W 295] (see below). This document was sent, in a letter to Matthew Robinson Boulton, with the further analysis of the income and expenditure of each department [MBP 285/28] that is reproduced below. The statements show Watt's familiarity and high level of accomplishment with the accounting process.

The following statement, in James Watt jnr's handwriting provides a summary of the ledger accounts for the major operating departments for the year ended September 30th 1798.

C^{rs}

1798

Sep ^r 30 th By Transfer of Buildings	541. 6. 4	3589.19. 8¼	1150. 4. ¼	
& Materials to an Acc ^t	303. 4.11	1192. 3. 4¾	2701.19.10¼	
in the name of Buildings				
& Machinery	844.11. 3	4782. 2. 6	3852. 3.10¾	9470.17.7¾
By Sales	1728.13.11	6575. 9. 1	6212. 7. 1¼	14456.10.1¼
By Inventory				
viz Tools & Utensils	245.14. 6	1018. 1. 6½	225.11. 3¾	
Goods & Materials	863.13. 4½	1027.19. 2¼	2947.19. 2	
	1109. 7.10½	2046. . 8¾	3173.10. 5¾	6328.19
	3682.13. ½	13343.12.3 3¾	13238. 1. 5¾	30264. 6.9
Gain		468.17.10½	381. 4. 3¼	
Loss	92.14. 4¼			

[MBP 285/28]

This schedule is supported by a number of documents [MBP 285/29 -285/33] providing the detailed calculations for the amounts entered in total. The transfers between departments are treated as sales by the transferring department and purchases by the receiving department, the transfers were made at a predetermined price which was above cost. This arrangement allowed each department to make a profit (or loss) and is in line with the scheme suggested by Hamilton [1788] in his *Introduction to Merchandise*. The production process was so arranged that the Smithy and Foundry Departments both provided the raw materials for the Fitting Department.

Until 1798 buildings and machinery were included in inventory but it is to be noted in this statement that buildings and machinery were transferred to their own account.

However, tools and utensils remains in inventory, the difference in value affecting profit directly.

A note to the above document remarks on the difference between the profit shown in the ledger and the profit shown on the schedule. The difference being due to an error in the allocation of interest to the departments. Interest was charged to the departments, as part of the general expenses, at the rate of 5% on floating capital at the beginning of the year. However, in this particular year interest appears to have been charged twice to the operating departments. The comment in the Journal correcting this mistake bears mentioning:

It must be remarked that the alteration in the balance of General Expences Account affect only the Appar^t gains or losses of the several Departments & not the result of the general Profit & Loss Account. This account is only affected by real deductions from the property as the Int^t paid to B&W. Estimated Interests or rent appears on both sides of it & are instituted solely for the purpose of taxing the different Departments with their respective Quotas & shewing their amounts at one view.

[B&W 295]

The profit reported in the schedule is the residual income in each department because the expected return on capital employed (5%) has been removed from profit in the form of interest on floating capital and rent on buildings and machinery and was used, as the above quotation indicates, to show the performance of each department. This was not an uncommon procedure in the eighteenth century, especially in partnerships where capital contribution was unequal [Pollard, 1964; Mephram, 1988; Hamilton,

1788]. The procedure allows a comparison of departments and an indication of their profitability as well as a measure of the opportunity cost of the funds employed.

The treatment of building an engine in the accounting records was more of a job cost situation with the processing departments transferring their finished work back to Boulton & Watt as the selling agency.

Conclusion

The Soho Foundry was a new venture, designed from its inception to build steam engines, consequently the factory was built to ensure smooth and efficient working, a great achievement when it is considered there were no examples to use as a model. The factory that was built and staffed with dedicated, highly skilled and innovative people operated for many years. The Soho Foundry was designed to operate in the same way as its products. As a steam engine was designed to produce power, so too was the factory designed to produce steam engines smoothly and efficiently. As steam engines were designed to be self-governing so too the factory, accounting providing an essential part of this governance.

The accounting system was set up to reflect the organisation of production. It was designed around profit centres and recorded the flow of materials and work from one department to another. Because the Soho Foundry was a pioneering venture it is important not to judge workable solutions found to the problems that arose in the light

of present knowledge and practice because of the differing contexts. The accounting processes extant at the Soho Foundry in its early years continued for many years so it is reasonable to assume that they supplied the perceived needs of that time. Certainly the number of documents showing calculations still in existence indicates that the accounting system provided a data base that was used by Watt in the managerial process, yet it does not appear to have been used to produce budgets or other forecasts.

Attention was paid to the profit centres, the Smithy, the Foundry and the Fitting Shop, because these were the main areas of activity in the organisation. Transfers between the profit centres were recorded and valued with a system of pre-determined costs being used to assign values to the products and materials transferred.

The Soho Foundry was in the business of selling power but all efforts were made to ensure that the sale of power was a profitable one. The Soho Foundry continued to manufacture steam engines for many years. In 1810 a new partnership agreement was made between James Watt jnr and Matthew Robinson Boulton, being the only survivors of the original partnership. Eventually, Watt jnr became the sole proprietor of the Soho Foundry when he bought out Boulton for £30000 [Gale, 1962, p 83]. In 1841 Watt formed a partnership with three others to carry on the Soho Foundry. After Watt's death in 1848 the Foundry continued under the name of 'James Watt and Company' making steam engines and other products, but it was losing momentum. In 1894 the firm became insolvent and the site was sold to W & T Avery Limited who still remain in possession [Gale, 1962].

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