

# Coalbrookdale, Cornwall and, Cylinders – new light from the Norris Files

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*Summary: This paper examines an important source of information on the cylinders and other components of Newcomen engines produced by the Coalbrookdale Company over a period of half a century. This source documents many engines previously unknown to historians as well as providing new detail on others. It adds considerably to our understanding of the diffusion of the Newcomen engine in the middle decades of the eighteenth century. It also reinforces the value of the continuing search for additional documentation and emphasises the risk of assuming that the completeness of what has been published previously cannot be improved on.*

## Introduction

I recently stumbled on an important source of information about early Newcomen engine cylinders and other castings, in the form of notes made by W.G. Norris (hereafter the Norris Files). This came about because after re-reading Davey's paper on the Newcomen Engine and the Appendix added by Norris in the 1903 Transactions of the Institution of Mechanical Engineers<sup>1</sup> (hereafter IME) following conversations about this at the International Early Engines Conference, I wondered if the detail behind the Norris appendix could still exist somewhere. But surely Mott, Raistrick, Trinder and others researching the history of Coalbrookdale and its contribution to the Newcomen engine would have used such a source?<sup>2</sup>

A few minutes on the internet, however, located a file of notes by Norris at the IME Library, listed as **IMS 113**, which looked promising. Emails to their helpful Archivist, Lucy Bonner, led to an invitation to consult these, and they turned out to contain the material he had cited.<sup>3</sup>

## W.G. Norris and the Coalbrookdale Company

W.G. [William Gregory] Norris was an active Member of the IME and was a lifelong employee and latterly the Managing Director of the Coalbrookdale Company.<sup>4</sup> The file he presented to the Institution following the Davey paper consists of 11 pages of handwritten notes (and a typed version), which Norris had compiled in 1903 from records then existing at Coalbrookdale, and then passed to the IME.

The Norris Files include details of some of the early Newcomen engine cylinders (before 1738) which have subsequently been researched in detail, and other snippets from later in the century. The surviving Coalbrookdale Company records contain some examples of both their Stock Book, which details what they produced and for whom, and their Cash Book, which records payments by amount and customer but not the items purchased. Researchers into the company's activities have made extensive use of the surviving examples of both forms of record but been frustrated by the lack of later records.

Most valuably, however, the Norris Files contain extracts from what seem to be a Stock Book for 1738-1748 which does not survive. Some but not all of Norris's entries can also be read across to surviving records of the Company: Stock Books exist for the periods 1717-27 and 1728-38; and the Cash Books for 1717-32 and 1732-48 also

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record some details not available elsewhere such as when engine builders transmitted the payments. These were important for Raistrick's book on the Darbys and a major source for Mott's 1962 paper.<sup>5</sup>

However, after 1748 there is a big gap in what Norris recorded until he provided some partial information relating to the 1760s.

### **The Norris Files - Scope**

The Norris Files vary in detail, but most entries give some or all of date, customer, location, items sent, weights, prices per hundredweight (hereafter cwt) and value of items. They list cover a total of over 100 transactions, comprising cylinders and unspecified parcels of engine / pumpwork parts which may have included cylinders. Many are new to records of engine building and others reveal different or complementary details of cylinders etc recorded elsewhere.

Most significantly, they provide evidence of cylinders sent to Cornwall in the early 1740s (though not always which mines they were for), the significance of which are discussed below.

Of the 96 cylinders the Norris Files recorded, 56 are documented elsewhere – but the Norris Files are the only source for 40 cylinders. Norris also gives information for 5 other parcels of castings which do not include cylinders but point to engines probably not previously recorded in the database of eighteenth century steam engines, although some of these are likely to duplicate known engines with slightly differing information. Norris also provides important corroboration or additional information for 31 of the 56 engines previously counted, several of which have only the name of the person to which the items were sent and cannot at present be tied to a particular installation but which in the future local experts may be able to place.

The list of these cylinders and other engine / pump parts is transcribed, and annotated where relevant, at Appendix 1, and the remainder of this paper examines the more important aspects of the Norris Files.

### **Norris and Goldney**

Thomas Goldney II and III were wealthy Bristolian Quaker merchants who were the Coalbrookdale company's largest shareholders. The elder Goldney was instrumental in Abraham Darby's move from Bristol to take over the then little-known Coalbrookdale ironworks in 1709, and sent his young son to train in business methods and accounting at Coalbrookdale under Richard Ford, who ran the business after Darby's death in 1717 and developed the cylinder casting business. The younger Goldney took over from his father on the latter's death in 1731 and also acted as the Coalbrookdale Company's Sales Agent for the west country, receiving, checking and forwarding shipments from them, and also handled goods from other enterprises in which he was involved including the Willey Ironworks.

Goldney's importance for our study is that from 1742 until his death in 1768 his transactions involving Coalbrookdale products are recorded, often in some detail, in his Account Book preserved at Wiltshire and Swindon Archives and analysed by Rogers in *The Newcomen Engine in the West of England* in 1976.<sup>6</sup>

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Much of the content of the Norris Files correlates with entries in Goldney's accounts for the period of overlap (1744-48): twelve of the cylinders and eight other parcels of engine castings in the Norris Files also passed through the hands of Goldney in Bristol for trans-shipment to customers locally or further afield, principally in Cornwall, and for several of these Norris adds important details, especially about timings. However, Goldney frequently recorded more detail about the customers and logged additional items of pumpwork and ancillaries not mentioned in the brief entries in the Norris Files; also has one cylinder (for the West Ham Waterworks of Thomas Byrd) which Norris did not mention. More work on the Goldney records that Rogers was only able to summarise would seem to be indicated.

Taken together the two sources also give useful detail on shipment times as the tons of castings were taken down the River Severn from Coalbrookdale to Bristol by a flat-bottomed river and estuary vessel of up to 60 foot and 40-80 tons burden called a "trow".<sup>7</sup>

### **Coalbrookdale and Cylinder Castings**

The early history of the Newcomen engine has been extensively studied and documented but a little background about its cylinders is appropriate for those not versed in this history.<sup>8</sup>

#### 1) Cylinders

Newcomen engine cylinders, because of their large diameter and walls made as thin as feasible (to save weight and cost), were invariably cast hollow, in sand around a former, then finished to improve their circularity; the smoothness of the inner surface; and their cylindrical integrity. The first Newcomen engines from c. 1712 onwards had brass cylinders which were small by later standards, in the range of 14 to 32 inches (35 to 80 cm) diameter and 7 to 10 feet (say 220 to 300 cm) length and weighed between 20 and 40 cwt (one to two tons).<sup>9</sup>

It is not clear whether these cylinders were truly "brass" as it is commonly thought of today (an alloy generally about two thirds copper and a third zinc, often with small amounts of other metals especially lead) as the term can cover a wide variety of specifications and proportions including semi-bronzes or bronze (principally copper with about 10% tin) or "gunmetal", a hybrid of brass and bronze (copper, tin and zinc). The specification for British Admiralty Gunmetal used in ships' cannon was 88% copper, 8-10% tin and 2-4% zinc. Brass and bronze are both 15-20% denser (heavier for volume) than "grey" cast iron. Stonier Parrott referred in 1719 to cylinders of "pot metal", an imprecise term common at this time covering various alloys of copper with lead and other metals. But as this cost 1s4d a pound and was worth 8d as scrap, this suggests a high-quality gunmetal product, if not classic brass. Little is known about who supplied these, though many brass and bronze foundries in London, Newcastle, Bristol and elsewhere are thought to have had the capacity to cast them.<sup>10</sup>

Brass and iron both have advantages and disadvantages as material for engine cylinders. Brass is thermally more efficient than iron and was recommended by some contemporaries such as Desaguliers.<sup>11</sup> However, fuel economy was rarely an issue in these early days, at least in collieries which made up the bulk of early customers; and the profit margins of the other main customer, lead mines, were higher which enabled them to justify the higher cost of coal. Brass was also much more expensive: three to

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five times the cost of cast iron, at least a shilling a pound [£110 a ton] compared to 32 shillings a cwt [£32 a ton] for early bored Coalbrookdale iron castings. A brass cylinder therefore cost anything from £150 to £250, a similar iron one £50-75. It was also challenging to make large brass castings perfectly cylindrically (which was also true, but less so, for iron ones since molten iron flows more freely than brass, which was however easier to work once cast).<sup>12</sup>

### 2) Coalbrookdale

The Coalbrookdale Company was formed in 1718 by a group of Quakers entrepreneurs led by Thomas Goldney following the death of Abraham Darby the first who, after moving from Bristol where he was engaged in a number of brass and iron working businesses, in 1709-16 practicalised and pioneered smelting iron ore and producing “grey” cast iron using coke, from the eponymous furnace in Shropshire.<sup>13</sup> The new company, led by Darby’s son in law Richard Ford then later Darby’s son Abraham the Younger developed techniques of casting large items in iron in “greensand”, which continued on the site for over 300 years, latterly producing the core of AGA cookers until 2017. Unusually for the time the company have left extensive though patchy records from the period we are concerned with.<sup>14</sup>

Their trade in the early eighteenth century was mostly in smaller castings such as kettles, pots and pans, fire backs, troughs and other miscellaneous domestic ware. Their superior casting techniques meant they competed with more expensive brass and bronze items which had earlier dominated the market, and also with lower quality, heavier and therefore more expensive cast iron ware from other sources cast in “loam”. They mainly sold these in bulk through a network of ironmongers and dealers,<sup>15</sup> but the company clearly recognised the business opportunity provided by the new prime mover and we can surmise that they started experimenting with cylinder casting almost immediately. The first record of them selling a “fire engine” cylinder can be dated to 1722 when a pumping engine at the nearby Lightmoor colliery used one. By this time over 30 other engines had been set to work in coal and metal mines around the country and probably the great majority had brass cylinders, though a 20” iron one was reported as “ready in London” in January 1719 (probably the product of a Wealden furnace and foundry); although a foundry in Bromsgrove may have supplied another in 1718 it is more likely that this would have been brass.<sup>16</sup>

Coalbrookdale presumably improved their smelting and casting techniques through trial and error. They competed successfully in the growing market on price and ability to deliver what customers needed – larger but affordable cylinders so engines could pump more water from greater depth. The first Coalbrookdale cylinders were simply cast then and smoothed internally by hand, but they soon improved the quality of their castings (important for thermal and mechanical efficiency of the engines) by boring them to make their internal dimensions more true (the much narrower barrels in which pump lifts oscillated had been bored from the outset) and in 1734 installed a more robust boring bar which enabled them to produce increasingly large cylinders with an acceptable degree of circular accuracy and straightness. Over time the amount of iron needed for any given size of cylinder was also reduced somewhat, by making the walls thinner and the material harder wearing.<sup>17</sup>

They also increasingly supplied to mine owners, either as part of cylinder orders or separately, cast iron pumpwork of varying diameters depending on the quantity of water to be raised and sold both bored and unbored versions as required – those with no

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moving pump apparatus did not need to be bored and therefore cheaper. These cast pipes were preferred to bored wooden ones in mines as they were longer lasting, easier to join, and more consistent in size and straightness which was of advantage to the deeper and deeper mines that were opened, but they could cost as much as if not more than the metal parts of the Newcomen engine. The Coalbrookdale records analysed by Mott and the accounts of Norris and Goldney, show that the labour and time involved in boring and therefore the cost, was considerable: Cylinders and bored pipe and barrels were charged at varying rates at different times, but typically unbored work was around 18-20 shillings a cwt or under two thirds of the cost of bored work charged at 30/- or 32/6d.<sup>18</sup>

### 3) Engine and Cylinder Numbers

The dynamics of the diffusion of the Newcomen engine have been extensively researched by many historians over the last half century.<sup>19</sup> By the time the Savery / Newcomen patent expired in 1733 over 90 and perhaps as many as 100 increasingly powerful Newcomen engines had been erected with cylinders approaching 40 inches (100 cm) in diameter. Around quarter of these are known to have had Coalbrookdale cylinders and most or all of the rest can tentatively be assumed to have been brass – unless the Coalbrookdale records are incomplete or other ironmasters were also casting significant numbers of cylinders.

Experts on the Coalbrookdale records of casting sales believe they are comprehensive for the dates for which they survive (though there are some reservations, see Appendix 1), and for some periods the Invoice Book and other records can be compared with the Cash Book.

And although there is evidence that they had the capability, only a small number of cylinders are thought to have been being cast by other ironfounders (in the Weald or elsewhere) in this early period (before c. 1745). Known exceptions are one supplied to Chelsea Waterworks by Bowen in 1742 and three supplied from London by Harrison, presumably the ironmaster of that name, to Whitehaven in 1735, 1736 and 1740, which are large ones for the time at 38, 42 and 42 inches diameter. There were almost certainly others, but if the numbers were significant it is surprising that no records of them have emerged.<sup>20</sup>

Generally, however, the Wealden ironmasters seem to have focused on cannon both large and small and some domestic castings; whereas Coalbrookdale (perhaps because the company was owned by Quakers) only made smaller ordnance for privateers and only for a short period (between 1740, when they installed a new boring apparatus, and the early 1750s).<sup>21</sup>

As cylinder sizes increased, reaching 60" diameter by 1748, so did the cost differential. Demand for Coalbrookdale's products took off: in the 15 years after the patent expired, something like two thirds of known engine cylinders (81 out of 130) can be ascribed to the firm. In the 1740s cast iron cylinders typically weighing 1.5 to 3 tons were charged at 30 or 32 shillings a cwt and therefore cost £50 to £100, so given the price differential discussed above, it is obvious why many purchasers chose them rather brass ones. Later engine cylinders reached diameters of over 70 inches (180 cm) and weighed over 5 tons apiece.<sup>22</sup>

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Coalbrookdale did not however have anything like the whole market for cylinders at any time. In particular, they sold relatively few cylinders in the North East in the period: only 8 between 1727 and 1748, when perhaps 35 or so engines were erected or rebuilt in the coalfield.<sup>23</sup> However, in this period most engines were relatively small compared to those built in the 1750s and especially 1760s. Brass cylinders were cheaper in the NE than elsewhere since there was competition between several local brass founders as well as cheap freight for brasswork from London founders in coastal shipping, principally returning colliers.

As already noted the Norris Files have a gap between mid-1748 and 1760, a crucial period when cylinders of 60" or more steadily became the norm in large mines under the leadership of the great viewer William Brown and Jonathan Hornblower in Cornwall. However, smaller cylinders were also in strong demand for shallower or less water-burdened mines, and the other ironfounders already mentioned may have supplied some of these. Norris does nevertheless record a dozen large cylinders and / or large consignments of unspecified engine and pump materials to North-eastern collieries and coal owners between 1762 and 1769. More work is needed to try to match these transactions with Brown's list of engines compiled in 1769 and the records and locations covered by Turnbull's detailed monograph on Brown.<sup>24</sup>

From the mid-1760s Coalbrookdale also began to have serious competition from the Carron Company on the east coast of Scotland. When the huge new Walker Colliery wanted two cylinders of over 70 inches in the early 1760s, they bought the first (of 74 inches diameter) from Coalbrookdale but the second (72 inch) one in 1765 from Carron. Both were equally well cast and regarded at the time as wonders of the art.<sup>25</sup>

### **4) Other Engine Components and Rebuilds**

A further note of caution is needed before we move on to look at the Norris Files in more detail. They detail the supply of castings in the form of cylinders and related main components such as bottoms and pistons, not whole Newcomen engines. Often other engine parts were included, and they regularly supplied pit barrels, pump lifts, unbored pipes and other metalwork for raising the water from the pit bottom to the surface or a drainage adit. Some of the pump barrels, the parts that were submerged in acid mine water, which they supplied were brass, although Coalbrookdale may have been acting as middlemen rather than casting these themselves (generally however, these parts would have been sourced from specialist brassfounders in Bristol, London or Newcastle or elsewhere as appropriate). Hammered boiler plates were made by many forgemasters such as Hallen locally (Raistrick says Coalbrookdale started making boiler plates themselves around 1750).<sup>26</sup>

Coalbrookdale did not make the small finely worked wrought iron or brass engine components – valves, rods, pins, screws, etc, which would be sourced from local blacksmiths or forges and foundries, nor the brick, stone and wooden components (see the section on Cornish cylinders below). The only time in this early period Coalbrookdale records cover all the aspects of building an engine is the erection in 1743 of a large Newcomen engine to recirculate water 170 feet from the tailrace to the headpool of the waterwheels that drove the bellows at their own furnaces.<sup>27</sup>

Furthermore, it is risky to assume that a new cylinder meant a completely new engine, if sold to an existing customer or to a location where a previous engine is known to have existed. Most probably did, even if the new engine was placed in the same engine

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house, since a larger cylinder would require a new bottom and piston, much or all new wrought iron and brass work, a bigger boiler, and perhaps new wooden components and pumpwork. So effectively a new engine and a lot of work for the engine erector.

But there was obviously a continuum between simply replacing a smaller, perhaps worn, brass cylinder package with a larger cast iron one (as is recorded in some instances), through a minor rebuild to a major rebuild to a completely new engine, and we rarely know the whole picture. Some rebuilds were also, as Turnbull has demonstrated for the North East and was also the case later in the century in Cornwall, marriages of a cylinder from one location with new and / or secondhand parts and a new boiler in an old or enlarged building.<sup>28</sup> There was moreover a market for secondhand engine parts, especially cylinders, as newspaper advertisements attest. Also, old brass cylinders had strong scrap value (half to three quarters of its new value), though cast iron scrap was not as valuable, perhaps ten percent. In other cases, all the major components were simply moved by an engine erector or colliery engineer to a different location and re-erected wholesale; where there is evidence of this, the database of eighteenth century counts this as a move and does not record it as a new engine.<sup>29</sup>

### **The Norris Files – the Detail**

Norris's eleven handwritten pages of notes are for the most part readily legible; though there are some unclear entries the typewritten version helps decipher these. Most give the customer, some but not all the location of the engine or the address to which the invoice was sent. Until 1750 Norris generally gave only the weight and cost of the castings with varying information on parts other than the cylinder. Mott's and Rogers' accounts use elaborate calculations of approximate cylinder diameter based on company records and corroborating evidence from Goldney's Account book and a scattering of other contemporary sources; this paper follows their approach unless the Norris Files gives specific detail.<sup>30</sup>

Weights were given in hundredweight of 112 pounds (hereafter "cwt"), quarters (28 lb) and pounds in the style 88.3.12. Costs were in pounds, shillings and pence. Generally but not always the prices per cwt of the different types of products were given in shillings. Bored work (cylinders, some bottoms, pump barrels) were usually 32/6 or later 30/- per cwt, less labour-intensive hollow cast ones such as pump pipes 20/- falling to 18/- and flat castings like pistons 12/- a cwt. For comparison, cast pig iron for re-melting or turning into wrought iron was around £7-8 a ton (7-8/- a cwt) delivered to Bristol.<sup>31</sup> Occasionally brass items were included, generally at 1/- a pound (£5.12/- a cwt).

It is not clear why prices were reduced around 1740; it may be that this was because of customer pressure or reducing production costs, though there is no evidence of a significant reduction of cast iron furnace costs at this time.<sup>32</sup> Or indeed why the company sometimes charged lower prices to favoured customers.

Although dates before 1750 were complicated by the fact that the official year started on Lady Day (25<sup>th</sup> March) so dates in the early part of the year were usually expressed in the style 1741/2, writing a century and a half later Norris took account of that and this paper also uses the modern style.

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Appendix 1 details the Norris Files and notes where these are different from other sources or are the only source. Notes in square brackets [ ] are not from Norris but are my comments and queries. There were three main groups of entries:

- before 1738 partial entries from the Stock Book and other sources, most of which confirm material already published;
- Between 1738-1748 detailed but probably not exhaustive extracts are provided, from what is assumed to be a now-lost Stock Book;
- Between 1760 to 1792 the notes comprise isolated snippets from other company records, also now lost.

### **The Early Cornish Cylinders**

The early Cornish cylinders are perhaps the most striking aspect of what Norris set down. Bradford Barton in his treatise on the Cornish Beam Engine referred to five cylinders sent to Joseph Hornblower for William Lemon's Cornish mines but as he provided no references later researchers discounted this; Rick Stewart in his recent book on pumping engines in Cornwall concluding:

“...it has not proved possible to verify his assertions; certainly no reliable historian makes reference to these cylinders.”<sup>33</sup>

We can now resolve this: starting in July 1742 the Norris Files list five cylinders invoiced to Lemon in Cornwall, two years prior to the Goldney Account Book's first reference to engine cylinders in September 1744. Whilst Goldney's records run from 1<sup>st</sup> February 1741/2 these five Cornish cylinders were not listed so presumably were not sent via him but despatched direct to Cornwall, perhaps through the agency of Joseph Hornblower as Barton suggests.<sup>34</sup>

Relationships between Bristol merchants and manufacturers with Cornwall were clearly complex, though beyond our scope here - linking tin, copper, brass, pewter and other metal trades. Norris also records two early deliveries in 1744/45, both consigned to Sir Francis Vivian, which can be tallied with Goldney's first Cornish engine orders, although in his accounts these were consigned to a different person, Abel Angove, who was presumably a partner in the mine, and through another Bristol middleman, pewterer Thomas Lanyon (the Lanyons were a well-connected Cornish family).

This flurry of orders contradicts the previous assumption that it took several years for the Cornish mine owners to commission pumping engines after the passing of the Act of Parliament approved in November 1741 including the drawback of the duty on coal used for “fire engines” in Cornwall (the text is at Appendix 2).<sup>35</sup>

Given the time it must have taken for an engine to be specified, an order drawn up and sent from Cornwall to Coalbrookdale, then the cylinder and other items to be cast, bored and despatched the date of the first cylinder being sent seems expeditious. Lemon presumably started planning as soon as the Act was passed, or more likely he and others, advised by Joseph Hornblower, were even before the passage of the Act planning to install Newcomen engines when and if the duty was removed.

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Regrettably, however, while two of these cylinders can be linked to Wheal Fortune and North Downs, it is not possible to assign the other three to individual mines. Also the details recorded do not give individual weights to cylinders, though the data we do have suggests sizes in the 40-44 inches range. Nor is it generally possible to reconcile them with the list in Borlase's *National History of Cornwall*, which Rogers also struggled to correlate with the Goldney account book. However it would appear that at least some of these additional cylinders were for mines in Borlase's list which Rogers could not tie down, although they may have been replaced by 1758 with larger cylinders or have been for completely different engines – Borlase itemised 14 engines and referred cryptically to “some others” which remain elusive. Goldney and therefore Rogers has details on 16, but two of Borlase's and four of Goldney's cannot be reconciled. Joseph Hornblower (see next section) wrote to his son Jonathan in 1749 about “enlarging” the North Downs engine”, presumably with a bigger cylinder and perhaps a better boiler, and Goldney forwarded a cylinder of about 52 inches to Lemon in that year which may have been for North Downs or Hewas. This letter also talks about another larger engine being erected at North Downs, although the Goldney papers have no reference before the 60-inch engine of 1756.<sup>36</sup>

### **Joseph Hornblower and the Profession of Engine Builder**

Joseph Hornblower, though based in the Midlands, was already well known in Cornwall.<sup>37</sup> He is generally recognised as the builder of the three Newcomen engines known to have been erected in Cornwall between 1725 and 1727, though these presumably had brass cylinders as he is only recorded as purchasing cylinders from Coalbrookdale for engines he was erecting (for a variety of customers) from 1731 onwards. No Newcomen engines are believed to have been built in Cornwall for 15 years after 1727, as the price of coal was prohibitive, so there was no local skilled and experienced engineer to undertake this work. Either he or some other competent person presumably visited Cornwall in 1741 and 1742, but whether in person or not, Joseph Hornblower was clearly the main player in these early 1740s engines; he later settled in Bristol, where he died in 1761.

The associate could have been his son, Jonathan Hornblower, who was 23 in 1740 and afterwards became the principal engine builder in the county for several decades. Jonathan does not seem to have settled in Cornwall until 1745 when he relocated from Shropshire with his new wife and child, though like his father he may have travelled back and forth in 1741-5.<sup>38</sup>

Another possibility is Daniel Hawthorn or Hawthorne of Pelsall near Walsall, another experienced engine builder who may have had a business relationship with Joseph Hornblower since their names were mentioned together in more than one order, and who was also purchasing cylinders on his own account in the 1740s. His name comes up frequently in other accounts of early engine installations.<sup>39</sup>

Alternatively they may have initially drawn up detailed specifications by exchange of letters. The Post Office had a well-established, albeit expensive, national system of carrying letters and small parcels using horseback “post-boys” at that time. Although the roads were so bad there were no regular coach routes into the Cornish peninsula, sailing vessels went up and down the Severn, and coastal ships traded from the ports on the estuary as far upstream as Gloucester or further, round the coast to sea ports in Devon and Cornwall. While Thomas Goldney developed an extensive business of trans-shipping cargoes from Coalbrookdale it was not actually necessary for their

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products to travel up-river to Bristol before being moved on to Cornwall (which raises the possibility that other cylinders and engine components did not pass through his hands in the period of the Account Book). If so, it is unclear where they would have been trans-shipped to larger vessels; though trows did occasionally sail coastwise to Cornwall those small enough to reach Coalbrookdale are unlikely to have done so.<sup>40</sup>

### **The Work of the Engine Erector**

We do not need to go into detail here, but it is relevant for context to note the complex set of activities involved in turning an order for a cylinder into a working engine. Tasks which needed to be planned would have included specifying and pricing up every part of the job, where to source the other parts of the engine and negotiating with suppliers, – brass or wrought iron valves and other parts, gears etc, copper and lead for boilers, wood for beams, brick and stone work, pumpwork (rods and barrels), and all the rest of the myriad hand-made items need to build a Newcomen engine and pump water from a mine: it was like building a house from scratch without builders' merchants or standard sizes. Many skilled tradesmen (blacksmiths, carpenters, stonemasons, plumbers and the rest), who could adapt to working with the available materials and often arduous conditions on site were also needed and the erector would often have to recruit these. There are several detailed accounts of how complex this task was in the first half of the century, and of how few people were competent to manage all this and make the engine work. We can easily imagine that if there had been no prior site visit the work of the erector must have been challenging, to say the least.<sup>41</sup>

### **Other Aspects of the Norris Files**

#### **(i) Before 1738**

The Norris Files start with a list of entries of 24 cylinders and other parts (including one where only a "fire engine bottom" was sent) between 1726 and 1738, all of which are recorded in varying sometimes different detail elsewhere. All but one of these are included in Mott's list, which also covered 12 not noted by Norris. These were either extracted by Norris from the "Stock Book 1728-38" still held at Coalbrookdale, or perhaps other now lost records. Norris also recorded information on pipes, buckets and their pump ironware, which are often itemised in the Stock Book but which Mott did not discuss in detail.<sup>42</sup>

All the Norris Files entries are in Appendix 1; noteworthy examples are:

- |          |   |
|----------|---|
| 1726     | The first entry in the Norris Files, a cylinder and bottom invoiced to Richard Beech who lived in North Staffordshire; which Mott suggests was for Wolverhampton but Norris from other sources says was "for Harwarden", as was an earlier cylinder sent in 1724.   |
| 1727 Jul | A cylinder, bottom and two pistons sent to Sir George Beaumont at Wyken, had a combined weight of 38 cwt and this suggests a cylinder of about 20-22 inches diameter. This engine was not listed by Mott or Rolt and Allen but included in Grant's thesis on the Warwickshire coalfield. Also included were pipes, 8 buckets and clacks charged at the full bored price of 32/6d per cwt and must have been the submersed parts of a set of pumps. This could be from one of the pages missing in the in the 1728-38 Stock Book; or possibly the Norris Files drew on a different source. |

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- 1731 May Another noteworthy entry is a “Fire Engine Bottom and Plate” at the unusual price of 24/- a cwt sent to Alderman Ridley in 1731 which was likely to be for an existing engine at Tanfield Lea Colliery. Mott does not record this, though it is in the Stock Book, and Rolt and Allen discounted the engine shown of a map of 1715 as a later addition; however, more recent research by Les Turnbull concludes this to be authentic and if an engine there needed a new bottom this supports an early date.
- 1733 Apr The Earl of Scarborough bought for Lumley Colliery a cylinder, 2 bottoms, a piston, a barrel, and 6 buckets weighing a total of 72½ cwt. Rolt and Allen believed this to be just a replacement cylinder but since two bottoms were purchased and Turnbull records that a second engine was in place by 1743 and probably earlier, this suggests it may have indeed been for a complete new engine.
- 1734 Oct Norris also records as Maes-y-Glyn, a lead mine in Flintshire, as the destination of a cylinder and bottom totalling 65 cwt (suggesting a diameter of 40 or 42 inches), 62 cwt of pump pipes, consigned to engine erector Joseph Hornblower which ties in with other local research by Rhodes and Bevan-Evans.

A further point worth noting is that, as Rogers recognised, the parcel sent to Hewish and Co. in 1738 was for Paulton Colliery, Somerset not Polton, Midlothian

### **(ii) Between 1738 and 1748**

The Stock Book for the following decade has not survived, so the Norris Files entries are the only consistent source that records cylinders cast in that period which did not pass down the Severn and through Goldney’s hands, though a few of the cylinders Norris listed have been picked up from the customer end by local researchers.

Some useful information is nonetheless available from the Cash Book for this period preserved at Shropshire Archives in Shrewsbury<sup>43</sup>, which records the payments received from customers (often via promissory notes or bills of exchange rather than true cash), but unfortunately not what was covered by each order; often payment was in stages not one lump, making reconciliation complicated. Mott analysed the Cash Book and tabulated (on page 81 of his 1962 paper) large transactions which appeared likely to be Newcomen engine cylinders and parts, but although this table correctly identifies most of the engine parcels it has inaccuracies, some of which can be explained from the Norris Files, which as already noted may have had access to the next volume of the Stock Book which recorded what was in each parcel.

Other issues have been resolved by more recent research on the iron industry and its customers in this period<sup>44</sup>. In particular, the customers of the following large parcels (by value) from the Cash Book recorded by Mott are not now thought to be purchasers of engine or mine drainage castings:

- \* Fothergill, James (his reference 49) – was an ironmonger
- \* Pennington, Thomas (50) – was a Bristol merchant and shipowner
- \* Titley, Thomas (51) – owned a slitting mill in Lancashire
- \* Blockley, Thomas (63) – was a locksmith and ironmonger

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Other corrections to Mott's list are that the parcel sent to Winster (43) was to Hulme, not Hulone (it has not been possible to identify which lead mine this was for); also he misread an engine consigned for Cobham and Makin as Cobburn (this was for Prescott Hall Colliery); and the two parcels sent to Smith at Attercliffe (62 and 66) are almost certainly for the same engine, part being pump barrels and pipes.

Turning to the (roughly) chronological listing in the Norris Files, the following entries are the most salient:

- 1738/9 Burslome (Burslem) Sparrow bought 7 pit barrels for the "Donnington Wood Engine". These were charged at 32/6 a cwt but were only 6 cwt so were probably the bottom barrels in which the pump lifts moved. Unless the Donnington Wood Engine was a water wheel these were likely for an unrecorded Newcomen engine.
- July 1740 Sparrow also purchased a cylinder (possibly around 38"), bottom, 2 pipes and 6 unbored barrels, which may have been for this engine or a completely different one; Norris does not record which.
- In 1739 Norris notes two large transactions involving Wm. Hulme and Co. of Winster, which were presumably for a lead mine. The cylinder and bottom weighed 76 cwt so a diameter of around 45" can be postulated based on other known weights. The transaction included a substantial order (149 cwt) for pump pipes. No other engines are known to have been erected in the county at this date, so this is probably not a duplicate.
- Sept 1739 Davies mentioned a cylinder supplied to Ferriday of Lightmoor Colliery in 1740 and Norris provides the detail: a smallish cylinder and bottom (36½ cwt suggesting about 26-28") and 96 cwt of pump pipes, buckets and clacks.
- 1739 Edward Busby bought a large parcel of cylinder and presumably other parts, totalling 105½ cwt, which is not recorded elsewhere. Also
- 1740 William Busby paid for a small cylinder (24 cwt with the bottom so around 20 inches) but a large quantity of pipes. Mott does not mention Edward but notes from the Cash Book that the total purchases of William Busby amounted to £432 so must have included more items than Norris saw in the Stock Book and / or possibly payment for both engines; the relationship between the two Busbys is not clear. The engines were probably either for Wyken in Warwickshire or Leicestershire collieries, since William Busby was the nephew of Sir George Beaumont of Coleorton and inherited mines at both places in 1737.<sup>45</sup>
- Feb 1741 An unusual transaction was the sale of a large cylinder and bottom (84½ cwt, suggesting a cylinder around 48 inches) to William and George Jukes, London ironmongers who were clearly agents not customers, at the wholesaler's discount of 26/- a cwt (normally 30/-), also 160 barrels weighing 237 cwt at only 18/-. This suggests water pipes, presumably for a waterworks, though it is possible that such a large cylinder may have been for a Northeastern colliery.

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April 1741 John Lowe, presumably the owner of Denby Colliery in Derbyshire, made another previously unrecorded order, of a cylinder, bottom sinking pipe and 2 barrels totalling 74 cwt, suggesting a diameter of perhaps 40 inches.

We now come to the William Lemon orders. Five parcels of cylinders and other parts were invoiced in 1742 and 1743, one of which we know from other sources was for North Downs (it is not clear which of these orders) and one for Wheal Fortune (which Norris did identify) but the other three cannot be tied to particular mines:

- 3<sup>rd</sup> April 1742 - a cylinder and bottom weighing 40 cwt, suggesting a diameter of about 30 inches; also two cast pistons of 17 cwt;
- 3<sup>rd</sup> May 1742 - a cylinder and bottom plus 2 bored and 37 other pipes, together 266 cwt but impossible to guess the cylinder size;
- 29<sup>th</sup> July 1742 - a further cylinder and bottom plus 7 bored pipes, totalling 321 cwt, though the arithmetic of this transaction does not add up correctly;
- 1742 no date - "For Wheal Fortune" a cylinder etc. for £115.16.5d, which at 30/- would give 77 cwt;
- July 1743 - a cylinder, bottom and piston totalling 76 cwt so perhaps 44 inches diameter.

An intriguing curiosity was that Lemon was also invoiced in 1742 for a small cylinder etc. "for his Dwelling House" costing £12.17.3. This is surely too large to have been merely a model or toy, assuming it was bored work charged at 30/- and therefore weighed around 8½ cwt, and suggests it was a small working Newcomen engine of perhaps 10-12" cylinder designed to pump water for his house in Truro, "The Princes House", which still exists. Rogers dismissed castings for a similar small engine for his country estate, Carclew, in December 1750 as merely a model but there is evidence that it was also a practical pump.<sup>46</sup>

Nov 1742 A possible further Cornwall order was from Hawthorn and Hornblower, a cylinder with ancillaries and 16 pipes weighing together 138 cwt. However it is perhaps more likely that this for one of their customers in the Midlands.

Mar 1743 This was definitely the case for the cylinder etc weighing nearly 108 cwt invoiced to Daniel Hawthorn, as Norris notes this was "for Oak-thorpe near Ashby" However, another cylinder of 38½ cwt (about 40") sent to Hawthorn in February 1744/5 cannot be traced to a particular site.

Nov 1742 The next previously unrecorded engine order was from Martin Pashley of Walsall (he was mayor of the town that year), presumably for a colliery; a cylinder, bottom and pipes, but the quantities and prices information is confused.

The Norris Files also give more details than he reported in the Appendix to the 1903 Davey article of the famous engine Coalbrookdale erected at their works in 1742/3. The Cash Book and other company records give details of the payments to the labourers

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who put it together and the lost Stock Book must have included the invoice for the major parts, as Norris records:

Cylinder, Barrels etc 301 cwt 1.20 [for which they only charged themselves £307.18.7, or 20/- a cwt]  
Brass work £60.9.1,  
Lead £48.5.0,  
The oak beam cost £10.15.0 and  
Plate Iron and Bricks £70.15.8,  
plus unspecified sums for bricks and masonry.

Labour amounted to £356 so the engine cost in total £854 plus the cost of the engine house. The transfer price of 20/- a cwt for the cylinder and pipes hints at the profitability of the Coalbrookdale engine business at the time. Unfortunately no record survives of the size of the cylinder, but it was presumably over 40 inches in diameter.<sup>47</sup>

From late 1744 the Goldney account book covers those parcels sent down the Severn via Bristol. The first item of note is a complicated transaction involving Sir Francis Vivian or Vyvyan, Abel Angove and Thomas Lanyon. Norris says the first shipment including a cylinder was invoiced by Coalbrookdale on 20<sup>th</sup> October 1744; Goldney received it on 31<sup>st</sup> December. However, Rogers explains that this was faulty and was returned, replaced later in 1745 by a larger cylinder (about 47" vs. 40"). The mine concerned was Trevenson / Pool Adit, near Illogan.<sup>48</sup>

- Feb 1745     While this was going on Coalbrookdale invoiced another cylinder to Daniel Hawthorn, 38½ cwt so only about 32" diameter, again probably for a Midlands customer but no other source confirms where.
- Mar 1745     A further parcel of a medium-sized cylinder (perhaps around 45"), bottom and piston was sent to Jukes in London, presumably via Bristol though not through Goldney and again at the wholesaler's price per cwt. The customer is unclear: either a London waterworks (though there is no engine of that date recorded in the capital) or for onward transmission. This was the first time a "piston ring" was mentioned in the manifest., though this may just be a cast piston plate.

Thereafter until late 1748 much of the content of the Norris Files and Goldney are in alignment, with receipt of shipments in Bristol typically about 3 months after despatch from Coalbrookdale. Norris also gives more detail of some of the engines Mott picked up through the Cash Book, as itemised in Appendix 1. Noteworthy entries include:

- Mar 1746     2 "Boyle Pans" were sent to Lemon; at 53 cwt these were substantial items and exceptionally do not seem to have passed through Goldney.
- July 1747     Coalbrookdale sent Edward Mundy of Shipley in Derbyshire the main components of a medium sized engine, including several that were not normally itemised at this time: cylinder, bottom, sinking pipe, blast pipe, clack and seat. Again there is no other record of this engine.
- Aug 1747     They sent through John Willetts of Wednesbury forge a similar load of engine components. Willetts did not have an engine at his works, and it is

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almost certain these were for the Chelsea Waterworks engine documented by Grudgings.<sup>49</sup>

1747/8 Two cylinders not identified by Rogers or Mott were sent to the York Buildings Waterworks in London. One with a bottom and sinking pipe totalling 44¾ cwt can be put at a 28 inch cylinder as it was advertised for sale along with the later one, which Norris confirms was 33 inches in diameter and weighed 47¼ cwt, in a London newspaper in 1749. They were however not replaced by larger engines until 1754 and 1763.<sup>50</sup>

Around this time the Norris Files start to give the sizes of the cylinders, which tally with other known details for the Goldney transactions. Two 1748 engines not recorded elsewhere are:

June 1748 A 46-inch cylinder and other parts totalling 97½ cwt sent to Jonathan Case for Whiston Colliery in Lancashire; and

June 1748 The first Coalbrookdale cylinder known to have been sold to a Scottish customer, a 55 inch one sent (via London not Bristol) to Ralph Smith, presumably for a colliery, and unusually this had a bottom and two pistons with weights given for both. A note added by Norris records "Ralph Smith & Co. allowed Daniel Hawthorn for erecting their Engine which Ralph Smith said was allowed to Richard Ford...£30".

### (iii) After 1748

The Norris Files cease for a dozen years from 1749 to until 1760. In that period there are 100 or so new engines recorded in the engine database but only 25 with known Coalbrookdale provenance, mostly from Goldney's Account Book and a few in Shropshire, though most engines outside the northeast and the largest ones there probably had their cylinders. Their first cylinder casting of 60 inches was sent to Cornwall as early as 1748, and although we cannot confirm this, the 60-inch cylinders recorded at Byker and Shiremoor (Billy Mill) in 1748-50 were presumably also from Coalbrookdale, unless the dimensions recorded were later replacements for smaller brass ones (few brass cylinders seem to have been more than 40 inches or so in diameter) or from another furnace, which seems unlikely.<sup>51</sup>

We can also postulate that in the 1750s Coalbrookdale had begun supplying increasing numbers of large cylinders to the collieries of Northumberland and Durham, though we have only sporadic documentary evidence of this period: one good example of known Coalbrookdale sales in the North East not recorded by the Norris Files is the two cylinders of 49 and 52 inches bought in 1761/2 for the Killingworth Moor Colliery.<sup>52</sup>

Episodic entries in the Norris Files, however, resume with a single reference in 1760 to "boiler plates" and 165 cwt of pumpwork for the Dawley Fire Engine [at Dawley Field Colliery], which Raistrick identifies as having a 61-inch 10-foot cylinder a year later.<sup>53</sup>

From 1762 the focus shifts to the North East coalfield with notes concerning the trade in large cylinders being sent to the North East for a variety of customers. Coalbrookdale's representative in Newcastle was Abraham Darby II's brother in law and fellow-Quaker, the publisher Isaac Thompson (their wives were sisters) and who seems to have worked with the viewer and engine builder William Brown in sourcing cylinders and

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other engine parts. Some but not all these shipments can be tied in with the list of engines compiled by Brown and detailed in Turnbull's book.<sup>54</sup>

None of the following seem to have passed through Goldney's hands, though most apart from perhaps the Nutt Hall shipment presumably passed down the Severn:

- The first entry in Norris' resumed notes was in January 1762 when a cylinder was sent to Hudson & Co. of Sunderland. This shipment weighed 204 cwt so must have been a large one and included pumpwork; however Turnbull is unable to identify a coalowner of that name, so they were probably shipping agents for a Wearside mine.
- Then in May 1762 "Goods" for Lord Ravensworth (one of the Grand Allies, and who had interests in several large collieries) weighing 439 cwt (nearly 22 tons) were despatched, presumably the parts of one or more engines and associated pumps, but it is impossible to say where they went.
- In December 1762 the Norris Files also referred to freight for "Cylinders" [plural], for Peter Lambton, of Lambton collieries.

In 1763 Norris gives details of three more large cylinders / castings shipments.

- In March: a 60-inch cylinder for Mr Tempest, probably for Penshaw colliery.
- In June: a parcel including a cylinder and worth £583 was sent to John Hussey Delavel, presumably for Hartley Colliery where he was at that time experimenting with direct steam winding of coal from underground.
- Also June: another cylinder and more castings valued in total at £559 was sent to Lambton, presumably in addition to the ones despatched the previous year.
- After a gap of two years, Norris noted that in 1765 a cylinder valued at £201 was sent to Humble, probably for Shiremoor Colliery.
- The same year a huge shipment of "Goods" totalling £602 was sent to Sir Charles Sedley of Nutt Hall or Nuttall colliery in Nottinghamshire. Brown listed one engine with a 60-inch cylinder which started work in 1766 but the size of this parcel suggests more than one engine, perhaps at a neighbouring pit and not erected by Brown; three engines are shown on a contemporary map.<sup>55</sup>
- In January 1766 Norris records freight of 3 unspecified cylinders to the Newcastle Warehouse from Bristol. These are presumably not the same as those recorded as shipped from Bristol in 1765 in Goldney's account book, one of which Turnbull thinks was actually for Duddingston Colliery near Edinburgh, which would have left Coalbrookdale some months earlier.<sup>56</sup>

Then in 1768 and 1769 three more cylinders were despatched to the "Newcastle Warehouse":

- January 1768, 70 inches x 10 $\frac{2}{3}$  feet (£101)
- January 1769, 67 $\frac{1}{2}$  inches x 10 feet (£98); and
- February 1769, 64 inches (£110)

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Given how long it took for the shipments to get down the Severn, round to Newcastle and then to be erected and operational the latter two may well have started work too late to be included in Brown's list.

As well as the transactions involving Northeastern collieries, the Norris Files itemised several other shipments of engine parts not otherwise recorded, though these were clearly only isolated examples of the firm's wider activities. The company had in the 1750s developed a process of hammering wrought iron plates, reflected in the following:<sup>57</sup>

- in 1766 they shipped 95 boiler plates priced at 28/- and weighing 36¼ cwt (just under 43 lb each) to Allan England of Tamworth, which was presumably for the Wilnecote colliery in the Staffordshire part of the Warwickshire coalfield. It is unclear whether these were for the engine already erected there in 1746 or a different one.
- Also in 1768 the Ketley Colliery Company bought a large consignment. This comprised a 60-inch cylinder, 10 feet long weighing 83 cwt, a bottom at 31¼ cwt, various pipes, 299 boiler plates of 103¼ cwt (38.7lb each) and 7 cwt of iron rivet rod, presumably for making the plates into one or more boilers.
- In 1769 a 47½ inch cylinder weighing 68 cwt, a bottom for this and a piston were despatched to Thomas Hussey for his colliery at Brownhills. The consignment also included two brass working barrels and 6 buckets and clacks, at 1s a pound, for the bottom of a column of pumps.
- Norris also gave details of the 1769 engine installed at Parrott's Bedworth colliery: a 63-inch cylinder weighing 77 cwt. The following year Coalbrookdale also supplied to Parrott a complete run of pumps including 37 pipes and the working parts including buckets and clacks.
- Again in 1769 Ketley Ironworks were supplied with two cylinders and bottoms (totalling 149½ cwt) and 2 pistons plus 4 pipes and a receiver. These seem to have been for a double recirculating engine, with cylinders of perhaps 48 inches or thereabouts, but no other references to this installation have been established.

Finally in this series of extracts from Coalbrookdale records, Norris mentions three more hitherto unrecorded engines delivered in 1792.

- The first was at William Kelson's colliery at Radford in Somerset. He records a 44-inch cylinder weighing 52¼ cwt, bottom, piston (turned not cast), and other items.
- Secondly, John Wilkes's colliery at Measham bought a 52-inch cylinder, bottom, piston, steam vessel, brass regulator (at 1/4d a pound) and steam pipes, totalling £201.

The very last item is a detailed list of all the parts of a 34 inch by 5 foot twin (hot and cold cylinders at either end of the beam) Heslop Engine supplied to Greysouthen Colliery in Cumberland in 1792, which is set out in its entirety at Appendix 3. Most Heslop engines were rotary ones for winding but this was for pumping.<sup>58</sup> The boiler was charged at 34/- a cwt, the cylinder castings at only 25/- a cwt compared to 32/6 to 30/- earlier in the century, reflecting perhaps greater competition or genuine lower production costs.

## **Conclusions**

The Norris Files add considerably to our knowledge of the diffusion of the Newcomen engine in the middle decades of the eighteenth century, especially in the period 1738-1748 but also highlight the gap in the 1750s when no Coalbrookdale records survive. They document many engines previously unknown to historians as well as providing new detail on others. It is hoped that historians with local knowledge will find the detail helpful for their researches and will be able to address some of the questions they pose and leave unanswered.

The circumstances of their rediscovery, following on that of the Goldney papers in the 1970s and the detailed local research which continues up and down the country, also reinforce the value of the continuing search for undiscovered additional documentation and emphasises the risk of assuming that the completeness of what has been published previously cannot be improved on.

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- 1 Henry Davey, "The Newcomen Engine", *Proc. Inst. Mech. Engrs* (Oct 1903), 655-704 esp. 673-6
- 2 R.A. Mott, "The Newcomen Engine in the Eighteenth Century", *Transactions of the Newcomen Society (TNS)*, 35 (1962), 69-86; Arthur Raistrick, *Dynasty of Iron Founders* (1953; revised Edition 1989 Sessions Book Trust); Barrie Trinder, *The Industrial Revolution in Shropshire* (Phillimore: 1<sup>st</sup> Edition 1973; 3<sup>rd</sup> Edition 2000); also A. Stanley Davies (1939) "The Coalbrookdale Company and the Newcomen Engine, 1717-1769", *TNS*, 20 (1939) 45-48
- 3 IMS 113 - List of Coalbrookdale cylinders 1726-1792 - Norris, William Gregory (hereafter "Norris"). Unpaginated. Held at the Institution of Mechanical Engineers, 1 Birdcage Walk, London SW1H 9JJ. I am grateful to Ms Bonner for her assistance in viewing and photographing this resource.
- 4 See the short biography at [https://www.gracesguide.co.uk/William\\_Gregory\\_Norris](https://www.gracesguide.co.uk/William_Gregory_Norris)
- 5 Shropshire Archives, MS 6001/330 (Stock Book 1717-27); MS 6001/329 (Cash Book 1718-32); MS 6001/331 (Cash Book 1732-48); Coalbrookdale Company MS 1 (Stock Book 1728-38). I am grateful to the staff at Shrewsbury and Coalbrookdale for their assistance in consulting these records.
- 6 K.H. Rogers, *The Newcomen Engine in the West of England* (Moonraker Press, 1976); Thomas Goldney's Account Book, Wiltshire and Swindon Archives, Chippenham, RO 473/295. See also P.K. Stembridge, *The Goldney Family A Bristol merchant Dynasty* (Bristol Record Society, 1998)
- 7 *Gentleman's Magazine*, 15 June 1758; Trinder, *Industrial Revolution in Shropshire*, 3<sup>rd</sup> edn, p54-5
- 8 The standard text is L.T.C. Rolt and J.S. Allen, *The Steam Engine of Thomas Newcomen* (Moorland, 1977)
- 9 see Rolt & Allen, passim and Appendix
- 10 Marie B Rowlands, "Stonier Parrott and the Newcomen Engine", *TNS*, 41 (1968), 49-67 esp. 63
- 11 See e.g. Rolt and Allen p##
- 12 Iron is cheap to produce, easy to cast, is rigid, has high compressive strength, machines and absorbs vibrations well, but has low tensile strength, is brittle and cannot be forged. Brass is corrosion resistant, malleable, ductile and a good conductor of heat but relatively soft so wears faster. Bronze is harder/tougher than brass, corrosion resistant, easily machined, it casts well and is malleable. Gunmetal combines the properties of both.
- 13 Nancy Cox, "Imagination and Innovation of an Industrial Pioneer: the First Abraham Darby", *Industrial Archaeology Review*, 12:2 (1990), 127-144
- 14 Raistrick, Chapter 1; Shropshire MS 329; MS 330; MS 331; Coalbrookdale MS 1
- 15 Cox, 133-4; Raistrick, Ch 1
- 16 Rowlands, 63; J.S. Allen, "The Introduction of the Newcomen Engine 1710-1733", *TNS*, 42 (1969), 169-190 esp. 170
- 17 Raistrick p128-32; Rolt & Allen p106
- 18 Mott, 74; Rolt & Allen, p108; Norris and Goldney, passim
- 19 See the database of over 2,600 steam engines erected in the eighteenth century in the Kanefsky database <http://coalpitheath.org.uk/engines/>
- 20 Steve Grudgings and Peter Tymkow, "Water-Raising Technologies of the Chelsea Water Works Company Prior to the Introduction of their First Boulton and Watt Steam Engine", *IJHET*, 84.1 (2014), 88-104 esp. 95,101; J.S. Allen, "The 1715 and other Newcomen Engines at Whitehaven" (*TNS*, 45 (1972), 237-68 esp. 265
- 21 Goldney Account Book, passim; Mott, 80; Raistrick, p66-68
- 22 Kanefsky database, ###; Rolt & Allen, pp67,106; Norris, passim; Rogers, p52
- 23 Kanefsky database, ###;
- 24 Les Turnbull, *The World of William Brown* (NEEIMME, 2016), p26-28 and Chapter 7 esp. p85
- 25 Raistrick, p145-6; Leeds Intelligencer 09/04/65; Turnbull p93-4,102
- 26 Raistrick p160
- 27 Norris; Raistrick p139; Coalbrookdale MS 331; Trinder, p28
- 28 Les Turnbull, "William Brown's giant Tyneside engines", *IJHET.*, 88.1 (2018), 103-123 esp. 117-8; Dickinson and Jenkins, *James Watt and the Steam Engine* (1927, reprinted Moorland 1981), Ch XXIII; R.J. Stewart, *Mine Pumping Engines in Eighteenth Century Cornwall* (Trevithick Society, 2017), p116-120

- 29 <http://coalpitheath.org.uk/engines/>
- 30 Mott, 74-6; Rogers, p51-4
- 31 Goldney, passim
- 32 Personal communication from Peter King
- 33 D.B. Barton, *The Cornish Beam Engine* (Barton, 1967), p19; Stewart, p43
- 34 Norris; Goldney Account book; Barton p19
- 35 14 Geo II c.41, s.III
- 36 William Borlase, *A Natural History of Cornwall* (Oxford, the Author, 1758) p172-5; Rogers p16-17; Joseph to Jonathan Hornblower, 21<sup>st</sup> August 1749, quoted in [http://penwood.famroots.org/joseph\\_hornblower.htm](http://penwood.famroots.org/joseph_hornblower.htm)
- 37 The biographies of Hornblower father and son are both confused. The most recent untangling is to be found at [http://penwood.famroots.org/joseph\\_hornblower.htm](http://penwood.famroots.org/joseph_hornblower.htm) and [http://penwood.famroots.org/jonathan\\_ann\\_carter\\_hornblower.htm](http://penwood.famroots.org/jonathan_ann_carter_hornblower.htm)
- 38 [http://penwood.famroots.org/jonathan\\_ann\\_carter\\_hornblower.htm](http://penwood.famroots.org/jonathan_ann_carter_hornblower.htm)
- 39 Hawthorn(e) stated in 1748 that he had been involved in erecting engines for over 30 years. See several papers by Allen, especially J.S. Allen, "The Newcomen Engine at Great Wyrley, 1722", *TNS* 41 (1968), 173
- 40 Cox, Appendix; Malcolm Wanklyn, "River Trade On The Severn 1565-1765" at <https://tewkesburyhistory.org/River-Trade-On-The-Severn-1565-1765> and David Hussey, *Coastal and River Trade in Pre-Industrial England: Bristol and its Region, 1680-1730* (Exeter, 2000)
- 41 Steve Grudgings, *Jarrit Smith's 1751 Newcomen Engine* (South Gloucestershire Mines Research Group, 2012) has a detailed discussion of this, as there is unusually a very full set of invoices for the engine. See also Rolt and Allen, passim; Rowlands, 49-67; Steve Grudgings, "From Calley to Curr", passim
- 42 Mott, 75, 81; Rolt & Allen Appendix; Allen "Introduction of the Newcomen Engine" etc.
- 43 Shropshire Archives MS 6001/331
- 44 I am grateful to Peter King for his advice in helping eliminate erroneous assumptions by Mott
- 45 Colin Owen, *The Leicestershire and South Derbyshire Coalfield* (Moorland, 1984), p113
- 46 Rogers, p35; <https://www.cornwallgardenstrust.org.uk/william-lemons-gardening-tools-and-sundries/>
- 47 Raistrick, p139
- 48 Rogers, p20-21
- 49 Grudgings & Tymkow, 96-7
- 50 London Evening Post, 8/6/1749; H.W. Dickinson, *The Water Supply of Greater London* (Newcomen Society, 1954), p61-5
- 51 Kanefsky database; Rogers p23; Norris; Rolt & Allen Appendix
- 52 E.W. Swan, "Sinking a Northumberland Colliery in 1761-2", *TNS* 25 (1945), 37-40
- 53 Raistrick, p317
- 54 Turnbull, Ch 7; Raistrick, p144; Stembridge, p78. I am grateful to Les Turnbull for advice on these shipments
- 55 Information from Les Turnbull
- 56 Rogers p49; Turnbull p94
- 57 Raistrick, p160
- 58 Adam Heslop patented his twin cylinder compound engine in 1790. He worked in Shropshire then returned to his native Cumberland and, after he had the parts for this one made at Coalbrookdale, set up a company to build his engines, some of which worked for nearly 100 years. At least 13 and probably more were built during the eighteenth century, mainly in these two counties, others in the early nineteenth. See Raistrick, p156-7; H.A. Fletcher, "The Heslop Engine, a Chapter in the History of the Steam Engine"; *Proc. IME* (Jan 1879), 85

## Appendix 1: Cylinders and other parts supplied by Coalbrookdale

(Compiled from notes by W G Norris, Institution of Mechanical Engineers IMS 113)

Date	Destination	Cwt/Q/lb	Cost £	References and comments
1726 in May	Richard Beech of Walton (“which apparently went to Hawarden”)			Rolt & Allen #43; Mott TNS 62 p75 says Wolverhampton
	1 Cylinder and Bottom @ 32/6	36.0.32	58.17.0	
	33 Screw pins	0.0.32	1.4.0	
1727 in Jul	Sir George Beaumont [Wyken]			Mentioned in Grant PhD App 10. Not in Mott or Rolt & Allen
	1 Cylinder, 1 Bottom, 2 Pistons @ 32/6			
	3 Pipes, 6 Pieces, 8 Bucketts and Clacks @ 32/6	59.2.26	97.1.3	
1728 in Jun	Lord Middleton [Wollaton]			Rolt & Allen #50, Mott TNS 62 p75.
	1 Cylinder, 1 Bottom, 1 Pipe @ 32/6	31.0.0	50.7.6	
	Carrying to Burton on Trent		3.2.0	
1728 in Aug	George Sparrow of Darlaston [? Darlaston]			Rolt & Allen #52, Mott TNS 62 p75.
	1 Cylinder and Bottom @ 32/6	36.0.12	58.13.6	
	1 Piston 3 Pipes bored 8 Bucketts and Clacks	21.0.7	<u>34.4.6</u>	
			92.18.0	
1731 in May	Alderman Ridley [Tanfield Lea]			Rolt & Allen p57; Turnbull p105-6
	1 Fire Engine Bottom, 1 Plate @ 24/- [unusual price]	51.0.9	61.5.11	
	[probably included other items inc. a cylinder?]			
1731 in Aug	Thomas Allan Esq of Allan’s Flatts			Rolt & Allen #62; Mott TNS 62 p75 #13

	1 Cylinder 1 Piston 3 Bottoms @ 32/6 Charges on Cylinder and Pipes to London	74.1.20	120.18.4 1.2.6	
1731 in Sept	Joseph Hornblower [Unknown Location]			Rolt & Allen #64; Mott TNS 62 p75; Raistrick p119,132
	1 Cylinder, 1 Bottom, 1 Pipe @ 32/6	40.0.7	65.2.0	
1731 in Sept	Richard Hartshorne, Wombridge nr. Wellington			Rolt & Allen #63; Trinder 1st p48; Mott TNS 62 p75
	1 Cylinder, 1 Bottom, 1 Piston @ 32/6 2 Pipes, 6 Buckets and Clacks	40.1.26	65.8.0	
1732 in July	Thomas Pilkington, Measham			Rolt & Allen # 67; Mott TNS 62 p75
	1 Cylinder 1 Piston 1 Bottom @ 32/6 3 Pipes, 12 Bucketts and Clacks	39.2.26	64.11.4	
1732 in Aug	William Green esq. Wyken			Rolt & Allen #68; Mott TNS 62 p75; Rowlands 68-9 p54
	1 Cylinder, 1 Bottom, 10 Bucketts and Clacks @ 32/6) 6 Elbow Pipes @ 28/- 10.0.2, 15 Barrs @ 12/- 16.2.19)	47.2.15	101.19.1	
1732/3 Feb 26	Richard Beech, for Hawarden			Rolt & Allen # 69; Mott 62 p75; Bevan-Evans p85
	1 Cylinder, 1 Bottom, 2 Pipes, 2 Clacks @ 32/6 Other expenses loading up at Salop	57.3.13	94.3.6 0.18.0	
1733 April 13	The Earl of Scarborough [Lumley]			Rolt & Allen #70; Beastall p17-20; Mott TNS 62 p75 (22)
	1 Cylinder, 2 Bottoms, 1 Piston, 1 Barrel, 6 Bucketts	72.2.23	119.15.5	

[Rolt & Allen say just larger cylinder but 2 bottoms suggests 2<sup>nd</sup> engine; Turnbull p84 lists a second engine before 1743]

1734 Sept 24	Sir George Beaumont [Wyken]			Owen p113; Raistrick p137,294; Mott TNS 62 p75. <b>First mention of cast iron wheels</b>
	<b>1 Cylinder</b> , 1 Bottom, 8 Barrels bored, 4 ?? @ 32/6	138.1.8		
	33 Barrells not bored, 4 Waggon Wheels @20/-			
	6 Rings and 4 Weights @ 12/-	411.2.7	497.14.7	
	Together			
1734 Oct 18	Joseph Hornblower [Maes-y-Glyn]			Rolt & Allen #75; Mott TNS 62 p675; Rhodes 68 p224, Bevan-Evans p85
	<b>1 Cylinder</b> , 1 Bottom, [65 cwt] 1 Pipe bored @ 32/6	70.0.14	[113.19.6]	<b>[arithmetic wrong]</b>
	7 Pipes unbored @ 20/-	57.1.4	[57.5.9]	
	An extra charge moulding and boring the Pipes £3.3.0		168.18.7	
1735 Oct 14	Henry Lambton [Lambton]			Mott TNS 62 p75; Turnbull p83-4
	<b>1 Cylinder</b> , 2 Bottoms, 3 Pipes bored @ 32/6	97.3.8)		
	14 Pipes unbored @ 20/-	118.2.0)	277.9.1	
1735 n.d.	William Richardson, Smalley nigh Derby			Nixon TNS 57 p17-21; Mott TNS 62 p75; Derbys Mercury 18/3/42
	<b>1 Cylinder</b> and 1 Bottom @ 32/6	45.0.2		
	3 Barrells bored 2 Sinking Pipes		[no costs given]	
	22 Barrells unbored ye length 63 yds 2 feet			
1736 Aug 30	Lord Middleton [Trowell Field]			Hopkinson 59 p#; Mott TNS 62 p75
	<b>1 Cylinder</b> and Bottom @ 32/6	43.3.4)		
	4 Pipes unbored 10yds 57/6 [per yard]	26.3.15)	99.18.0	
1736 Aug 29	Lord Dudley [unknown location]			Mott TNS 62 p75
	<b>1 Cylinder</b> and Bottom @ 32/6	25.3.2	41.19.5	
1736 Oct 29	Burslome Sparrow & Co. [Stow Heath Colliery, Wolverhampton]			Greener TNS p95; Rana TNS 2009 p164; Mott TNS 62 p75

	1 Cylinder 1 Bottom	43.2.0	55.19.3	
	3 Pipes @ 32/6 [bored]	16.3.12)		
	14 Pipes @ 20/- [unbored]	80.3.15)	108.5.6	
	3 Barrells unbored @ 20/-	15.3.16	15.7.10	
1736/7 Mar 29	Lord Dudley [Dudley Wood]			Allen TNS 65, 68-9; Mott TNS 62 p75; King 2007 p44
	1 Cylinder, 1 Bottom, 4 Pipes @ 32/6	64.3.7)		
	23 Barrells unbored @ 20/-	153.1.8)	258.12.9	
1736/7 Feb 6	Burslome Sparrow & Co. [Darlaston Colliery?]			Mott TNS 62 p75
	1 Cylinder, 1 Bottom, 2 Barrells bored @ 32/6	55.0.24	89.14.6	
	9 Barrells 24½ yds 7 Pipes 19½ yds @ 57/6		126.10.0	
1736/7 Mar 9	Hewish & Co., Paulton, Somerset [Mott has Polton, Midlothian]			Rogers p41; Mott TNS 62 p75
	1 Cylinder, 1 Bottom, 1 Sinking Pipe, 1 Piston and [??],			
	3 Barrells bored, 2 Buckets, 2 Clacks all @ 30/-	39.0.6	58.10.6	
1738 May 27	Richard Ridley Esq. [Byker]			Turnbull list; Mott TNS 62 p81 (says 2 Cyls)
	1 Cylinder, 1 Bottom @ 32/6	58.2.21	95.7.4	
1738 July 19	John Lawton of Lawton [Lawton Colliery]			Mott TNS 62 p75; Lawton 2013 pxlii; Nevell IA Cheshire p59
	1 Cylinder, 1 Bottom, 1 Sinking Pipe, 4 Barrells bored	57.0.13)		
	18 Barrells unbored, 51 yds @ 26/-	)	174.17.3	

[end of Coalbrookdale Company MS 1 (Stock Book 1728-38)]

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n.d. [1738/9]	Burslome Sparrow for Donnington Wood Engine			No other reference
	7 [?Barrs?] @ 12/-	6.0.0	3.12.0	
1739 May 30	Wm. Hulme & Co. Winster [Mott spells Hulone]			Mott TNS 62 p81 says paid 1740
	1 Cylinder and Bottom @ 32/6	76.3.0)		
	4 Pipes, unbored @ 18/-	38.0.14)	158.18.11	
	6 Pipes bored 54.2.19 @ 30/-, 9 Pipes unbored 56.1.9 @ 18/-		140.12.4	
1740 July 23	Burslome Sparrow & Co. [unknown colliery]			No other reference
	1 Cylinder, 1 Bottom, 2 Pipes bored @ 30/-	69.2.24)	[104.12.1]	
	6 Barrells unbored @ 18/-	[c. 36½ cwt]	[32.16.2]	
			137.8.3	
1740 Sept 1	Sir Edward Gascoigne [Garforth, nr. Leeds]			Hudson 71 p28-30; Mott TNS 62 p81
	2 Bottoms, 4 [?Pieces?]	30.0.0	45.19.2	
	1 Cylinder @ 32/6	45.1.6	73.12.4	
1740 Sept 1	William Ferriday & Co. [Lightmoor]			Davies TNS 39 p47
	1 Cylinder and 1 Bottom @ 30/-	36.2.18	54.19.10	
	Pipes, Buckets and Clacks [@18/6?]	93.3.8	87.13.6	
1740 Oct 8	Edward Busby Esq. [unknown location]			No other reference
	1 Cylinder @ 30/-	105.2.19)		[very large parcel, must inc. other parts]
	2 Pipes @ 18/-	16.0.3)	172.18.6	
1740 Dec 26	William Busby Esq. [unknown location]			Mott TNS 62 p81
	1 Cylinder and Bottom @ 30/-	24.0.12)		

6 Barrells @ 18/-	54.3.26)	85.15.6	
28 Pipes @ 18/-	253.1.19	227.19.11	
1740/1 Feb 13	William and George Jukes, London [?waterworks]		No other reference
1 Cylinder and Bottom @ 26/- [large, c. 50"]	84.2.0)		[low prices]
160 Barrells @ 15/- [small bore, only 1.5 cwt each]	237.2.14)	298.3.0	
1741 Apr 17	John Lowe Esq. [Denby Colliery]		No other reference
1 Cylinder 1 Bottom, 1 Sinking Pipe, 2 Barrells	74.0.1	111.0.3	
1742 23 Apr	Benjamin Perryn [Llyn-y-Pandy]		Mott TNS 62 p81; Rhodes TNS 68 p223-4
1 Cylinder and Bottom @ 30/-	62.3.8	98.15.5	
1742 3 Apr	William Lemon Esq. [unknown Cornish Mine]		No other reference
1 Cylinder and Bottom @ 30/-	40.0.6)	79.19.5	
2 Pistons @12/6	17.3.12)		
1742 3 May	William Lemon Esq. [unknown Cornish Mine]		No other reference
1 Cylinder and Bottom @ 30/- and 2 Pipes Bored			
37 Pipes @ 18/-	266.2.10)	276.8.4	
1742 11 June	Hornblower & Co. for Cheadle [presumably a colliery]		No other reference
1 Cylinder etc. @ 30/- )	113.0.13	132.11.6	
16 pipes @ 18/-			
1742 29 July	William Lemon Esq. [unknown Cornish Mine]		No other reference
1 Cylinder and Bottom @ 30/-, 7 Pipes Bored	321.0.8	338.10.2	

1742 n.d	William Lemon Esq. For Wheal Fortune			No other reference
	1 Cylinder etc [no rate given]	[77cwt 1qtr]	115.16.5	
1742 n.d.	William Lemon Esq. "For his Dwelling House" [Truro]			No other reference
	1 Cylinder etc. [small engine for domestic use]		12.17.3	
1742 Nov 15	Martin Pashley [Walsall, presumably a colliery]			No other reference
	1 Cylinder 1 Barrell bored @ 30/-	32.2.7	55.18.7	
	1 Barrell 7cwt 3.14, 1 Cylinder Bottom. 1 Pipe 5.1.4 @ 18/-		7.18.6	
1742 25 Nov	Hawthorn and Hornblower [unknown location]			No other reference
	1 Cylinder etc. @ 30/- )	138.3.16	159.18.2	
	16 pipes @ 18/-)			
1742/3 28 Mar	Daniel Hawthorn "for Oak-thorpe nr Ashby"			No other reference
	1 Cylinder etc. @ 30/- )	107.3.16	132.9.8	
1742/3 28 Mar	Coalbrookdale Fire Engine			Trinder 1st p161, 74 p27; Raistrick 53 p138-9; Mott TNS 62 81
	Cylinder, Barrells etc. [latter must be @ 20/-]	301.1.20	307.18.7	
	For Brass Work £60.9.1)			
	For Lead £48.5.0)			
	For Plate Iron & Brick £70.15.8)		179.9.9	
1743 n.d.	William Lemon Esq. [unknown Cornish mine]			No other reference
	1 Cylinder and Bottom @ 30/-, 1 Piston @ 12/-	76.0.25	108.7.0	

1743 [Jul?].	John Holford & Co. [possibly Pant-y-Buarth]			CBD Cash Book 2; Mott TNS 62 p81
	1 Cylinder and Bottom 1 pipe bored @ 30/-	96.0.25	108.7.0	
1744 8 July	Sir Abraham Elton [Cowthorn Hill, Bristol]			Goldney; Rogers p35-6
	1 Cylinder , 1 Bottom, 1 Pipe @ 30/-	52.3.3	79.3.3	
1744 20 Oct	Sir Fr. Vivian [returned as faulty]			Goldney; Rogers p22-3
	1 Cylinder and Bottom @ 30/-, 5 Pipes @ 18/- 3 Pipes @ 18/-	91.2.27 18.3.18	120.1.10 17.0.4	
1744/5 4 Feb	Cobham & Makin [Prescot Hall]			Harris 54 p112; Longton p127
	1 Cylinder, 1 Bottom, 1 Piston @ 30/- 1 Jackhead 1 Sinking Pipe)	53.2.20	79.3.8	
1744/5 4 Feb	Daniel Hawthorn [unknown location]			No other reference
	1 Cylinder @ 30/-	38.2.16	58.2.11	
1745 29 Mar	W. & G. Jukes, London [unknown location or larger cyl for 1741 engine]			No other reference
	1 Cylinder and Bottom @ 26/- ) 1 Piston and 1 Ring @ 12/- )	79.1.13	95.7.9	
1745 4 July	Sir Fr. Vivian [Trevenson / Pool Adit, replacement, c 47"]			Goldney; Rogers p22-3
	1 Cylinder 1 Brass Pipe etc	118.0.26	196.4.10	
1745 9 Sept	Thomas Goldney, Bristol [Paulton Colliery, Somerset, 30" cylinder]			Goldney; Rogers p41

	1 Cylinder 1 Bottom 1 Piston etc 2 Pipes Bored, 1 Sinking Pipe	58.3.0	85.2.2	
1745 21 Nov	Thomas Goldney, Bristol [Goldney; Joseph Percival for Ludgen Lees]			Goldney, Rogers p23
	1 Cylinder 1 Bottom 1 Sinking Pipe	79.3.5	116.3.8	
1745 22 Dec	Thomas Goldney, Bristol [Goldney = Joseph Percival for Roskear]			Goldney, Rogers p24
	1 Cylinder 1 Bottom 2 Pistons 14 Barrels unbored	79.3.24 146.2.14	119.18.11 126.10.4	
1745 10 Nov	Gadlys Company, near Mold [?Bagillt][Anthony Barker]			Mott TNS 62 p81; Rhodes TNS 68 p70
	1 Cylinder, 1 Bottom, 1 Piston Plate, 1 Barrel, bored	76.0.21	109.0.11	
1745/6 14 Jan	William Lemon & Co.			Goldney, Rogers p20-1
	1 Cylinder 1 Bottom @ 30/- 1 Sinking Pipe 2 Pistons @ 12/-	64.1.24 20.3.13	96.13.10 14.1.1	
1745/6 Mar	William Lemon & Co			No other reference
	2 Boyler Pans @18/-	53.1.0	47.18.6	
1746 6 Mar	Nicholas Twigg & Co., Winster [probably duplicate]			Mott TNS 62 p81
	1 Cylinder and Bottom @ 30/- 1 Sinking Pipe, 1 Clack, 3 Barrels @12/-	107.1.1	160.17.9 29.3.6	
1746 Apr	Joseph England & Co. [Wilncote]			Mott TNS 62 p81
	1 Cylinder and Bottom, 3 Working Barrels, 12 Buckets and Clacks @ 30/-	83.2.4	125.6.1	

	1 Piston, Braces, Gudgeons etc.	23.2.23	15.13.5	
1746 Apr	Thomas Goldney, Bristol [Freeman & Co. for Dolcoath]			Goldney, Rogers p24
	1 Cylinder 2 Bucket Doors		72.6.3	
1746 June	Thomas Goldney, Bristol [Freeman & Co. for Dolcoath]			Goldney, Rogers p24
	1 Cylinder Bottom	17.1.19	26.2.7	
	1 Sinking Pipe 1 Piston Plate	12.1.23	9.0.7	
1746 17 July	Daniel Hawthorn of Pelsall [unknown location]			Mott TNS 62 p81
	1 Cylinder 1 Bottom and Sinking Pipe @ 30/-	61.1.22	92.3.4	
	1 Blast Hole and 3 Pipes @ 15/-,	38.0.5		
	1 Piston @ 12/-)	4.3.26	37.5.0	
1747 20 July	Edward Mundy [Shipley Colliery, Derbys]			No other reference
	1 Cylinder, Bottom &c. and Sinking Pipe @ 30/-	50.1.11)		
	Blast Pipe, Clack and Seat &c. @ 18/-	19.0.22)	94.5.0	
	Piston @ 12/-	2.1.21)		
1747 30Aug	William Reading [or Ridding], Measham			Mott TNS 62 p81
	1 Cylinder, Bored Pipes &c., 2 Working Barrels @ 30/-	95.1.8	142.19.7	
	1 Piston @ 12/-	9.5.0	5.8.6	
	2 Blast Pipes, 6 Pipes etc. @ 18/-	115.2.2	103.19.4	
1747 30Aug	John Willetts of Wednesbury Forge [for Chelsea Water Works]			Dickinson 54 p57; Grudgings 2014 p96-7
	1 Cylinder, Bottom, 1 Sinking Pipe @ 30/-	52.1.18	75.12.3	
	1 Piston & Damper Plate @ 12/-	8.1.2	<u>4.19.2</u>	
			80.11.5	

1747 20 Oct	Thomas Goldney, Bristol [for Berrow & Edwards, but where?]			Goldney; Rogers p36; Grudgings corresp.
	1 Cylinder, Bottom 2 Pipes bored and Sinking Plate	41.2.20	60.10.4	
	1 Piston	1.2.19	<u>1.0.1</u>	
			61.10.5	
1747 10 Jan	Daniel Hawthorn of Pelsall [unkown location]			Mott TNS 62 p81
	1 Cylinder and Bottom, 1 Sinking Pipe 2 Barrells	65.2.11	98.7.11	
	2 Blast Hole and other Pipes	102.3.15	92.11.10	
	1 Piston Plate and 2 Door Plates	4.2.11	<u>2.15.2</u>	
			193.15.11	
1747 23 Mar	York Buildings Company, London [Waterworks]			Lond Eve Post 8/6/49 (says 28" cylinder)
	1 Cylinder, 1 Bottom, 1 Sinking Pipe @ 30/-	44.3.4	67.3.6	
1747 10 April	Lord Ward [unknown colliery]			Mott TNS 62 p81
	1 Cylinder, 1 Bottom 2 Working Barrells @ 30/-	83.3.2	135.13.10	
	1 Piston 4 Bucket Doors @ 12/-	10.2.15	6.7.7	
	15 Pipes, Blast Hole, &c. @ 18/-	183.0.14	<u>14.16.3</u>	
			306.17.8	
1747 10 Dec	Abel Angove for Drannack Engine [Herland]			Goldney; Rogers p23
	1 Cylinder 55 ins. dia.(71.1.4) 1 Bottom (31.3.11)	103.0.15	154.14.0	
1748 10 Feb	William Lemon "for Hayle Engine" [unknown Cornish mine]			Goldney; Rogers p20-1
	2 Brass Working Barrels 9 ft long 8¼ Ins dia.	20.2.2	114.18.0	
1748 14 Mar	Warmley Brassworks			Goldney; Rogers p28-30

	1 Cylinder 36 ins. dia. (but it being too heavy agreed to let it go for £60)	51.3.13	60.0.0	
	1 Cylinder Bottom @ 30/-	13.0.8	19.12.1	
	7 Pipes @ 18/-	45.1.23	<u>40.18.2</u>	
			120.10.3	
1748 11 May	Abel Angove & Co. [Pool Adit]			Goldney, Rogers p23
	1 Cylinder 60 ins. 1 Sinking Pipe @ 30/-	98.0.15	147.5.0	
	3 Brass Pipes @1/- per lb	49.0.18	275.6.0	
	1 Cylinder Bottom for do. @ 30/-	41.2.13	<u>62.8.5</u>	
			484.19.5	
1748 20 Jun	Jonathan Case for Whiston Colliery nr Prescot			No other reference
	1 Cylinder 46 ins. dia., 1 Bottom, 1 Working Barrel @ 30/-	90.0.5	135.1.4	
	1 Piston @14/-	7.2.23	<u>5.7.0</u>	
			140.8.4	
1748 20 Jun	Abel Angove & Co. [probably Pool]			No other reference
	20 Pipes 6ft. long 14 Ins. dia. @ 18/-	222.3.22	200.13.0	
1748 2 July	Thomas Tomkys [Colliery, West Bromwich]			Mott TNS 62 p81; Lead Black Country p21
	1 Cylinder 36 ins. dia., 1 Bottom )			
	1 Jackhead 1 Small Sinking Pipe- ) @ 30/-	79.3.2	119.13.0	
	2 Pipes bored 9 ft. long 20 ins. Dia.)			
1748 2 July	London Warehouse			
	1 Cylinder for York Buildings 33 ins. dia. @ 30/-	47.1.4	70.18.6	Lond Eve Post 8/6/49

1 Cylinder for Scotland [Ralph Smith] 55 ins. dia @ 30/- )	83.1.4	179.2.8	No other reference
1 Bottom for do. @ 30/-, 1 Piston 11.1.5 and 1 do. 10.2.11)		<u>                    </u>	[arithmic confused]
		250.1.2	

Ralph Smith & Co. allowed Daniel Hawthorn for erecting their Engine which Ralph Smith said was allowed to Richard Ford - £30.

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Gap in Journal 1749-1759 inclusive

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1760 n.d,	Dawley Field Engine		Trinder 1 <sup>st</sup> p45; Raistrick p317
2 Working Barrels and Pipes		465.1.24	??
Boiler Plates			
1762 Jan	Cylinder for Hudson & Co., Sunderland	204.9.8	No other reference
May	Goods for Lord Ravensworth	439.0.0	No other reference
Dec	Freight for Cylinders from Bristol, charges of unloading, and landing, for Peter Lambton Esq.		
1763 Mar	Cylinder, 60 Ins., for Tempest Esq.	[no details]	[prob. Penshaw] No other reference
1763 Jun	Cylinder, for Sir John Hussey Delavel	583.16.6	[prob. Hartley] No other reference
1763 Jun	Cylinder, for Lambton	559.16.0	[Lambton] No other reference
1765 Sep	Cylinder, for Humble	200.17.9	[prob. Shiremoor] No other reference
1765 May	Goods for Sir Charles Sedley [Nuthall, Notts]	602.5.10	Turnbull p103; Brown List
1766 Jan	Newcastle Warehouse		No customers stated
	Captain Flynn: Freight of 3 Cylinders from Bristol.		[prob. Benwell & Walbottle] No customers stated
	Pd 30 Labourers, 3 days, at landing, extra expences £7.14.5		No customers stated
1766 1 Mar	Francis Bassett Co. Tehidy for Dolcoath Mine		Rogers p25; Harris 74 p15; Farey II p92

[no weight / price detail]

1766 1 Mar Thomas Daniel & Co. Bristol for Poldory Mine Rogers p21

[no weight / price detail]

1766 1 Mar Thomas Daniel & Co. Bristol for Pennalls Mine [Penhalls] Rogers p22

[no weight / price detail][no evidence of Newcomen engine]

1766 n.d Allan England, Tamworth [Wilncote Colliery] [for 1746 engine?] No other reference

95 Boyler plates @ 28/- 36.1.0 50.15.0

1766 n.d Sir Jarrett Smith, Bristol [Coalpit Heath] Grudgings 2012; Rogers p31-34

74 Boyler plates @ 28/- 33.1.15 46.14.9

1768 12 Jul Francis Bassett Co. for Dolcoath Mine Rogers p25; Harris 74 p15; Farey II p92

1 Cylinder 10ft. 63 ins. @ 30/- 83.0.0 124.11.4

1 Piston in liason[?] @ 16/- {Goldney says "with stems" and Bottom 39.3.14 32.0.0

1768 n.d. Ketley Coal Co. No other reference

1 Cylinder 10 ft. long 60 Ins. @ 30/- 83.0.0

1 do. Bottom @ 30/- 31.1.10

Various Pipes and Screw Pillars @ 20/- 95.0.1

299 Boyler Plates @ 28/- 103.1.6

Rivet Iron Rods for do. @ 20/- 7.0.0

1768 n.d. Thos. Daniel & Co for Chacewater Mine Rogers p18-19; Rowe 32 p151ff; Farey p190

[no weight / price detail]

1768 n.d.	John Ennis and Thomas Harris, Camborne, for Higher Rosewarne and Wheal Gerry			Rogers p27
	[no weight / price detail]			
1768 Jan	Newcastle Warehouse			No customer stated
	1 Cylinder 10 2/3 ft. long 70 Ins. @ 32/-	101.3.9		
	1 do Bottom	37.1.26		
	1 Piston @ 22/-	23.3.26		
1769 4 Jan	Newcastle Warehouse			No customer stated
	1 Cylinder 10 ft. 67½ ins. @ 32/-	98.3.0	??	
	1 do. Bottom @ 22/-	33.1.17		
	1 Piston @ 12/-	22.3.0		
1769 Feb	Newcastle Warehouse			No customers stated
	1 Cylinder 10 ft. 64 ins. @ 32/-	110.2.0	??	
	1 do. Bottom @ 22/-	36.2.10		
	1 Piston @ 12/-	20.0.9		
1769 ? Feb	Herbert Mackworth Esq. [Gnoll Colliery, Neath]			Goldney; Rogers p48
	Working Barrels [no details]			
1769 ? Feb	Thomas Daniel & Co (Truro) for Wheal Virgin Mine			No other reference
	Pipes 9 ft. long 16 Ins. [no details]			
1769 4 Mar	John Mackey Esq. of Parr [Mackay][Parr Colliery, Lancs]			No other reference

	1 Cylinder 10 ft. 63 ins. @ 30/-	77.1.20		
	1 Cylinder Bottom @ 32/-	32.0.8		
	1 Piston @ 12/-	19.2.6		
1769 26 June	Thomas Hussey, Brownhills [Colliery]			No other reference
	1 Cylinder 10 ft. long 47½ ins. @30/-	68.0.20	[102.5.4]	
	1 do. Bottom @ 22/-	18.2.23		
	1 Piston @ 12/-	10.0.25		
	2 Brass Working Barrels @ 1/-	31.0.9		
	6 Brass Buckets and Clacks @ 1/-	2.1.25		
1769 13 April	Richard Parrott Esq. & Co. Bedworth [Colliery]			Davies TNS 39 p47; White 70 p53
	1 Cylinder 10 ft. long 63ins. @ 30/-	77.1.20	[116.2.11]	
	(also 1770 1 Jan) 37 Pipes, 1 Receiver, 1 Sinking Pipe,			
	4 Working Barrels, 9 Buckets, 1 Sinking Clack,			
	1 Iron Regulator, 1 Hotwell Pan [no weight / price detail]			
1769 26 July	Ketley Furnace Compy.			No other reference
	2 Cylinders & 2 Bottoms @ 30/-	149.2.14	[244.8.8]	
	2 Pistons @ 12/-	56.2.14	[33.19.6]	
	4 Pipes & 1 Receiver	23.0.11	[??]	
1770	Liverpool Warehouse [no customer details]			No other reference
	1 Cylinder Bottom & 1 Sinking Pipe @ 30/-	31.0.14	[46.13.9]	
1792 Apr	William Kelson, Radford, Somerset [Colliery]			No other reference
	1 Cylinder 10 ft long, 44 Ins. dia.	52.1.0)		
	1 Bottom for do,	11.2.16)	95.16.9	

1 Piston Turned	8.0.14	8.2.6
1 Cylinder Cup	3.1.16	2.14.3
1 Steam Box and Lid	<u>12.2.7</u>	<u>10.1.0</u>
	87.3.25	116.14.6

1792 Apr            John Wilkes Esq. Measham nr Derby [Colliery]            No other reference

1 Cylinder 10 ft long, 56 Ins. dia.	72.2.13)	
1 Bottom for do,	20.1.6)	125.2.1
1 Steam Vessel	7.3.2	6.4.3
Brass Regulator @ 1/4d	1.2.4	11.18.3
1 Piston	18.3.18	14.3.8
Steam and other Pipes		<u>44.3.4</u>
		201.11.7

1791/92            William Walker, Greysouthen Colliery, Cumberland            No other reference; See also Appendix 3

Detailed breakdown cost of twin cylinder Heslop engine, two 34" x 5' cylinders

Boiler charged @ 34/-, cylinders etc @ 25/-, pipes @ 13/-            Total £494.18.3

### Appendix 3: Engine to Adam Heslop's Arrangement and Patent

(note by W G Norris, Institution of Mechanical Engineers IMS 113)

#### William Walker & Co, Greysouthern, near Workington [Greysouthern]

Pumping Engine, Boyler, &c.	Cwt	at	£ s d
1 Boyler in six parts, 11 ½ feet dia., with screws etc	<b><u>51.1.9</u></b>	34/-	87.4.7
2 Cylinders 5 feet long, 34 ins. dia	34.2.1		
2 do. Bottoms	<u>16.2.5</u>		
	<b><u>51.0.6</u></b>	25/-	63.16.4
1 Piston for hot clinder with ring turned	7.2.16		
1 do. cold do.	<u>5.2.18</u>		
	<b><u>13.0.6</u></b>	25/-	16.6.4
1 Double nozel and one single ditto with three bonnets	11.0.7		13.13.7
Fitting up the nozels			3.3.0
1 Cylinder cup	2.2.21		2.3.0
1 Eduction Pipe, 1 Feed Pipe, 1 Injection Pipe	5.0.16		4.12.7
1 Gudgeon, 1 Plummer Block	6.1.7		4.9.7
1 Steam Clack and 2 Cocks	1.1.16		3.5.0
3 Buckets and Clacks	1.1.12		1.10.0
6 Slides, 2 Arches, 1 Connecting Box	7.3.5)		
4 Groove Plates to Plug Frame	1.2.2)		6.15.0
137 Iron Links for Chains	8.2.2	14/-	5.19.0
Blast Pipe, Clack Seat, etc.	42.1.26	25/-	31.15.6
19 Pipes. 9 ft long. 10 ins. dia.	142.0.13	14/-	92.7.8
92 Pins fixed to the Chains	2.2.12	4d	4.17.9
6 Adjusting Screws, Screws, Burrs in a Cask	1.1.1)		
	6.1.17)	5d	26.1.3
6 Do.	3.2.1)		
4 Archplates, 2 Catch Pins, 1 Spanner	2.2.27)		
Pins and Glands fixed to Beam	1.3.15)	4d	26.13.10
4 Martingales, 4 Piston Rods & Caps	9.2.19)		
Working Gears in Cask and fixed in Nozels	2.1.16	1/-	13.8.0
6 Eyes to Nozels, Cross Bars, Valve Plates	0.3.19		2.2.11
Swords for the Buckets	0.3.22		1.15.4
2 Screws fixed at each end of Beam	0.1.9	2d	15.4
2 Copper Valves and Seats	1.3.4)		
Brasses	0.1.7)		13.4.11
Oak Timber. Deals		42.19.0)	
Sawing Spikes and Nails		3.7.2)	<u>68.16.8</u>
Carpenter's Labour		22.0.16)	

**£494.18.3**

## **Appendix 2: Drawback on Coal for Fire Engines**

**Extract from Act of Parliament of November 1741 (14 Geo II c.41, s.III)**

*“And whereas for many Years past there have been no considerable new Loads or Veins of Tin and Copper discovered, and the greatest and most considerable Mines of Tin and Copper within the County of Cornwall are become so deep, that all Means for the draining Water out of then have already proved ineffectual; and it hath been found by Experience, that under the present Duties upon Coals the Application of Fire Engines to the draining the Waters out of the Mines in the said County of Cornwall hath been impracticable, from the great Expence attending the same : Therefore for the Encouragement of such valuable Works, wherein a great Number of Tinnors, Labourers, and Adventurers are employed, and subsist thereby ; Be it enacted by the Authority aforesaid, That from and after the Twenty-fourth Day of June one thousand seven hundred and forty-one, for all Coals which shall be used in Fire Engines, for the draining Water out of the Mines of Tin and Copper, within the said County of Cornwall, and for which Duties have been first answered and paid, a Drawback shall be allowed and made of all such Duties, upon Proof by Oath made before the Customer or Collector of the said Duties (which Oath he is hereby impowered and required to administer), that such Coals have been so used and applied; which Drawback of all the said Duties shall be returned and paid by the Collector of the said Duties to such Person so making Proof as aforesaid.”*