The Saltford Brass Mill Project – A Decade of Industrial Archaeology

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Introduction

Saltford Brass Mill is a Scheduled Monument and Grade II* listed building located on the River Avon mid-way between Bath and Bristol. The mill, which is adjacent to Kelston Weir which provided its power source, was in operation as a water-powered brass-battery and rolling-mill from 1721 until 1925. But Saltford mill was not an isolated facility; it was part of a conglomeration of metal-working sites operated by the Bristol Brass Company which smelted copper, melted brass, produced brass pans, kettles, sheet metal and wire, and transported those materials to Bristol for export.

The company traded under various names including: the ‘Bristol Brass Company’; the ‘Bristol Brass and Wire Company’; the ‘Brass Battery and Wire Company of Bristol Esher Upper Redbrook and Barton Regis’; and the ‘Harford and Bristol Brass Company’. The brass company was at its peak in the late 1700s but contracted dramatically in the early 1800s as its overseas markets diminished and the company was subject to competition from Birmingham. By 1814, the company had reduced from nine sites to three: Avon Mill and Chew Mill in Keynsham and Saltford Mill. Harfords advertised the company for sale in 1828 and eventually leased the company to Charles Ludlow Walker in 1833. By 1855 Saltford Mill was described as ‘old and decaying’. Further attempts were made to sell the company which was eventually bought by the Bain brothers, Donald and David, in 1862. The brothers carried out some modernisation of Saltford Mill in 1881 allowing battery and rolling to continue for a number of years. The last battery took place in 1908 and rolling stopped in 1925 when the company ceased trading.

Following the closure of the brass company, Saltford Mill was purchased by Eric Butler (a director of William Butler and Company, ‘Tar, Rosin and Oil Distillers’ of Crews Hole), who lived at the ‘The Craig’ adjacent to the brass mill. Butler adapted the mill to become a sports-centre; which included the installation of a squash court lit by electric light powered by a 10kW waterwheel-driven dynamo. Later in the twentieth century, the mill was acquired by Charlie Shepard who used it for the construction of boats (now Bristol Boats Ltd, based at Saltford Lock) but by the 1970s the mill had fallen into a state of decay. Attempts were made to redevelop the site but in recognition that the mill was the last survivor of the brass industry the building was listed Grade II* in 1975.

In 1976 a survey was carried out by BIAS of the Saltford site and in 1981 the Avon Industrial Buildings Trust (AIBT) took out a 99-year lease on the listed building. The AIBT embarked upon a programme of conservation and restoration with emphasis on the annealing furnace with the project being led by Joan Day. Joan had undertaken extensive research into the brass industry in the 1960s and 70s, which culminated in the publication of her book ‘Bristol Brass: The History of the Industry’, in 1973, which remains the definitive work on the subject. More recently, a short history of the Avon Valley Copper and Brass Industry was published by Joan Day and the author in BIAS Journal no 46 [2013].

The restoration work proved costly and options were considered by which the site could be developed to find a commercial use for the site while preserving the important structure. Alternatives were proposed, including the creation of holiday cottages within the mill, but which would require ground works to install a water supply and sanitation. An archaeological excavation

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1 Grid Reference: ST 68714 67002
was carried out which revealed that extensive remains existed below ground and as a consequence the site was scheduled in 1986. The citation which accompanies the schedule states that “it is the most complete survivor of the complex of facilities involved in the copper and brass industry”.

The building was subsequently surveyed by the City of Hereford Archaeology Unit in the early 1990s [iii, iv] with the conclusion to their first report stating:

The scheduling of the main part of Saltford Brass Battery Mill in 1986 was a clear recognition of the historic and archaeological importance of the site... The past twenty years or so has seen a marked change in the way the national heritage is seen... if the status and protection now given to important industrial monuments is to be seen to be genuine... then sites such as Saltford need to be treated with the same amount of respect as any medieval castle, for example.

The survey identified that the building was in a very poor condition and as a consequence of its importance the building was restored by English Heritage in 1995 but was not taken into national guardianship. Following restoration, the mill remained in private ownership but the AIBT lease was taken on by the Bath and North East Somerset (B&NES) council and the Saltford Brass Mill Project, a wholly voluntary organisation, was established in 1997 to work with the site owner and lease holder to care for the building, conduct research into its history, interpret the building and open the mill to the public.

In the 25 years since its restoration, survey of the mill and further research into the brass industry has yielded more information about the operations conducted there and the products it produced. The objective of the paper is to provide a record of that research, in particular evidence that has come to light in the last decade.

**Brass Products and their Markets**

It is widely recorded that the products produced in Saltford Brass Mill were hollow-ware kettles and pans (known as Guinea Kettles and Lisbon Pans) plus sheet metal, with the larger mill and company headquarters in Keynsham (Avon Mill) specialising in the production of brass wire. Brass hollow-ware was produced in Saltford Mill by water-powered battery-hammers between 1721 and 1908 and brass-sheet was produced by water-powered rolling between c.1765 and 1925. A question which is often side-stepped in extant publications, however, is what was the market for those products and what stimulated the creation of a company as large as the Bristol Brass Company?

Evidence to one stimulation for the industry lies in five small objects which lay at the back of a display cabinet almost hidden from view. The objects place Saltford Mill in a different context. Rather than being an interesting pre-cursor to the industrial revolution, the brass industry, of which Saltford Mill was a part, was a key player in the 18th Century trade between Bristol and West Africa. The objects are manillas; stylised bracelets used as ‘commodity money’ in 18th Century West Africa. All have card tallies attached to them, printed on one side with the name ‘Harford & B B Co, Keynsham’ (Harford and Bristol Brass Company) who operated the Bristol company from 1786 to 1833. On the reverse of the tallies, in hand-written text, two of the manillas are described as ‘coinage of Ivory and Gold Coast area’ and ‘coinage of the bonny District, Nigeria’ (Figure 1). The other three objects are described as a ‘Woman’s Arm Ring: worn above the elbow, Africa’ and a ‘Man’s Arm Ring: worn above the elbow, Africa’ and a ‘Man’s Ankle Ring, Ivory or Gold Coast & District’ (Figure 2).
The objects are evidence of involvement in the Triangular-Trade – the 18th Century Slave Trade. Further evidence to this trade is provided by Timmins in the ‘Industrial History of Birmingham [1866]’, describing how:

“Immense quantities of a species of money, known as ‘Manilla’, were at one time produced in Birmingham by casting. It closely resembled an object figured in Knight’s Pictorial England (a species of ring money), and was exported to the Spanish settlements on the New and Old Calabar, and the Bonny Rivers in Africa. In addition to that produced in this town (Birmingham), it was largely manufactured by the Bristol house of Harfords, and by the Cheadle Company, and was cast of a metal composed of copper, with a very large proportion of lead as an alloy, and hardened by arsenic.”

In ‘Slavery Obscured’ (2001) Madge Dresser observes that:

Records of the slaver James Rogers show that Joseph Harford’s firm was still exporting brassware aboard Guinea ships as late as the 1790s.

The evidence suggests that two of the manillas in the Saltford collection were cast in Keynsham in the late 18th or early 19th Century. The Slave Trade Act of 1807 prohibited the trade; hence there would be no demand for such objects after that date. The three ‘African’ manillas do not appear to have been made in Britain but were probably cast in West Africa and brought back to England as examples of the art-work produced by African artisans melting down manillas, pans or kettles, and
re-casting them by use of the lost-wax method of casting. This chimes with an observation made by Neil MacGregor in the ‘History of the world in a hundred objects’ viii. MacGregor cites the Benin Brasses as one of the hundred objects that define the history of humanity. The objects were cast in Benin in West Africa c.1450, some 250 years before the formation of the Bristol Brass Company. The brasses were made by re-casting manillas or melting-down pans which Portuguese merchants had traded for pepper, ivory and slaves. This practice continued through to the 18th Century and similar art-works can be seen in the British Museum dating from the 1700s, the period in which the Bristol Brass Company was active. The origins of the names of the products produced by the Bristol Company therefore becomes evident: Guineas – reflecting the destination for the kettles – and Lisbons – reflecting the types of product which the Portuguese has sourced from central Europe as barter goods for trade in West Africa.

The slave trade between Europe, West Africa and the America’s was over 250 years old when Bristol merchants broke into the trade triangle. European trade with West Africa had been initiated in the fifteenth-century by the Portuguese; however, Bristol’s engagement was held-back by three British acts of Parliament, the ‘Company of Mineral and Battery Works’ of 1565, the ‘Society of Mines Royal’ of 1568 and the company of ‘Royal Adventurers Trading to Africa’ (Royal Africa Company) of 1660. These acts created a royal monopoly for mining for bullion, which included copper by nature of copper ores containing traces of silver, production of battery-ware and trading with Africa. The Glorious Revolution of 1688 resulted in James II being overthrown and William & Mary being invited to reign, but with restrictions on their power. This was enacted by the 1689 Bill of Rights which repealed the three aforesaid acts and opened up the trade on copper and brass goods to Africa operating out of Bristol.

Early in Bristol’s involvement in the Triangular-Trade, Thomas Phillips, a Bristol merchant-ship captain, described the goods that were required for trade with West Africa in ‘A Voyage from England to Africa and forward to Barbados’ ix, published in 1694. He wrote:

“Cowries were essential, the smaller the more esteem’d. The next in demand are brass neptunes or basons, very large, thin and flat. Certain textiles were also acceptable, but only to a limited extent; near half the cargo value must be cowries and brass basons to set off the other goods”.

By the mid to late 18th Century, frequent trading voyages were undertaken between Bristol, West Africa and the West Indies. A typical inventory of a cargo destined for Bonny in West Africa in 1785 was described by Professor MacInnes in ‘Bristol: A Gateway to Empire’ [1939] x, reproduced at Figure 3. Of note are the 5 cwt of 22in Neptunes (a type of brass pan in demand in West Africa) costing £40.002, the 15 cwt of manillas costing £56.00 and the 1000 copper rods costing £50.00.

15 cwt of manillas would have equated to approx. 5,400 items; hence each cost approx. 2.4 old pence (1p). Based upon the pans in the Saltford Brass Mill Project’s collection, a 22 in Neptune would have weighed approx. 3.5 kg. 5 cwt of Neptunes would therefore have equated to around 70 pans, each pan costing approx. 12 shillings (60p) at 1785 prices. It is poignant to consider that the full cargo costed £1,226 with which it was proposed to purchase 250 slaves; equating to approx. £5.00 per head - a slave could therefore be bought for approx. 8 Neptunes! A slave could be sold in the West Indies for approx. £20.00 each.

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2 £1 at 1750 prices equates to approx. £220 at 2020 prices.
Similar inventories were uncovered by Richard White of Bath Spa University in research for his 2017 ‘Sweet Waters’ project. The artefacts included letters of instruction from investors to the masters of slave ships. Five of those letters relate to the Snow Molly [1750] ix, the Snow Molly [1752] x, the Snow Swift [1759] xi, the Snow Africa [1774] xii and the Snow Africa [1776] xiii. The letter to the master of the Snow Molly states that the cargo should contain ‘200 Brass Neptunes which can be bought from Harford Lloyd and BW.Co’, i.e. the Bristol Brass Company, by then known by the catchy title of the ‘United Brass Battery, Wire and Copper Company of Bristol, Esher, Upper Redbrook and Barton Regis’, in which Harford Lloyd was a partner.

The demand for hollow-ware can be seen, but what was the demand for sheet metal? One possibility is the demand for sheet cooper or brass for the sheathing of ships to protect them from the naval ship-worm teredo navalis. The ship-worm, which could measure as much as 9mm in diameter and 59 mm long, caused immense damage to wooden ships, boring into the ships timbers and destroying the fabric of the ship. As early as 1740, Nehemiah Campion, a partner in the Bristol Brass Company, suggested sheathing ships in copper to prevent invasion by the worm. Copper-sheath would provide a mechanical barrier to entry of the worm. The copper would also act provide an anti-fouling barrier preventing the growth of weed and barnacles. The Royal Navy were the first to implement copper-sheathing, cladding HMS Alarm in 1763 prior to a successful two-year deployment to the West Indies. Bristol built merchant ship-builders followed suit and there are

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3 A Snow is a two-masted, square-rigged vessel typically used in the trans-Atlantic trade
records of Bristol built merchant ships being copper-bottomed. One such ship is the Hester\textsuperscript{iv}, a copper-bottomed ship of 191 tons, built in 1768\textsuperscript{v}. Was the demand for copper-sheet the driver for modifying Saltford Mill from being a purely battery-mill to a battery and rolling mill?

Copper and brass manufacture was perfected in Bristol to satisfy the demands of the triangular trade but it also meant that when the industrial revolution began to take hold in the late 18\textsuperscript{th} Century, engineers such as Boulton and Watt had the materials at hand from which to construct the machines which fed the revolution. As Timmins observed in 1866\textsuperscript{vi}

\begin{quote}
The making of brass at Bristol is an important link in the history of the progress of the brass manufacture in England and as from it, Birmingham received a portion of its supply in the early period of her brass manufacture.
\end{quote}

The contrast between Bristol and Birmingham is that Bristol focused on trade whereas Birmingham focused on industry. Figure 4, reproduced from ‘The Red Gold of Africa’\textsuperscript{vii}, shows a plot of copper and brass exports to Africa between 1701 and 1807 annotated with key points in the Bristol Brass industry. The plot shows the growth of exports through the 18\textsuperscript{th} Century and the subsequent collapse of the trade coincident with the Slave Trade Act. This mirrors the growth and decline in the Bristol Brass Industry. At its peak around 1790, the Avon and Chew Valleys hosted 12 brass and copper mills engaged in battery or rolling with 51 hammers in operation. By 1814 this had fallen to 3 brass mills and 1 copper mill with 9 hammers in operation. The Bristol Brass Company came down to Avon Mill (the company’s headquarters), Chew Mill and Saltford Mill, and this reduced further to just Avon and Saltford Mills by the late 19\textsuperscript{th} Century. With the abolition of slavery and the collapse of the West African trade the Bristol industry contracted dramatically whereas Birmingham was embracing the industrial revolution and became the centre of technological development of which the brass industry was a key part.

We must therefore see the history of Saltford Brass Mill in three distinct phases: Phase 1, as part of the 18\textsuperscript{th} Century brass industry supplying the triangular trade operating out of Bristol; Phase 2, as part of a much-reduced industry supplying sheet metal, wire and battery-ware to domestic markets in the 19\textsuperscript{th} Century; and Phase 3, in which the mill is used for other purposes and eventually subject to restoration as a scheduled monument.

\textsuperscript{iv} Hester was engaged in the trans-Atlantic trade and is recorded as leaving Bristol in February 1788 with a crew of 22. The vessel arrived in Annamaboe, on the Gold Coast of Africa in September and sailed for the West Indies in October 1789 with 320 slaves onboard. The ship arrived in Jamaica in December 1789 where the slaves are sold, being described as ‘pretty good’
Saltford Mill

Saltford Mill’s part in this history was the manufacture of Guinea kettles and Lisbon Pans for the Africa trade and the production of sheet metal for sheathing merchant ships engaged in that trade to protect them from attack by the teredo navalis ship-worm.

Inspection of Saltford Mill today indicates that it incorporated four watercourses serving four waterwheels. A fifth waterwheel existed in a separate out-building but was not part of the brass-production process; the wheel drove a grindstone in an ancillary workshop 55m upstream. This paper focuses on the main body of the mill. To differentiate between the watercourses, they are numbered W1 to W4 with W1 being the eastern-most wheel closest to the river and W4 being the western-most wheel closest to the road.

Documented History

Following a visit in 1754, the Swedish metallurgist, RR Angerstein described Saltford Brass Mill as comprising three workshops and twelve hammers:

On the road between Keynsham and Bath there is yet another (battery mill), comprising three workshops and twelve hammers\textsuperscript{XX}.

Just over a century later, in 1859, an inventory of Saltford Mill described the works as containing six hammers in two battery-mills and a rolling-mill containing two sets of rolls. Evidently six hammers had been removed to enable the conversion to a rolling mill. The inventory described each battery-mill as comprising a 15ft (4.6m) waterwheel driving three hammers with multiple hammer-heads and anvils associated with each mill (there were 245 hammer-heads and 48 anvils associated with Battery Mill No 1 and 199 heads and 36 anvils with Battery Mill No 2). The rolling mill was powered by two 15ft waterwheels driving two pairs of rolls, the bed of one being 5ft 6in (1.7m) wide and the second 3ft 6in (1m) wide. The two rolling-mill wheels also drove three pairs of shears. It is this layout that we can identify in the mill today with the eastern wheels, W1 and W2, powering the rolling mill and the western wheels, W3 and W4, driving the battery-mills.
Brass battery ceased in 1908 but rolling continued until 1925. Eric Butler removed all of the machinery relating to the brass industry to enable conversion of the building to a sports facility, including construction of the, hydro-electrically lit, squash-court. Butler installed, or more probably converted, one waterwheel to drive a dynamo via a system of chain drive, overhead lay-shaft and belts. This waterwheel and dynamo power generating set remain functioning today, albeit down-rated to 12 volts output from its design 210 volts!

**Dimensional Survey of the Mill**

When the author joined the Saltford Brass Mill Project in 2007, several sketch layouts of the mill existed but no detailed dimensioned plan of the mill had been produced. It was recognised that a detailed survey of the mill was required to aid interpretation and in 2018 a full dimensioned survey of the mill was undertaken, which fortuitously coincided with an inspection of the subterranean culverts and repair of penstock gate W1. In 2016, a joint survey by B&NES and Historic England recommended that a survey be carried out of the mill’s sub-structure to assess its condition and propose an ongoing programme of repair and maintenance. Penstock gate W1 had also been deteriorating for a number of years and a joint inspection conducted in 2017 by B&NES, the SBMP and the Canal and River Trust (CRT) recommended that the penstock gate should be replaced within two years. Funding became available in late 2018 and a coffer-dam was rigged in the main headrace to dewater the mill to the downstream river level enabling a full visual inspection to be carried out of the normally flooded culverts and chambers. B&NES had also recently acquired a 3D laser scanning capability as part of the Roman Baths Archway Project, employing a Leica RTC360 3D laser scanner, which they were able to deploy at Saltford. The survey therefore comprised a combination of visual inspection, photographic record, conventional measurement, aerial scan using a drone and 3D laser scan from which an accurate dimensioned plan of the mill could be produced.

The laser scanner is a portable, tripod mounted, device which when activated automatically scans a 3-dimensional envelope around itself measuring the distance to all structures and objects in line-of-sight. The system then creates a ‘point-cloud’, being a accurate digital record of an object or space saved as a very large number of ‘points’ covering the surface of sensed objects. The Leica scanner has a measuring rate of 2 million points per second and a coloured 3D ‘point-cloud’ can be created in under two minutes. The brass mill is a complex structure; the mill was therefore scanned from multiple data collection positions with the mill eventually being scanned from 60 data collection positions which created around 300GB of data.

Figure 5 shows a plan of the mill produced from data collected during the survey. The key features to note are: battery mill number 1 and annealing furnace, both now demolished, on the eastern side of the site between the standing structure and Shallows Lane, once powered by a waterwheel in watercourse W4; battery mill number 2, once powered by a waterwheel in watercourse W3, and associated annealing furnace (still standing) with Eric Butler’s squash court erected on the site of the battery hammers; the rolling mill once powered by waterwheels in watercourses W1 and W2, with the position of the large ‘breaking in’ rolls and postulated position of the finishing rolls; the western annealing workshop showing the extent of the building and remaining structure of the furnace fronts; the operating waterwheel in watercourse W2, drive-train and dynamo; the previously undocumented culverted tail-races of watercourses W1 and W2; the previously unknown

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5 A penstock gate is a water control gate that controls the flow of water to a waterwheel. Penstock gates are also known as sluice gates, slide gates or stop gates.
subterranean chamber housing the head-race to watercourses W3 and W4; and the previously unknown culvert W0.

**Watercourses**

The watercourses and associated waterwheels were the power-house of the mill. Figure 6 shows a plan of the brass mill below ground level, which by contrast to the plan of the workshops at Figure 5 provides a very different impression of the site. The major upstream head-race is fed from Kelston Weir (Figure 7) and splits into five smaller watercourses immediately upstream of the mill which pass through and under the mill before returning to the river. There is evidence of four waterwheels within the mill with bearing mounts being visible in watercourses W1 to W4. The working waterwheel is in-situ in watercourse W2 and there are remains of a waterwheel in-situ in watercourse W1. The fifth watercourse, W0, was unrecorded before the mill was dewatered in 2018. This watercourse is not associated with the fifth ancillary waterwheel and its purpose remains the subject of speculation. Each watercourse is culverted and the mill floor is a continuous platform laid on top of the tunnels and chambers.

The watercourses can be considered in two groups: the western sweep which powered the battery mills and the eastern sweep which powered the rolling mill. Each watercourse comprises a head-race fed from the major upstream leat, a penstock gate controlling the flow of water through the watercourse and a tail race returning the flow to the river. Three of the penstock gates remain functional: W1, W2 and W4. Watercourse W3 is blocked at the inlet to its culverted head-race and its penstock gate has been removed; probably carried out in the late 1920s as part of Eric Butler’s conversion of the mill. The working waterwheel in watercourse W2 drives the 1928 dynamo and is not associated with brass production, the dynamo being installed by Eric Butler to light the squash court. There are also the remains of a waterwheel in watercourse W1 which drove the rolling mill up to the brass mill’s closure in 1926.

It is interesting to speculate on the date of construction of the watercourses and the order in which they were created. The mill is recorded on Ordnance Survey maps of the area (Figure 8)\textsuperscript{xxi} and other maps dating back to Thorpe’s 1742 ‘Map of 5 miles Around Bath’ (Figure 7)\textsuperscript{xxii}. The mill is recognisable in its current configuration on a tythe map of 1839\textsuperscript{xxiii}; hence it is concluded that the watercourses we see today were fully developed by that date. The layout of the mill shown by Thorpe is different to the current layout; the mill being ‘cruciform’ in plan as opposed to the ‘square’ we see today. The question is whether Thorp’s map shows an accurate or a stylised plan of the mill. The mill was leased by the Bristol Brass Company in 1721 and converted to a brass mill. It might therefore be expected that significant changes were made to the watercourses at this time; but it is known that watercourses were in existence before this date, variously powering a grist mill and fulling or tucking mill.

When Angerstein visited Saltford in 1754 he recorded twelve hammers in three workshops\textsuperscript{xxiv}. The arrangement of hammers at Saltford in 1859 was two banks of three hammers, implying that four waterwheels were in operation in 1754. But an alternative explanation is that the twelve hammers observed by Angerstein were in three banks of four implying that only three waterwheels were then in operation. Figure 13 shows the arrangements at Atsch Mill taken in 1905 which shows a bank of four hammers adding weight to this theory. When the mill was modified in the late 18\textsuperscript{th} Century to incorporate a rolling mill, six hammers were removed and two waterwheels were adapted to drive the rolls. If there were only three wheels in operation when Angerstein visited the mill, watercourse W2 could have been dug when the mill was adapted for rolling. One bank of four hammers could have been removed and the two remaining banks reduced to three hammers each. There are no
records of the watercourses having been modified since that date and based upon this and the cartographic evidence, it is assumed that the plan of watercourses we see today is the plan that existed in the late 18th Century.

The shape of the watercourses is also of interest: the western watercourses W3 and W4 sit on a common sweep of the leat implying a common date of construction; the eastern watercourse W1 sits of a separate sweep of the leat, implying a different date of construction; but watercourse W2 flows between the sweeps, it’s the head-race being on the western sweep and its tail race discharging into the eastern sweep. When the mill was adapted to house a rolling mill, some realignment of the wheels would have been necessary to enable two wheels to drive one set of rolls and this arrangement may be associated with that adaptation of the mill.

Other evidence that may give a clue to date of the watercourses is the presence of copper-slag in the construction of the leat walls and the design of the penstock gate mounting.

The culverts are constructed from a combination of local rubble stone and ashlar but copper slag has been used in the construction of the tail-race walls. Copper-slag was a by-product of the copper smelting process, the slag being a mixture of iron and silica which was discharged in a molten form from the reverberatory furnaces and hence which could be cast into building blocks. The presence of such material in the leat walls is evidence that they were repaired or modified when the brass company was smelting copper in the region. This would imply a date between 1721 and 1790, the focus of copper smelting having moved to Swansea by the late 18th century.

The mounting arrangements for penstock gates W2, W3 and W4 are very similar, being secured in ‘L’ shaped insets cut into stone lintels and held in place by wooden wedges, implying that they are of a similar date. The mounting arrangements for W1 is subtly different, being secured by iron bolts fitted in holes drilled through the stone lintel, implying a different date of construction.

**Western Watercourses**

It was evident that watercourses W3 and W4 were connected to the upstream head-race by culverts but what was not realised was that the culverts were actually a common subterranean chamber approx. 6m x 5.75m. The reasons for the construction of such a large chamber, which extends under the current dynamo room are not clear. The chamber was clearly constructed by the ‘cut-and-cover’ method. It may be that the area was originally open water but that the mill was extended and the leat covered by a shallow vault to increase the mill floor area and ease movement around the site.

**Eastern Watercourses**

Watercourse W1 served the wheel driving the upper roll of the larger ‘breaking-in’ rolls. Both the head-race and tail-race are culverted and the 2018 watercourse survey revealed evidence that both have been extended over the life of the mill, a number of discontinuities being observed in the culvert marking the divisions between older and newer structure. Mapping evidence (Figure 7 and Figure 8) suggests that the watercourse as seen today was fully developed by 1839 and hence by inference by the late 18th Century. It is assumed that the central part of the race is the original culvert which was extended once to the north and twice to the south.

The core of the culvert is 14.6m long, with the head-race extending 5.9m upstream of the penstock and the tail-race extending 4.8 m downstream of wheel. The tail-race has been extended by a further 6.6m to the north, the extension possibly being culverted when the two eastern annealing furnaces were constructed to provide a working floor in front of the furnaces. A discontinuity in the
head-race suggests that either the culvert has been extended or that at some point in time a secondary sluice gate was installed to enable repair work on the penstock. The discontinuity is in the bridge approach road and the head-race extends a further 4.25m to the south. The culvert extension may possibly have been built in conjunction with construction of the bridge. The head-race also shows that it was further extended by 1.7m to provide an enlarged apron for the approach to the bridge over the head-race providing access to the mill island. This was possibly required when a southern extension to the mill was built which can be seen on the earlier ordnance survey maps and older photographs of the mill, but which had been demolished in the 1920s.

**Watercourse W0**

Watercourse W0 was previously unrecorded. The watercourse runs SW to NE and extends for approx. 5m. The culvert is constructed from well-appointed masonry and so clearly had a defined purpose but that purpose is unclear. There are no records of a waterwheel being installed in the eastern part of the mill. Two possibilities are therefore that either: there was an earlier wheel (pre-1721) in the eastern part of the mill which was abandoned when the mill was adapted to become a brass mill; or the culvert housed a river sluice which was later moved to the southern end of the island.
Figure 5  Plan of Saltford Brass Mill – Laser-Scan Survey October 2018
Figure 6 Saltford Brass Mill Watercourses
Figure 7  Evolution of Saltford Brass Mill – 1742 to 1883

1742
Thorpe.  5 Miles around Bath

1839
Tithe Map

1883
Ordnance Survey
Figure 8  Evolution of Saltford Brass Mill – 1886 to 1932
Penstock Gates

The four penstock gates are all of similar, but not identical, design and it is interesting to note the subtleties of each. Prior to the surveys carried out between 2012 and 2018, the only drawing of the type of penstock gate used by the Bristol Brass Company held by the project was a small sketch on a plan of Keynsham Wire Mills dated 1828, reproduced at Figure 9. The sketch depicts the penstock as a single gate rising from the bed of the leat to above river level. The gate is mounted on a stock by which it could be raised or lowered from the working floor of the mill.

Penstock gate W2 was replaced in 1999, when the waterwheel was restored to operating condition, but no records were made of the design and operation of the gate, in particular those parts of the mechanism that were normally submerged. The gate unfortunately failed in 2012 when a panel of the gate broke free, jammed the waterwheel, and allowed the uncontrolled flow of water through the watercourse and across the wheel. A temporary coffer-dam was rigged upstream of the penstock to protect the waterwheel and repair the gate, which also provided an opportunity to investigate how the penstock worked.

The Saltford penstock gates were found to be more sophisticated than the 1828 sketch, as shown in Figure 10 and Figure 11. The Saltford penstock gates are hatches in a retaining wall and the penstock comprises fixed upper shuttering and a moveable lower gate or hatch. The hatch is secured to a stock which extends to the mill floor from where the gate is lifted or lowered by a rack-and-pinion. The hatch slides in two iron guide rails set into the masonry of the leat walls. The gate is angled at approx. 45° to the vertical to act as a nozzle to accelerate the flow of water as it passes through the penstock and direct the flow onto the wheel. The Saltford wheels are all undershot and this arrangement highlights the principle of operation of such wheels whereby the potential energy of the water retained in the head-race is converted to kinetic energy as it passes through the penstock before acting by impulse on the wheel.

Figure 9  Drawing of a wheel at Keynsham’s Avon Mill. 1828
Figure 10  Penstock Gate W1

Figure 11  Penstock Gate W2
Penstock Hatches

The hatch in penstock W2 is 1.8m high x 1.2m wide and, as restored in 1999, was 30mm thick. A number of older penstock gates are displayed in the mill, inspection of which revealed that at the start of life the thickness of those gates had been between 35mm and 45mm; hence significantly thicker than the hatch installed in 1999. The ageing mechanism was erosion of the upstream face by the flow of water over the hatch leading to thinning of the material and ultimately leakage at the weak-points of the joints between the timbers. The thickness of the timber at the start of life was over-engineered to provide a significant margin for erosion. The penstocks would therefore leak-before-break; hence there would be warning of an impending failure and the likelihood of unexpected catastrophic failure was low. By selecting thinner material for the replacement 1999 gate, this margin did not exist which accounted for the experienced failure. The hatch was patched in 2014 and replaced in 2016 with timber 36 mm thick. Since that date, the hatch has been routinely cycled to enable operation of the waterwheel on open days. The hatch was inspected in 2018 when the mill was de-watered and showed minimal evidence of degradation.

Penstock W1 slowly deteriorated between 2012 and 2018 by which time there was considerable leakage through the hatch and there was concern that the gate would fail. Dewatering of the mill enabled the gate to be replaced. After de-watering, the hatch timbers were found to have been originally 50 mm thick and although there was significant leakage through the tongued-and-grooved joints, the hatch itself retained significant strength and was not in danger of failing. In 2018, the gate was replaced using greenheart timber 45mm thick. The gate is now routinely cycled to prevent silting.

Penstock W3 had been removed around the time that operations as a brass mill ceased, possibly in the 1920s when the squash court was constructed, however the guide rails, fixed shuttering and mounting arrangements for the operating gear remain in-situ enabling comparisons to be made with the other penstocks.

Penstock W4 is of similar design to W1 and W2 but is constructed from iron not timber. The rails in which the hatch slides and the hatch lifting mechanism are identical to W2 and W3 and spacer pieces have been fitted to the hatch to align the thinner iron structure with the guide rails and operating gear. It is concluded that the gate was originally timber but was later replaced with an iron structure. This could either have been in the 1880s when attempts were made to modernise the mill or in the late 1920s as part of Butler’s modification of the mill.

Fixed Shuttering

The fixed shuttering of the four penstocks is again similar but with subtle differences. The shuttering in penstocks W1, W3 and W4 are iron but the W2 breast wall is timber. The reasons for this difference in construction is not evident.

Stocks

The stocks are also similar but with subtle differences. The W1 stock is a single piece of timber extending from the foot of the gate to above the working floor of the mill (Figure 10). The W2 stock is a constructed from two pieces of timber connected near their mid-point by an overlapping butt-joint just above the hatch (Figure 11). The ends of the timbers are shaped to create a swan-neck. The W4 stock is similar to W2 but constructed from a steel 'I' beam, shaped to create a swan-neck.
Inspection of the stock shows that it would have originally been a timber stock similar to W2 but replaced by a steel beam requiring spacer pieces to enable it to align with the operating mechanism.

**Waterwheels**

The mill contains substantial remains of waterwheels in watercourses W2 and W1 - the rolling mill watercourses. The wheel in watercourse W2 is operational and drives the 1928 dynamo. The remains of the second wheel are in-situ in watercourse W1, albeit only the axle and parts of the wheel’s spokes survive. Four waterwheels were recorded in an inventory dated 1859\textsuperscript{xxvi}, all being described as ‘15ft x 3ft 6in. dia. wood shaft and gearing’. Wheel W1 has an iron axle and timber spokes. W2 is an iron wheel, 18ft dia. with wood being used for alignment wedges in the hub and starts for mounting the paddles only. These would appear not to be the wheels recorded in the 1859 inventory. The fact that the two wheels are different diameters and of different construction suggests that they were not used as a pair to drive the rolling mill; it would be expected that the two wheels driving the top and bottom rolls of the mill would be the same size. It is assumed that remains of wheel W1 are the remains of the wheel that drove the upper roll of the larger rolls in the mill’s final years of operation as a brass mill and that wheel W2 was either moved from another position in the mill or brought in specially to drive Butler’s dynamo in 1928. One possibility is that wheel W2 was originally in watercourse W4 and is the wheel that was installed in 1881 to drive the modified battery mill. Those modifications were unsuccessful and so by 1928, although the wheel would have been 47 years old it would have had very little use.

**Battery Mills**

**Battery Mill No 1**

Battery-Mill No 1 is shown as intact on the 1903 OS Map but had been demolished when the survey was undertaken for the 1930 OS Map, presumably demolished by Butler in the late 1920s to enable the widening of the Shallows lane.

Joan Day describes in ‘Bristol Brass’ how a new set of hammers were installed at Saltford in 1881\textsuperscript{xxvii}. The hammers made greater use of wrought and cast iron in their construction but without the elasticity of the timber frame and helves the vibration was excessive and the new hammers were abandoned in favour of the older timber construction. Two iron-beams are installed as lintels over the window adjacent to the extant annealing furnace, the examination of which indicates that they have been reused from another purpose, possibly the unsuccessful modifications of 1881.

A few years later a more successful alteration took place in which the 15ft (4.6m) waterwheel was replaced by an 18ft (5.5m) wheel, the timber drive shaft was replaced by a hexagonal cast-iron shaft and new cast iron cog-wheels were installed into which were mounted wooden cams. The waterwheel turned at 18 rpm driving three cog-wheels, each with 20 cams so delivering 6 blows per second per hammer! A partly exposed cam-wheel is buried on the road-side in the Shallows Lane outside the battery-mill No 1 acting as a protective bollard. It is conjectured that this is part of the modifications carried out in the later 1880s.

The exposed axle-bearing mounts of waterwheels W3 and W4, their position in relation to the penstock gates and score marks in the leat walls indicate that these fittings relate to the two 15 ft wheels recorded in the 1859 inventory. The position of the opening for the shaft driving into battery-mill No 2 is such that it could not have accommodated the larger wheel. There are also problems interpreting the modification within battery-mill No 1 as the exposed waterwheel axle-
bearing mount and penstock gate could not have accommodated the larger wheel. But possible clues are an additional bearing-mount located slightly down-stream and above penstock W4. It is possible that a second axle bearing was installed 0.9 m above the earlier bearing and 0.9m further downstream to accommodate the larger wheel. The larger wheel could be the wheel now in watercourse W2 driving the dynamo – this would have been the best of the four wheels existing in 1925, relocated following demolition of battery-mill No 1. The drive would need to be translated 1m upstream to be accommodated in the existing mill structure; necessitating either a geared-drive or a chain-drive. Both types of drive are known to have been employed at Saltford Mill and Keynsham, Avon Mill. Evidence of heavy gearing is provided in photographs of the rolls at Avon Mill and the dynamo at Saltford Mill is driven by a chain-drive.

Battery Mill No 2

The walls of Battery-Mill No 2 remain intact but construction of Butler’s squash-court removed all evidence of brass-production machinery. By the time that Joan Day had published ‘Bristol Brass’ in 1973xxviii, she had determined what the battery-hammers looked like but the exact location within the mill had not been fully established. More recent research has now determined their location, size and form, drawing-together a number of pieces of evidence. Joan published a reconstruction of a set of battery hammers in ‘Bristol Brass’ as described to her in the late 1960s by Tom Shellard who had worked in the mill as a boy before the World War 1 [Figure 12]. The orientation of the hammers place this as the set of three hammers in Battery Mill No 2, later occupied by the Squash-Court and driven by waterwheel W3. Joan’s later research uncovered a photograph of a set of battery hammers in operation in Atsch Mill, Stolberg near Aachen in Germany. The photograph [Figure 13], taken in 1905, was given to Joan by Dr Karl Schleicher and published in her 1984 paper, ‘Continental Origins’xxix. The battery hammers are believed to be very similar to those installed at Saltford.

The squash court has covered all evidence of the hammers within the mill but in 1985 an archaeological excavation revealed the head of a pile beneath the squash court [Figure 14]. The location of an axle bearing of waterwheel W3 remains visible external to the mill and the score marks in the W3 leat wall are also consistent with a 15ft diameter wheel, correlating with the 1859 census. The drive-shaft opening, location of the penstock gate and inspection hatch are all visible external to the mill. From this evidence, the location of the drive-shaft within battery-mill No 2 has been determined.

In ‘The Art of Converting Copper into Brass’ [1749/1764]xxx, Galon provides a very detailed description of the battery mills he observed in Namur, including dimensions, method of construction and speed of operation. Galon observed that:

“It is known that before 1695, all brass at Namur was beaten by hand and that this year saw invention of Battery Mills driven by water. The first of these mills was established on the R. Meuse and its inventor was given exclusive privilege”.

It was such battery mills that Abraham Darby must have observed on his journey to continental Europe c.1705 (Day, 1984)xxx and hence the technology that he brought back to Bristol. Galon provides an accurate and dimensioned drawing of the battery-hammers at Namur, reproduced at Figure 15. If we overlay Galon’s drawing on the plan of battery-mill No 2, aligning the axle with the extant waterwheel bearing mount and placing the outer hammer on the position of the excavated pile beneath the squash court, we get a very close fit [Figure 16].
In 2017, a hammer-head was uncovered in the in-fill of an arch close to the extant annealing furnace. The hammer-head is made of iron and weighs 10 kg (22 lb). This would have been one of the heads in use when the battery ceased at the mill in 1908.

Based upon this evidence, a full-size reconstruction of a single battery hammer has been erected and installed in the squash-court / battery-mill No 2 to portray to visitors the nature of operations undertaken in the mill [Figure 17].

Figure 12   Artists impression of Battery Mill No 2 as described to Joan Day by Tom Shellard
Figure 13  Battery Hammers at Atsch Mill, Stolberg near Aachen, 1905

Figure 14  Archaeological Excavation, Battery Mill No 2, 1985
Figure 15  Two sets of battery hammers - The Art of Converting Copper to Brass – 1749

Figure 16  Overlay: Modern Plan of Saltford Mill, Archaeological Excavation and Galon’s Plan
Operation of the Hammers

With regards to the speed of the hammers, Joad Day estimated that the waterwheels turned at approx. 12 RPM with 20-30 cams on the drive shaft delivering 200 to 400 blows per minute\textsuperscript{xxxii} (3 to 6 blows per second). Galon describes the waterwheels at Namur turning at 17½ RPM with 13 cams on the drive shaft delivering 225 blows per minute (just under 4 blows per second) with a lift of approx. 5mm. Written notes left by Alfred Davies, the last manager of the mill, and his cousin Ethel Davies provide further evidence. Alfred Davies recorded that:
(At Keynsham) the height of fall of water averaging about 7’ 2”. Speed of the wheels about 18 to 19 revs per minute under fair load.

Ethel Davies also produced a sketch of the battery mill at Saltford, reproduced at Figure 19, with the note:

(sketch) showing roughly the method of making the pans. Flat discs of brass were revolved by hand under the powerful hammers in such a way as to dish up the flat plate into a pan with steeply sloping sides and a flat rim. The last battery to operate was at Saltford. The last pans to be made in Britain by this process were made in 1908. The earlier hammers struck 360 powerful blows per minute. 3 hammers.

The action was therefore one of rapid blows rather than a slow, heavy, pounding; a contemporary account of working the brass describing the process as more akin to a potter working clay than a smith forging iron. The replica hammer at Saltford has 20 cams on the drive shaft and we estimate the speed to have been between 12 and 18 RPM giving a striking rate of 4 to 6 blows per second. By comparison, the wheels at Finch Foundry at Sticklepath in Devon turned at approx. 15 RPM, with 16 cams on the stecling hammer drive shaft delivering 4 blows per second.xxxiii

Figure 19   Sketch of the Battery Mill at Saltford – Ethel Beatrice ‘Daisy’ Davies

Rolling Mill

As recorded in the 1859 inventory, the rolling mill was powered by two 15ft waterwheels driving two pairs of rolls and three pairs of shears. The rolls were not installed when Angerstein visited the mill in 1754, which gives rise to three questions: when were the rolls installed, what was the driver for converting part of the mill from battery to rolling and where were they located within the mill?
**Dating of the Rolls**

The date at which the rolls were installed in Saltford Mill was clearly later that 1754. Angerstein also records that rolling and slitting was taking place in Keynsham (Avon Mill) by that date; hence the technology was available to the Bristol Brass Company. A plan of Avon Mill dated 1828 shows four sets of rolls but these are all have narrow beds, between 2 ft (0.6m) and 3 ft 6 in (1m), clearly optimised for rolling strip metal as a precursor to wire drawing. It is assumed that the conversion of the two sets of battery hammers in Saltford to a rolling mill took place c.1765. A key question is what occurred around this time which created a demand for broader sheets of copper or brass. A possible answer lies in need for sheet metal to sheave ships engaged in the triangular trade and naval ships built in Bristol which were required to stay on station in the West indies for long periods on time.

**Location of the Rolls**

Tom Shellard described to Joan Day that in the early twentieth-century the two sets of rolls were powered by waterwheels W1 and W2. Each set of rolls was two-high and set one behind the other. One set of rolls was more powerful, being described as ‘breaking-in’ rolls, used for early passes of new material, and the second set of rolls were ‘finishing-rolls’ used to produce a fine surface on finished materials. Tom Shellard reported that the rolls could not be used at the same time but had to be set-up for one operation or the other.

There are a number of pieces of physical evidence with the mill: the remains of waterwheel W1 are in-situ, albeit slightly displaced which must have occurred when the wheel was lifted off its bearings and the drive-shaft arch bricked-up, presumably as part of the Butler conversion; a timber bed-plate for the bearing pedestal for wheel W1 also remains in-situ. This is a 1m x 0.3m x 0.3m timber block mounted on a timber foundation, itself mounted on a stone wall foundation; a wheel-pit exists adjacent to waterwheel W1 and the mill-side of the leat wall; waterwheel W2 remains in-situ, but noting the current wheel is a larger 18 ft wheel, not the 15 ft wheel recorded in the 1859 inventory, possibly moved from position W4 as part of the Butler conversion; a second timber pedestal bearing mount exists, opposite waterwheel W2 drive-shaft but on the waterwheel W1 side of the mill; two lifting-eyes remain in-situ, mounted in a heavy box-structure framework inserted into the roof adjacent to waterwheel W2. This is clearly a modification to the roof structure which has required the cutting and adaptation of the original king-post roof (it is postulated that the lifting-eyes were to enable the upper roll to be lifted in preparation for a first pass of a new slab of material); and a drawing and photographs exist of a similar arrangement in Avon Mill, Keynsham, a detail of the drawing being reproduced at Figure 20.

Based upon this evidence, it is concluded that the ‘breaking-in’ rolls were driven by waterwheels W1 and W2. Wheel W2 would have driven the lower-roll directly. Waterwheel W1 would have driven the upper-roll, but via a large reversing gear running in the wheel pit, similar to the Avon Mill arrangement. The spacing of the lifting-eyes suggest that these were the 5 ft 6 in ‘breaking-in’ rolls. Based upon the photographic evidence, a replica of the rolls has been constructed to provide visitors with a visual interpretation of the arrangements within the mill.
Figure 20  Avon Mill Rolls – 1828

Figure 21  Avon Mill Rolls – c.1925
The second set of rolls are more problematical. There is no evidence remaining of the bed-plates for the rolls. One possibility is that the finishing rolls were driven from one waterwheel only, waterwheel W1, in a similar manner to the smaller set of rolls at Avon Mill. The upper and lower rolls could have been driven by a single wheel, with one roll been driven directly and the second via an integral reversing gear. This would have ensured that the two rolls operated at a synchronous speed, necessary to produce a flat plate. If this were the arrangement, a square drive would be expected on the end of waterwheel W1’s axle. This is not the case but this may be because the drive was sawn off as part of Butler’s modifications.

Annealing Furnace

The annealing furnaces at Saltford Mill are well documented. Photographic evidence shows in the early twentieth-century there were four annealing furnaces, one associated with each of the battery-mills (furnaces No 1 and No 2) and two associated with the rolling mill (furnaces No 3 and No 4). Furnace No 2 remains essentially intact, appearing as it would have looked when last fired in 1925 (Figure 23).
The most significant element of reconstruction is the inner muffle which had been removed before 1970, presumably in the 1920s. Furnace No 2 bears a strong resemblance to a furnace described by Angerstein as existing at Keynsham in 1754:

*The annealing furnaces are fired with wood but the ones for sheets are fired with pit coal place in two narrow fireplaces on either side of the hearth as shown in (the) attached drawing (Figure 24)*

The annealing furnaces at Keynsham shown on a plan of Avon Mill dated 1828 are free-standing, as shown in Angerstein’s sketch. The Saltford furnace is built within its own hood and chimney, but the elements of the furnace as essential as described by Angerstein, being a freestanding muffle located within a firebox with two hearths, one on either side of the muffle. No definite date of construction is known for the Saltford Furnace, but the similarity to Angerstein’s description shows that the Bristol Brass Company were aware of the technology by 1754. Nehemiah Champion, a partner in the Bristol Brass Company, had patented a method of annealing brass in 1723. This involved placing the brass inside containers which were sealed with clay to protect the metal from the harmful sulphur fumes from the burning coal. This was a pre-cursor to the furnace described by Angerstein, but not the same. William Champion is known to have built the two similar furnaces to that at Saltford at Kelston in the late 1760s. We can therefore postulate a date between 1750 and 1760 for construction of the Saltford furnace.
One aspect of the furnace which has come under additional scrutiny is a small auxiliary oven in the side of the furnace. The auxiliary oven backs onto the fire-box and was at one-time fitted with its own lifting door. Earlier interpretations were that this was a food oven, taking advantage of the high temperature generated in the main furnace. The annealing effect requires the temperature of the brass to be raised to between 650°F and 700°F (340°C to 370°C) which is too high for cooking! In 2015, Dr Stephen Birkett, Associate Professor in the Department of Systems Design Engineering, University of Waterloo, Ontario Canada visited the mill as part of his research into 18th century wire-drawing techniques. Stephen is an experimental archaeologist who replicates engineering processes in order to restore harpsichords and pianos. Stephen postulated that the side-oven could be a means of measuring the amount of heat applied to the metal undergoing the annealing process. People working with ceramics will be well aware of the use of pyrometric cones to control the firing of pottery or porcelain wares. Josiah Wedgewood experimented with methods of measuring firing temperatures in the 18th Century using the shrinkage of fired porcelain as a measure of heat input. Wedgewood was elected to the Royal Society in 1782 for his work to create accurately scaled pyrometric beads which could be used for this purpose. Could something similar have been adopted for measuring annealing heats and temperature? It would have been important not to open the main furnace door during the annealing process as this would have lost valuable heat and also created a temperature gradient across the furnace resulting in uneven annealing of the metal in the furnace. There is no evidence of what material might have been used in the auxiliary oven, but if the postulation is correct it may have been a clay or a metal which changes its characteristics when fired.
A third aspect of the Saltford furnace of note is the turntable shown in Angerstein’s sketch. Tom Shellard described such a turntable as existing at Saltford. A bearing mount is sunk into the floor in front of Furnace No 2 within an equivalent bearing mount in balance-beam support above it. There is also an alcove built into the wall adjacent to the furnace into which a turntable could move. The turntable is a key feature of the annealing furnace. It would be important to have the door of the furnace open for a short a time as possible to prevent a temperature gradient being created across the furnace. There is therefore clear evidence of such a turntable have being used in conjunction with Furnace No 2 and a replica has been constructed to demonstrate its operation to visitors to the mill (Figure 26). A similar alcove was observed by BIAS members when a survey of the battery-mill No 1 was conducted in 1976. Bearing mounts also exist in the timbers that were recovered from the front of Furnace No 3. It therefore appears that each of the four furnaces was serviced by a turntable.
Industrial archaeology carried out at Saltford Mill over the last decade has emphasised that the site is much more than an interesting precursor to the industrial revolution. Re-evaluation of the artefacts in the Saltford Brass Mill Project’s collection shows that the driver for the foundation of the Bristol Brass Company was the supply of brass products to Bristol based Merchant Venturers engaged in the trade with West Africa, including Guinea Kettles, Lisbons and Manillas. The Africa Trade dominated through the 18th Century and Saltford was a key site within the brass company’s portfolio, continuing in operation from the leasing of the mill in 1721 until the company ceased trading in 1925. After the abolition of slavery in 1807, the company’s fortunes changed considerably and throughout the 19th and early 20th Centuries a much-diminished company focused on domestic markets. The company changed hands a number of times in this period but continued to trade as the ‘Harfords and Bristol Brass Company’.

Conclusion
In its life, Saltford Mill was subject to many innovations. In the 1720s, the mill was adapted from a grist mill to become a water-powered brass battery mill employing high-speed hammers. Such hammers were a new invention; having being invented in 1695 for use on the River Meuse in the Low Countries. It was this technology that Abraham Darby brought back to the Avon Valley. Evidence can be seen of how the mill was modified to accommodate multiple waterwheels, initially driving twelve hammers, as observed by Angerstein in his travel journal of 1754, and later modified again to reduce the number of hammers to six and introduce two sets of rolls. The introduction of rolls was probably in response to the demand for sheet metal to sheave Bristol built ships engaged in trade in the Atlantic to protect them from attack by the teredo navalis ship-worm. The introduction of rolls may have required the digging of an additional leat through the mill.

In addition to the exploitation of power from the river, the mill shows evidence of advances in metallurgy, with the annealing of beaten brass, and the early use of coal for industrial processes recording the onset of our love affair with fossil fuels. The annealing furnace shows evidence not only of how the material being annealed was protected from the harmful effects of sulphur but also how the temperature in the furnace was monitored and how the loading and unloading process was improved by use of a turntable to reduce heat loss and maintain a uniform temperature across the furnace during successive firings.

With the decline of the industry there were little if any changes to the mill in the early 19th century. The cartographic evidence therefore indicates that configuration of the mill as seen today has been little changed from the late 18th century.
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