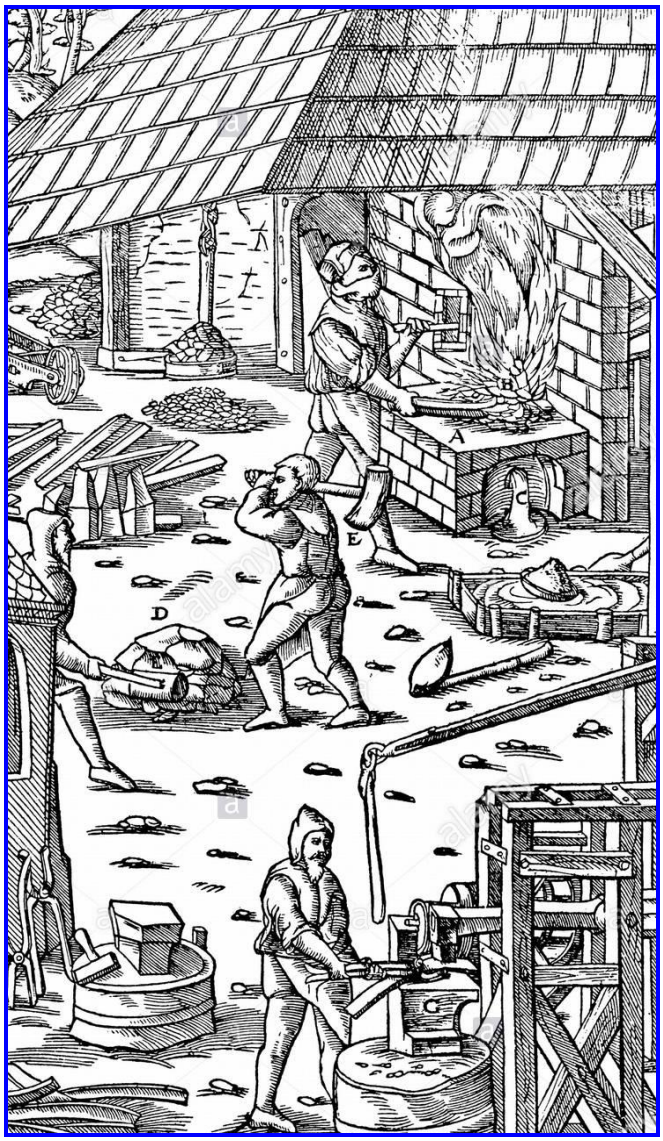
IRON ORE MINING AND SMELTING AT STAUNTON HAROLD



AGRICOLA "DE RE METALLICA BASLE 1556 WOODCUT"

- Smelting iron in the Bloomery Furnace at A whilst operating the hand bellows
- Slag being released at C
- Hammering the white hot bloom to produce solid metal at D
- Hammering out bars with a mechanical hammer at G

BY SAMUEL T STEWART

PREFACE

Although limited information is available, it was felt by the author that this important discovery relating to local industrial history over 400 years ago should be recorded, as other interested parties may wish to seek permission to carry out further investigatory work.

IRON

Iron has been produced since the Iron Age, when men found that the metal was stronger than bronze for use in tools and weapons. It was probably first discovered when someone used ironstone rocks to surround a fire and afterwards found blobs of melted iron. The colour of the mineral is a quite distinctive red or orange and this makes it easy to find and mine. Processes for extracting the iron from the ore developed over the years and the generic term for this is "smelting".

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The following information is transcribed from a difficult to read lease held within the Shirley papers at the LL&RRO & dated August 7th 1624:-

In 1624, Sir Henry Shirley, 2nd Baronet, who married Dorothy Devereux, the daughter of the Earl of Essex, leased to ***John Wenham the elder of Battle, Sussex*** *for three years at £40 per annum, all that furnace, finary and blomary for iron work at Staunton and all ponds, pools, dams, water-courses, streams and floodgates, and all the right to dig ironstone at "****Cotton's Gate****" in the lands called "****Two Lounts****" at Staunton. Shirley agreed to provide the necessary buildings, tools and equipment, including the bellows, and also supply the lessee with wood for charcoal production.* ***More importantly coal mined on the estate was available to produce coke to fuel the iron ore smelting process, and this is referred to in the agreement also.*** *The wording of the lease clearly confirms that the mining of iron ore and subsequent smelting of it was already taking place at that time.* ***In the lease, John Wenham is described as a "Wealden Ironmaster", who was forced to move his business to Staunton because of a shortage of wood and charcoal used in the smelting process in that area.***

Presumably Sir Henry Shirley, 2nd Baronet, foresaw the potential to increase production using John Wenham's expertise.

The Wealden iron industry was located in the Weald of south-eastern England. It was formerly an important industry in the area, producing a large proportion of the bar iron made in England in the 16th century and most British cannons until about 1770. Iron making in the Weald used ironstone fuelled by charcoal made from trees in the heavily wooded landscape. The industry in the Weald declined when iron making began to be fuelled by coke made from coal, which did not occur accessibly in that area, but was readily available in the Midlands from where the competition first arose from c.1610 when coke produced from coal replaced charcoal to fire the iron ore smelting furnaces.

Shirley's coal mines had the capacity to produce up to 18,000 tons of coal per annum at that time, which is remarkable. Henry Shirley inherited from his father Sir George Shirley, 1st Baronet (1559-1622) who had invested heavily in coal mining. The following is an extract from a lease held at the LL&RRO (26D53/512), which demonstrates his investment:-

This indenture made on 23rd April 1606 between George Shirley of Staunton Harold in the County of Leicester and William Wallis of Staunton, aforesaid Yeoman, John Yeomans of Melbourne from Derby, Yeoman, and William Holmes of Staunton, aforesaid collier. George Shirley gives leave to William, John and William their executors or administrators to erect and build in Staunton, six houses for six colliers……..

GEORGE SHIRLEY, 1ST BARONET (1559-1622)

George Shirley, 1st Baronet (of Astwell, Northamptonshire), was the son of John Shirley of Rakedale (Ragdale) Leicestershire, and Jane Lovett. John Shirley had died in 1570 before his father Francis, thereby leaving Francis' grandson George to inherit the title together with Staunton Harold and the other estates in 1571, plus Astwell (on the death of his Lovett grandfather) in 1586. George studied at Oxford University (Hart Hall) from 1573. After a number of years in education, including being at Gray's Inn in 1602, he served as Sheriff of Leicestershire c. 1603. **He was made a Baronet in the first institution of that dignity in May 1611 and was buried with his father at Breedon on the Hill in 1622.**

George married a lady by the name of Frances Berkeley 1587, daughter of Henry Lord Berkeley, with whom he had four sons (including the eldest Henry), two of these dying as infants. His second marriage was to Dorothy Wroughton but there was no issue.

Like many others of his contemporaries, he made sure of his monument in his lifetime, and raised the fine two storied alabaster memorial of himself in Breedon Church.

It appears from accounts of 1592-1595 that he invested in Staunton with rich furnishings and tapestry. The accounts details show how these elaborate furnishings were done actually on site, and portray a manor house now contrasting greatly to its neglected condition in 1517. It has been suggested that George Shirley may have been responsible for the enlargement of the Elizabethan manor house at Ragdale in the reign of James I, with the substitution of red brick as a building material, in the place of timber. The authors view is that the main enlargement of the manor house should be attributed to his son Sir Henry as 100,000 bricks were delivered to Ragdale four years prior to his death in 1633 (Stemmata Shirleina).

The arms of George Shirley were confiscated for about four years on suspicion of his involvement with the Catholic religion, although outwardly appearing to conform to the teachings of the Church of England. He appears to have died a Catholic.

HENRY SHIRLEY, 2ND BARONET (c.1588-1633)

George Shirley, 1st Baronet, was succeeded by Henry Shirley 2nd Baronet, his eldest son, who married Lady Dorothy Devereux (d.1636), who was the youngest daughter of Robert Devereux, the 2nd Earl of Essex. They were married at the church of St. Lawrence Pountney, London. Henry was one of four children born to his father George and his wife Frances Berkeley. Henry's oldest and youngest brothers George and John respectively, died as infants. His surviving older brother Thomas Shirley was born 1590 and died in 1654. He was recorded as living at the manor of St. Botolphs Bridge, Huntington. In 1628, Henry was a prisoner in the Fleet for scandalizing the Earl of Huntingdon. In 1633, the year of his death, he was busy rebuilding the manor house of Ragdale in Leicestershire, an estate inherited from the Bassett family by marriage with the Shirleys'. **Sir Henry was a great lover of genealogy as well as heraldry; as by his directions, the fine family pedigree (formerly preserved at Staunton Harold Hall) was completed in 1632.**

In the Derbyshire Archaeological Journal "The Charcoal Iron Industry in the East Midlands 1580-1780" by Philip Riden, he writes:-

……***At the opposite end of the region, a furnace was in use on the Shirley estate at Staunton Harold by 1606, if not earlier, which in 1624 was leased to John Wenham of Battle, Sussex, apparently the only instance of Wealdon investment in the east midlands iron industry.***

The continuing vitality of the East Midland iron industry is also illustrated by attempts to smelt the rather thinner ores of the south Derbyshire coalfield. A fumace at Hartshorne is mentioned in 1699 and 1702 but described as disused by William Woolley in l7l2|8. Another at Melbourne is first documented in 1735 and the Staunton Harold furnace is included in the list of those closed between 1750 and 1787.

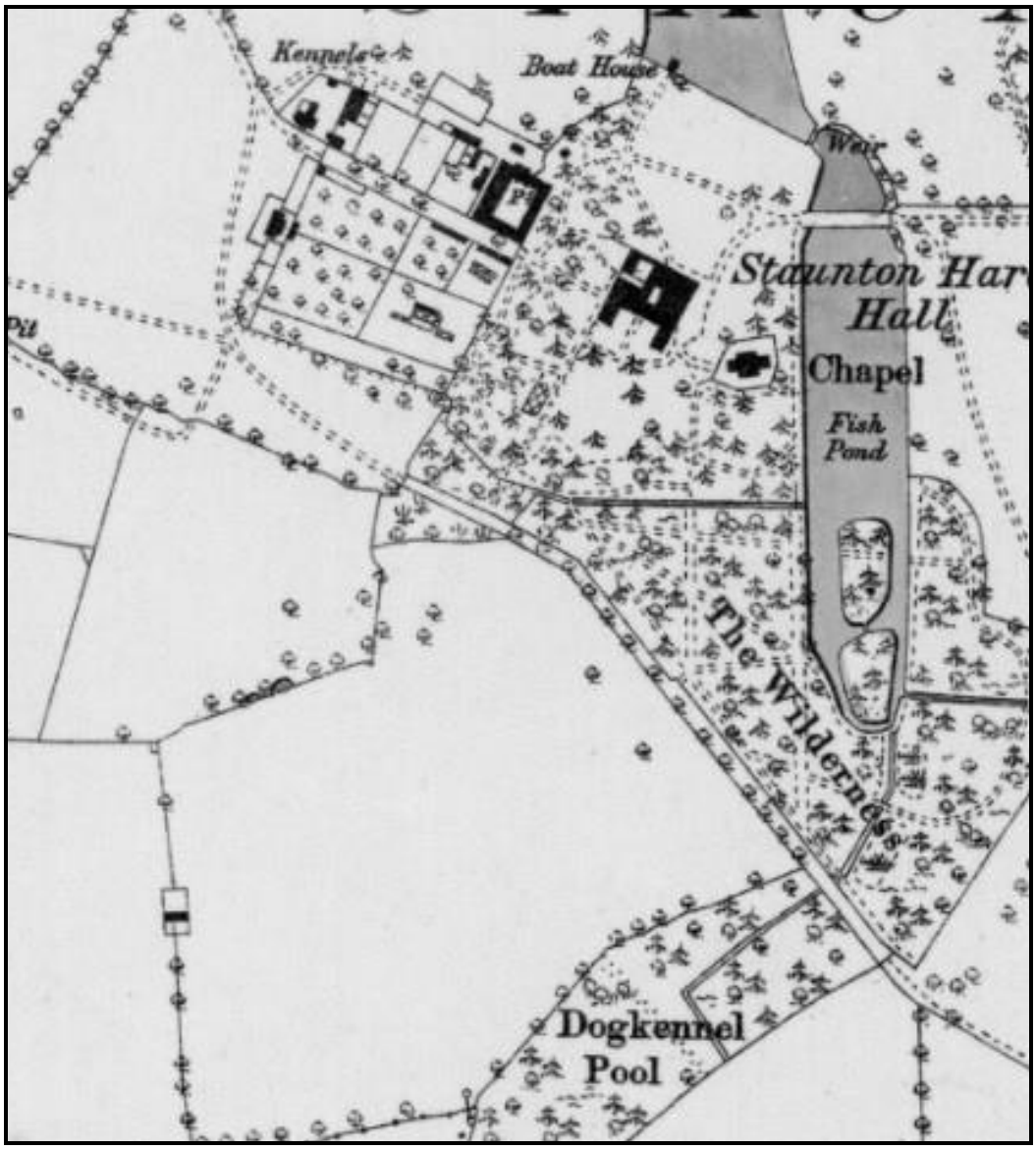
By the mid 17th century, the earliest iron works in the east midlands appear to have been abandoned. By 1790, 90% of British pig iron was smelted with coke. 8 local sites appear in a list of furnaces closed between 1750 and the 1780's either for want of fuel or because of the introduction of coke-fired smelting. Of these Toadhole, Hartshorne and Staunton Harold have virtually no other recorded history.

Iron ore extraction was probably done by digging a series of pits about five metres in diameter and up to twelve metres deep with material being winched up in baskets suspended from a wooden tripod. This was less destructive of the land as spoil from one pit could be used to backfill the previous pit allowing continued land use and not disrupt the view from the manor house too much.

The presence of iron ore within the clay measures in the area is still confirmed by the fact that brown / orange coloured water still flows out of the ground now.

Water power became important with the introduction of blast furnaces and finery forges in the late medieval period. Blast furnaces needed to operate continuously for as long as possible and a series of ponds were often created in a valley to give a sustainable flow for the waterwheel. A campaign, as the production run was known, usually ran from October through to late spring when streams began to dry up. Finery forges with three or four waterwheels to drive bellows and hammers needed more water than a furnace at times, although continuity was not as important. They tended to be sited downstream from a furnace if they were in the same valley. Ponds were created by building a dam known as a pond bay.

Following field walking research carried out at Staunton Harold, with permission of the land owners, remarkable finds were made with regard to the statement in the 1624 lease referring to …… "*ponds, pools, dams, water-courses, streams and floodgates*".



Extract from 1885 O/S map

The remains of what is thought to be a dammed furnace or hammer pond was located in the area of Dogkennel Pool shown on the above map. This would have been fed by two streams from the south west, and the mill race and water wheel driven furnace bellows or hammers would have been situated at the opposite right hand corner of the pond. A millrace or millrun describes the current of water that turns a water wheel, which was controlled by sluice gates. The remains of the sluice gate, shown in the following photographs would have controlled the level of water in the mill pond by released excess water into the adjacent brook which ran alongside the mill pond.

SUPPLEMENTARY INFORMATION ON HAMMER AND FURNACE PONDS

The water in a Hammer Pond was used to drive the water wheel which provided power to the hammers in the forging process, whereas the Furnace Pond supplied the water power to drive the water wheel which operated the furnace bellows. The ponds would be located close to each other but were dependent on the layout of the site, and the design for the water supply would have been virtually identical.

Clay dams, were built around the ponds to contain the flow of water from existing streams and the Furnace or Forge buildings were therefore sited below the water level, thereby providing increased pressure to drive an over shot water wheel.

Over time, there would be a build up of silt reducing both the flow and storage capacity of the ponds. What were known as Feeder Ponds were often constructed upstream to provide an emergency top up for the main pond.

Water shortages would have halted production and have had the effect of destroying the furnace also. If the temperature of the fire reduced to a level where the iron inside solidified then the whole furnace would have had to be taken apart and re-built.

Smelting in Blast Furnaces would have been concentrated from October to March say, when water supplies were plentiful. Forges demanded a plentiful supply of water also, but the process was not continuous, which would have given the ponds more time to refill.

The above photograph shows the furnace or hammer pond sluice gate walls at the side of the brook, Note the accurately dressed radius on the ends of the stones.

This photograph shows one side of the two grooves which the sluice gate ran in. The wooden sluice gate would have been raised and lowered by the operator to control the amount of water in the pond with any excess being allowed to flow into the brook adjacent to it.

We were extremely fortunate to discover two examples of what are lead key plates, as shown in the above photograph. Holes were drilled in the ends of the large stones and these were laid in the appropriate position next to each other with a gap in-between the faces.

Molten lead was then poured into the gaps which flowed into the holes and formed a non-corrosive key plate. This helped to prevent movement of the stones, and also to seal the gaps to prevent any excess seepage of water.

This lead would have undoubtedly been mined and smelted on the Staunton estate at Dimminsdale lime and lead quarries nearby.

SUPPLEMENTARY INFORMATION ON THE BLAST FURNACE & FINERY FORGE

As a "Finary" is mentioned in the lease, this confirms that a form of blast furnace was being used there at the time to produce the "Pig Iron" although due to the terrain it was not possible to carry out any further investigation, and much more work needs to be carried out as the author feels that more important evidence would come to light.

The first record of a Blast Furnace in Britain is in 1496, when they were introduced into the Weald. They began to spread to other parts of the country during the 1550s and many were built thereafter. The Blast Furnaces made pig iron from iron ore and the basic principle was similar to that of the bloomery furnace in that oxygen was removed from the iron oxide by carbon monoxide from burning charcoal.

A "charge" of iron ore, coal and limestone was poured in from the top and heated and dried by the hot gases being blown through the furnace by water wheel driven bellows from below. Lower down, the iron ore melts as the carbon starts to burn and from just below the middle of the furnace, molten iron drips down through the remaining fuel onto the hearth at the very bottom of the furnace. In the lower part of the furnace, the limestone acts as a flux and draws together many impurities together into a layer of slag. The air blast from the bellows is introduced a little way above the hearth and must be strong enough to stop the burning contents of the furnace stack dropping into the hearth but also not be so strong as to blow the contents out of the top. The slag is the lighter material so it floats on top of the molten iron and was drained through a hole called the "slag notch" by knocking out a clay plug. The molten liquid iron was removed in a similar manner by the removal of a plug in the "tap hole" at the bottom of the furnace where it poured into a receiver in the ground filled with sand into which hollow moulds had been formed which formed the pigs of iron after it had cooled. In the larger furnaces, several pigs were cast together forming what was known as a sow.

The blast furnace was more efficient than a bloomery because it permits continuous production. The furnace remains in operation throughout, with slag and metal being tapped off as required and more iron ore, limestone flux and fuel being added as necessary. The process also permits the scaling of the furnaces to almost any size, the larger furnaces giving even greater improvements in efficiency. Early furnaces were usually located on sloping ground, close to a stream. Water was used to drive the early bellows via a water wheel to create the draught, while the slope helped to provide a near level roadway onto the top of the furnace. Early blast furnaces used charcoal as the fuel.

From the 15th Century, finery forges were introduced that used pig iron to produce bar iron. They consisted of two hearths. In the Finery Hearth, a Finer used charcoal to burn the carbon off the pig iron, producing a bloom. This was then consolidated using a water wheelpowered hammer. It was then placed in the Chafery Hearth, where a Hammerman used either charcoal or coal to reheat the bloom and then beat it with a hammer to drive the molten slag out of it. He then drew the bloom out into a bar to produce what was known as bar iron.