Wolverley Lower Mill and the beginnings of the tinplate industry

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Editorial Note

This is the second of two papers on the subject of the early history of tinplate in Britain. The first is by Peter Brown and was published in our last issue, vol 22, part I, 1988, pages 42 to 48.

Introduction

It has long been known that Andrew Yarranton was involved in an attempt to introduce tinplate manufacture into Britain. Peter Brown (above)[1] has dealt with this in some detail. The purpose of this paper is to examine in detail the nature, course and direct results of the experiment.

Most of what has been written previously has been based on what Yarranton himself wrote[2]. Two further sources throw new light on the course and outcome of the experiments. Firstly there are accounts of Andrew Yarranton and his assistant, Ambrose Crowley, with their sponsors[3]. Secondly there is an inventory of tools and equipment at Wolverley Lower mill (or forge)[4].

A. Wolverley Lower Forge

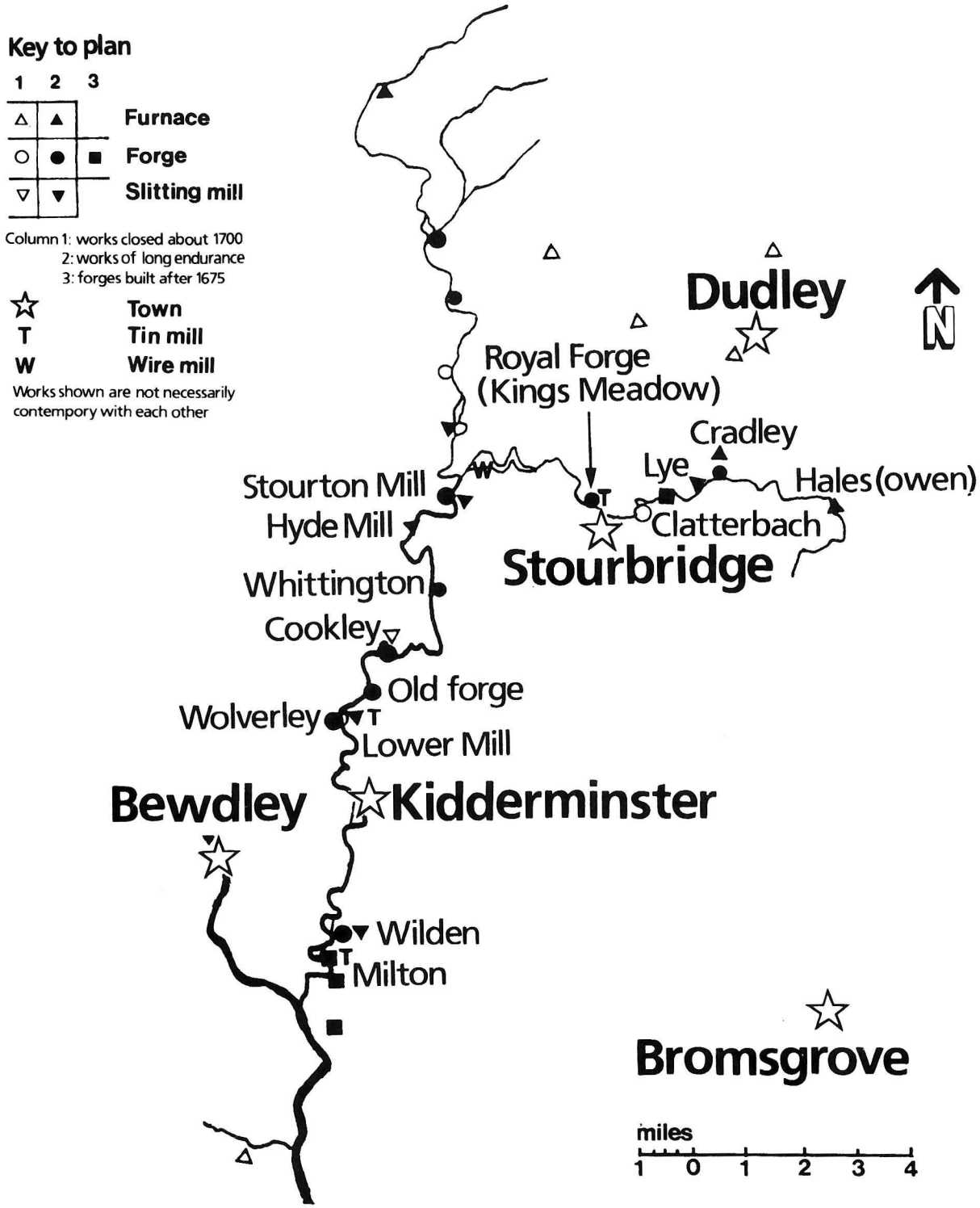
Wolverley Lower Forge (or mill) was built in about 1669 by Joshua Newborough and Philip Foley[5]. Both of these men were sponsors of the tinplate experiment[6]. They also worked Wolverley Old (or Upper) Forge together as partners[7]. Joshua (or Josuah) Newborough (or Newbrough or even Newbrook) must by this time have been an elderly man[8]. He had been a partner in the Old Forge since it was built on the site of a double corn mill about 1652[9]. By 1661 he had become a partner with Francis Boycott and others in Leighton furnace and Upton and Sheinton forges in Shropshire.[10] It would however seem that his main business was as a Stourbridge ironmonger.[11]

Philip Foley was a young man at the outset of his career. Both his father Thomas Foley and grandfather Richard Foley were very important ironmasters, holding the dominant position in the iron industry in the Black Country and around. When the Lower Mill at Wolverley was built his father had recently passed over to him control of a vast network of iron works in the West Midlands.[12] Other members of his family were also involved in the iron industry. His elder brother Paul operated most of the furnaces in and around the Forest of Dean.[13] His eldest brother Thomas Foley II of Witley subsequently succeeded their father as a partner in Tintern furnace and forges and as sole operator of the wireworks there and at Whitebrook.[14] His uncle and then his cousin both called Richard Foley of Longton had ironworks in Cheshire and North Staffordshire — Lawton[15] and Mearheath furnaces[16] and Warmingham,[17] Consall and Oakamoor forges[18], and perhaps also Cranage forge.[19] Another uncle Robert Foley was an ironmonger at Stourbridge as was his son of the same name. Henry Glover was a further uncle of Philip Foley. Besides being Thomas Foley's cashier at Stourbridge and general manager of his ironworks, he had his own business interests as an ironmonger in partnership with Robert Foley and George Gibbons.[20] He was also Philip Foley's predecessor as a partner in Wolverley (Old) Forge[21] and in the tinplate experiment.[22] It is not impossible that in one or both of the latter roles he was merely an agent for Thomas Foley.[23]

It seems likely that Andrew Yarranton encouraged Joshua Newborough and Philip Foley to build a tinplate works even though the other sponsors of the experiment were not interested. He was probably also responsible for the selection of the site, for it solved another problem that he had. There was a shallow ford, probably by Wolverley Bridge, where boats using the River Stour (which he had made navigable[24]), were grounding. Their agreement with the navigation proprietors provided for a trench (or leat) to be dug with a weir at the upper end and for passage of boats to be allowed.[25] A later document refers to two locks.[26] It would thus appear that Yarranton drew up plans and only then considered who owned the land. The result was that the acquisition of the land needed for the mill involved at least five different leases, purchases and agreements.[27]

The nature of the works may be deduced from an inventory of tools and equipment included which is annexed to a lease of 10 January 1678[/9][27] when it was taken over by John and Richard Wheeler who had previously been Philip Foley's managers.[28] The lease mentions houses occupied by Thomas Cooke, Edward Best and Peter Hussey.[29] Thomas Cooke was a slitter.[30] The other two shops included tinning pans; Best's shop also contained chafery bellows and some tinplate "but exceedingly rusty"[31]. It would thus seem that Edward Best's shop was a standard forge with a chafery but lacking the usual finery. This absence of a finery explains why Wolverley was the destination of a trade in blooms.[32] The absence of a finery is unusual but not unique. The sale of blooms is most exceptional.[33]

Peter Hussey's shop seems to have been a plating forge. After 1692 and perhaps also previously, he and Samuel Hallen used to sell their parings to the Foley Partnership.[34] After his death his son left Wolverley to build Prescott forge near Stottesdon as a plating forge[35] and also Hardwick forge nearby,[36] being referred to as Peter Hussey of Wolverley, panmaker.[37] Leonard Hussey perhaps a relative was also a plater in 1685, probably at Coalbrookdale.[38]



The ironworks of the Stour Valley before the Industrial Revolution

Figure 1

The presence of tinplate and of tinning pans would seem to be clear evidence that the mill had previously had the objective of manufacturing tinplate. The agreement with the navigation proprietors refers to the proposed mill as a "new hammer mill platinge worke forge ironwork or slitting mill".[39] The reference to 'ironworke or slitting mill' was included to cover the eventuality that "platinge" proved to be uneconomic or impracticable for other reasons. When the worst happened due to patent trouble,[40] it was possible to use the mill for other purposes. The rolling mill was used for slitting which is a similar process, one of the plating forges was used for panmaking which is another kind of plating, and the other was used for drawing out blooms of iron.

B. The process

1. **The Problems of tinplate manufacture**[41]

To make good tinplate the plates must be of even gauge. Before tinning the plates must be rendered completely free of oxidation which is normally present in the form of a thin black surface layer on the iron. It is from the presence of this oxidation that untinned plate was usually referred to as blackplate. Lastly the tin must be spread evenly over the plate. If the tin is not merely a thin layer, the cost of the plate will be greater. If the tin does not completely cover the plate the places that are untinned will rust. Plates may be produced either by hammering them out or by rolling between heavy rollers. The forging of plates is a highly skilled process due to the difficulty of getting an even gauge. Rolling has different problems; water driven machines develop only limited power, usually insufficient to roll plate cold; hot rolling is difficult because the plates cool too quickly; on top of these there is the technical problem of adjusting the roll so that the gap between them can be decreased as the gauge decreases.

Yarranton tells us virtually nothing of the process involved; Robert Plot, writing in 1686 describes the process of tinning as applied to various manufactured goods such as stirrups, spurs and buckles:[42]

> "For iron they proceed in this manner: they melt tin in a pan withe a rateable quantity of yellow rosin mix't which will swim above the tin to a thickness of a crown, into which the wares being first soaked in old sharp clarified whey to cleanse them of all filth and duely heated and then dip't into this mixture and shaken about by the mediation of the rosin they become tinned all over"

He then goes on to talk about tinning brass and copper, which involved black rosin and sal ammoniac in the process.

"The contemporary German process was as follows:[43]

> *The Way of making Latten-Plates*
>
> Take tough Iron, that will bear the Hammer well; and having hammer'd it thin, ply it into the Size you would have cut your *Latten;* then put this Iron into a Mixture of Clay and Water, of a pretty Consistence, and let it stand two or three Days; then take it out and hammer it again, as thin as you will have it for your Purpose; the aforesaid Mixture, that sticketh between the Iron Leaves, keeping them from being beaten into one another; then cut those iron Leaves asunder, with strong Sheers, and throw by the Cuttings, as useless; then put these Iron Leaves into a Mixture of Rye Meal, coarsly ground, and common Water, pretty thick, the Clay being first rubbed off, and let them steep therein four Days; then take them out, and dip them into a Kettle of melted Tin, but draw them quickly out again; then put these tinn'd Leaves between the Wires of an Iron Bar, made with Wires fit for this Purpose, that the superflous Tin may run off, into a Pan to receive it underneath. And because the Tin will grow cold at the lower End, and so thicker, in an Iron, an Inch deep, filled with melted Tin, dip the thicker Ends of your Leaves, one after another, and the hot Tin will melt down the Excess of Thickness, but you must take them out again quickly; and, with a woollen Cloathe, between your two Fingers, wipe them off beneath; which you will see to have been done, in all *Latten-Plates,* by certain Strokes appearing at one End. These are made shining, by rubbing them all over with woollen Rags."

As regards the tinning process itself it is not possible to detect any difference between what Yarranton and his associates did and the German process. The only major difficulty would seem to be providing a flux for the tin; this was something well known as indicated by Plot's account.[44] In this there would be no difference between tinning ironplates and other iron goods, at least in principle. Apart from this the problem would merely be one of developing an adequate technique for removing excess tin and polishing the plates.

2. **Pickling**

As mentioned above, it is vital that plates be freed of every trace of oxidation. Today several strong acids are available; in the late seventeenth century they did not have any. Plot mentions whey[44] which contains lactic acid. The Germans used fermenting rye meal,[45] presumably stood in an open tank so that it turned to vinegar — acetic acid. There is no indication what Yarranton used. The accounts merely refer to "greace", liquor and "stuff for making ye liquor". A reference to "rasin"[46] must mean rosin or the flux.

The first improvement in the method of pickling seems to have been the introduction of sal ammoniac (ammonium chloride), around or shortly before 1730:[47] Accounts of the later tinmill at Mitton in the Stour Valley refer to barley "flower" and bran, but also to sal ammoniac, around 1740. This may indicate that the two processes were being used together. There might be an advantage in combining the two as the resultant mixture would form some hydrochloric acid which is a strong acid. The substitution of barley for rye is probably solely due to price or availability.[48]

3. **Plating**

The German process for making plate purely involved hammering it out. In England in the eighteenth century

Wolverley Lower Mill in the 1830s

(based on the tithe map for Wolverley)

The buildings are probably more extensive than at an earlier date, but there is no reason to believe that the weirs and locks have altered much except for the removal of flash locks and the building of the canal. The river when supposed to be navigable would probably have been a little wider.

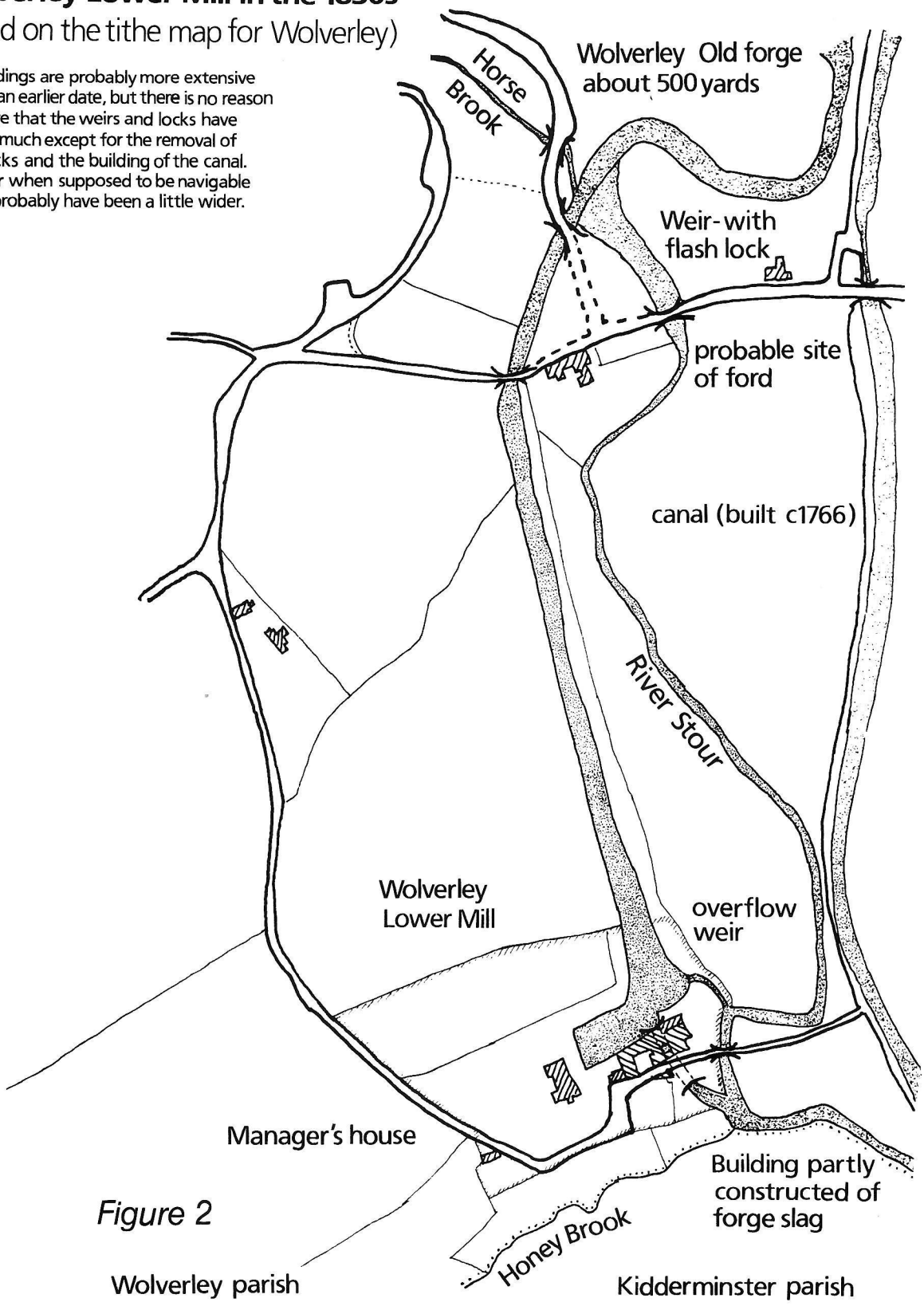


Figure 2

the process was largely one of rolling. The question arises as to who devised the process of rolling. The key to this development is most likely to be linked to the process of slitting iron bar into rods in a slitting mill. The earlier stages of the slitting mill's work involved cutting a bar of iron, as produced by a forge, into small pieces with water powered shears. These pieces were heated in a hearth and then rolled between flat rolls. No great width was needed for this purpose and the rolls were quite narrow. After this the resultant thick plate was rolled between thick rolls (or cutters) which slit it into rods suitable for nail making.[49] This is certainly how slitting mills operated later; it is not possible to be entirely certain that the process may not have been improved with the passage of time.

The slitting mill is not ultimately a British invention, however much the process may have been improved here. The first mill in this country was set up by an immigrant from Liége (now in Belgium) about 1590. At that time it was no novelty either there or in Western Germany.[50] In the half century before the tinplate experiment a number of slitting mills had been set up in the West Midlands[51] and the process would have been well known to men such as Yarranton and Crowley, even if they had not actually carried it out themselves. It is nevertheless probable that the process was not known in Saxony; certainly there is no evidence that rolling had any part in tinplate making there.[52]

C. The course of the experiment

While in the course of the experiment it is likely that a number of alternatives were tried out, those conducting the experiment seem to have settled fairly quickly on a combination of rolling and hammering. The iron was rolled at Wilden forge where there was also a slitting mill.[53] It was then carried to another forge which is variously referred to as the forge, the tinwork and Kings Meadow forge. At this forge at Stourbridge it was beaten out and tinned. The plates must in some degree have been forged at each forge as the stock of the experiment included cast hammers and anvils at each place as well as a wrought iron hammer at Stourbridge.[54]

Rolling was plainly not found to be an easy process:[55]

"The slitters say they would rather slit 2 tons of iron than rowle one ton for plaits

The first time 3 days plaiting 1 day altering The second time 1 day plaiting 1 day altering	The 6 days work in all which would have (?) draw out 7 tons of iron

The chargenders (?) work 5 times that the anvil was up and put in again £0-5-0
for wood 5 times blocking and wedging £0-5-0
3 pounds candells £0-1-3"

Presumably a different anvil and also a different hammer were required for plating from those used for drawing out iron into bars; perhaps they were a different shape.

The experiment was carried out at two different 'times'. The first 'time' began about 24 August 1667 when Ambrose Crowley received five hundredweight of iron from Philip Foley and half a ton from Joshua Newborough:[56] The second 'time' involved one and a quarter tons from Wilden forge delivered on 1 February 1667[/8], followed the following summer by about fourteen hundredweight from a selection of sources including Swedish iron and Cleobury iron; they even tried Osmond iron from Hubbals Mill near Bridgnorth[57] that was normally used for wire making; the latter was not rolled.[58]

The experiment produced considerable waste. Besides 428 saleable tinplates there were 482 square plates of which 118 had been tinned but were "spotted and not fit for sale". There was also eleven hundredweight of blackplates unpared and many were defective.[59]

D. The outcome of the experiment

There can be no doubt that the experiment was considered a success. This is indicated not only by Andrew Yarranton's statements but also by the success of sales; the most telling indication of this is however the willingness of hard headed businessmen like Joshua Newborough and Philip Foley to invest their money in building a tinplate works at Wolverley.

On completion of the experiment King's Meadow Forge reverted to its old function. The tinning pans and most of the tools were sent to Wolverley.[60] The change of site was probably influenced primarily by the need for more power. It would also have been considered desirable to carry out the whole process on a single site.

It appears the original intention was to build a tinmill at Halfcot[61] (SO868861). Here the Stour Navigation Proprietors were digging a long cut, starting at Willetts Mill (near Bells Mill) about a mile upstream. A mill with an overshot wheel at the lower end of this cut could have had a fall of water of something like 25 feet. The cut, which carried water until modern times, is about 6 foot deep with a V-shaped section. This site was never used for a tinmill; there was a corn mill in 1715 which had been converted to a wire mill by 1733.[62]

The reason for the change of the proposed site is not entirely certain. It is likely that it was realised that the amount of water that could flow along the cut was not enough to meet the demands both of the navigation's flashlocks and of the mill. Alternatively the Navigation Proprietors who had trouble raising the finance to complete the navigation may have decided against becoming involved in another speculative venture at the same time. Perhaps Andrew Yarranton as navigation engineer and his employers just saw it as safer to use the Halfcot site for a corn mill and use the idea of building a tinplate works to solve another navigation problem. The new site at Wolverley had a number of advantages over that at Halfcot. Lying just downstream of their Wolverley Old Forge,[63] Philip Foley and Joshua Newborough would have had some control over the

water supply, not that the River Stour is the most controllable of rivers. Although the possible fall of water is less, the flow at Wolverley is greater due to further tributaries having joined the River Stour. These include its largest tributary, the Smestow Brook. At Wolverley a trench some fourteen or fifteen foot wide, much larger than the Trench Brook at Halfcot, was dug. This runs from the mouth of the Horse Brook in the village of Wolverley to the mill site which lies some 500 yards to the south. It still carries one channel of the river today. The final section was slightly embanked between levees. Even with such careful design the fall of water across the wheel was probably only some five foot. Nevertheless the greater flow of water probably meant that the power available was greater than at Halfcot.

It is unlikely that the two stage process of rolling and then hammering was used for want of power. There was a water powered rolling mill a couple of miles downstream at Falling Sands in the southern outskirts of Kidderminster in the early nineteenth century[64] (SO829746). An enormous wheel pit from this mill may be seen in the riverbed today. It is most likely that this mill had sufficient power to roll plate cold; if so, there is no reason why the earlier mill just upstream should not have done so. That it did not is shown by the presence of two shops in the mill with forge hammers.

The reason for choosing a two stage process is more likely to be some technical difficulty. This might for example be connected with the need to adjust the gap between the roll as the plate became thinner as it was rolled. It may be that the overcoming of this problem should be attributed to the work of John Hanbury's employees at Pontypool rather than to this period.

The enterprise was thwarted by the renewal of a patent. The partners in the experiment had known that a licence would be required 'to set on foote the said trade', that is, 'of making plates of iron and tinning them'.[65] What they probably had in mind was a licence from the Company of Mineral and Battery Works. The hammering out of plates would have been a battery work that would have infringed their patent.[66] This licence would not have presented the insurmountable problem that Chamberlain's 'trumped up patent' (as Yarranton called it) did.[67]

E. The later history of Wolverley Lower Mill

Due to this patent trouble, Wolverley Lower Mill was never again used as a tinplate works. The alternative uses[68] of a slitting mill, a forge for drawing out blooms of iron into bars and a pan forge continued for many years. Pan-making probably ceased when Peter Hussey moved to Stottesdon in south-west Shropshire in 1708 shortly after his father's death to establish Prescott and Hardwick Forges.[69]

The drawing out of iron probably continued until the early 1730s. Between 1734 and 1736 there was a substantial increase in the amount of iron slit for Edward Knight & Co to over 900 tons per year.[70] This cannot wholly be accounted for by the inclusion of Lower Mitton Forge in the Knight partnership about the same time. In 1678 Thomas Cooke as slitter had been guaranteed a minimum of 350 tons per year to slit,[71] which was probably almost as much as was practicable. In 1731 in taking the Old Forge which had hitherto usually been held with the Lower Mill Edward Knight agreed to have 300 tons of bar iron per year slit by Stephen Podmore at the Mill.[72] This is not necessarily its whole capacity but probably represents the pattern of trade while the two had been held together over the preceding period.[73] Thus the increase to 900 tons per year[74] may perhaps indicate the conversion of the forge shops to slitting.

Thomas Cooke probably remained at Wolverley until Stourton Forge became a slitting mill in 1695,[75] being described as head workman there when he died in 1699.[76] At Wolverley he had been allowed five shillings per ton that he slit, out of which he had to provide himself with cutters,[77] and perhaps pay a labourer or two. He received a bonus for wasting less than a hundredweight per ton in cutting, being penalised if he did worse. No doubt it was a good living.

When Richard Wheeler became bankrupt in 1703, his son John Cook became tenant of Stourton Mill[78] and was succeeded by a son of the same name.[79] Sixty years later the mill was held briefly by Capel Cook, probably as the latter's executor.[80] His first name is an unusual one but was in use by the Hanbury family of Pontypool.

This suggests a close family link between Thomas Cooke 'of Stourbridge', who became John Hanbury's right hand man in establishing a tinplate works at Pontypool,[81] and the slitter at Wolverley Mill, where tinplate had once been made. The exact relationship between the two Thomas Cookes is not known, but it is not unlikely that it was father and son. The man who went to Pontypool would probably be too young to have actually seen tinplate being made, but it is likely that the technical details of the process were passed on to him by his father or by other workmen who had been at Wolverley, thus enabling John Hanbury to operate the first successful tinplate works in Britain that endured as such for a substantial period.

In 1740, when the Knight family wished to set up a tinplate works, they arranged for John Cook II of Stourton to go to Pontpool (as they called it).[82] As Edward Knight and Co were among his largest customers,[83] he was no doubt willing to oblige them by making an all expenses paid visit to cousins. With this information Edward and Ralph Knight were able to set up a rolling mill at Bringewood on the Herefordshire/Shropshire border and a tinmill at Upper Mitton outside Stourport,[84] where they traded profitably until 1778.[85] After this a lease was granted of the Bringewood works, due to expire in 1814.[86] During this period the works comprised a furnace, a forge, a rolling mill and apparently also a tinmill.

The only[87] other tinplate works in the Midlands in the mid eighteenth century, at Oakamoor on the River Churnet in the Staffordshire moorlands, belonged to the Cheshire Ironmasters.[88] Richard Knight had been a partner in this firm when they renewed their lease of

Mearheath Furnace in 1727,[89] and is likely still to have been one when his sons were building their tinplate works. Edward Knight and Co were regular customers of the Cheshire Ironmasters for their 'Cheshire Coldshort' pig iron.[90] The first tin required for the Mitton tinmill was obtained from Rugeley,[91] where the Cheshire Ironmasters had a slitting mill.[92] This suggests that Oakamoor tinplate works may belong to the same period and have been built on the basis of John Cook's information.

Thus the enterprise of Andrew Yarranton in going to Saxony to discover how tinplate was made there, and his skill and inventiveness and that of Ambrose Crowley in improving the method, particularly in the application of rolling to the process, are not to be seen as some historical sideline unconnected with the later industry; rather it was their work that led to the later highly successful industry. The opportunity that slipped through the hands of Joshua Newborough and Philip Foley, when Andrew Yarranton failed to come to terms with William Chamberlain about 1673, was taken up a generation later by the son of one of their former employees. From this the successful works at Pontypool was set up, and from there came an industry that has spread round the world.

APPENDIX

Kings Meadow Forge

The experimental tinworks at Kings Meadow Forge is only named in one place, in an inventory of goods left at the end of the experiment.[93] This does not locate it; the location is however indicated by references to the carriage of goods to 'Stourb'[94] and 'Stour'.[95] The latter cannot be a reference to the river;[96] indeed the destination can be shown to be about eight miles from Wilden, which fits Stourbridge well.[97] At a later date there was a forge in Amblecote called Royal Forge, standing beside the river Stour opposite Stourbridge. The existence of a meadow called Kings Meadow immediately to the east of Royal Forge[98] confirms that the two names relate to one and the same forge.

Ownership of the forge before the end of the experiment is not known; it seems quite probable that it belonged to Richard Foley and then to his son Thomas but was sold at the time Philip Foley took over the latter's Midland interests in 1669.[99] There is a note on the final inventory for the experiment that John Finch was to 'allow' in respect of a hammer; this could suggest either that he took over the forge at that time or that it was his forge all the time.[100] It is likely that in 1673 the forge passed to Joshua Newborough as part of a complicated series of transactions also involving Wolverley Old Forge and Cookley and Stourton Forges.[101] From him it no doubt passed with his other ironmaking interests to Joshua Bradley and his other sons in law.[102] In 1688 Joshua Bradley sold the forge to Ambrose Crowley II[103] whose family probably retained it, though perhaps not making iron, until it was sold to Francis Homfray sometime before his death in 1737. The forge remained in the ownership of the latter's family until J A Addenbrooke sold it to James Foster in 1847, resulting in it being added to the Stourbridge ironworks known as John Bradley & Co.[104]

References

1. **P Brown,** *above pages 47-48.*
2. **Yarranton,** *i, epistle to reader & ii, 149-151.*
3. **Foley,** *E12/F/VI/KT series.*
4. **Downton** *73, lease of 10 Jan 1678[/9].*
5. **Downton** *535;* **Knight** *1504;* **Downton** *73, lease of 1 Jun 1669.* The names of the builders are frequently repeated in title documents for the mill. *eg Knight 1504-1609 passim & 7151-3 & 7168 & 7125.*
6. **P Brown,** *above page 43;* Philip Foley probably succeeded to his father's share.
7. **Schafer, 1978. Foley** *E12/F/VI/KE/passim.*
8. He passed his property to his sons-in-law soon after 1678 and probably died not long after. **Knight** *7105. cf* **Shrewsbury Bor Lib** *deed 3093, also* **Downton** *423.*
9. **Foley,** *E12/F/VI/KE/1, recitals.*
10. **Shrewsbury Bor Lib** *deeds 3093, 3100 & 3230.*
11. He is so described in **Foley** *E12/F/VI/KE/1*
12. **Schafer, 1971,** *passim and* **1978,** *introduction.*
13. *as ref 12 and* **C Hart, Industrial History of . . . Dean** *(1971) passim.*
14. **Foley,** *E12/F/VI/AF/passim;* **H W Parr & D G Tucker, Technology of wiremaking at Tintern 1566-c1880** *JHMS.* **17,** (1), (1977), 15.
15. **Foley** *E12/F/VI/MAF/3, 4 32.* It is significant that the same ledger *(ibid/MAF/32)* was used first for Lawton then for Mearheath.
16. **Foley** *E12/F/VI/MAF/1, 2 & 8;* **Awty 1957,** *79-81.*
17. **Awty 1957,** *79.*
18. *as ref 16.*
19. **Foley** *E12/F/MAF/2* records the dispatch of two tons of pig iron from Mearheath furnace to "Cranage". The absence of any customer's name attached to this implies that the forge belonged to one of the partners in Mearheath, or was otherwise very closely connected. As it was not Philip Foley operating Cranage it must have been Richard Foley.
20. **Schafer 1978,** *introduction;* **Foley** *E12/F/VI/KBC/8;* **Foley** *E12/F/VI/KAC/passim.*
21. **Foley** *E12/F/VI/KE/1.*
22. **P Brown,** *above page 42.*
23. It is suggested that this is why he is omitted from the dedication in **Yarranton,** *i.* It is frequently difficult to decide when some of Foley's managers are mere agents and when they are doing things in their own capacity.

24. **Yarranton,** *i, 64-5;* **Staffs Rec Off** *D(W) 1788/61/5.*

25. **Downton** *73, lease of 1 Jun 1669.*

26. **Downton** *73, deed of 30 Jun 1678.*

27. **Downton** *535;* **Knight 1504;** *as ref 26, recital of lease of 28 Jun 21 Charles II* [1669].

27a. **Downton** *73, lease of 10 Jan 1678*[*9*]. The identity of the year follows from the identity of the parties, implying that it is after *ref 26.*

28. **Schafer 1978; Foley** *E12/F/VI/KBF/passim.*

29. *as ref 27a.*

30. **Birmingham Cent Ref Lib,** *Archives, Z 10* (being his articles of engagement with John and Richard Wheeler.

31. *as ref 27a.*

32. **Johnson 1950,** *43* suggesting rolling of iron and steel blooms; **Foley** *E12/F/VI/DEF/1-6, 9.* Blooms came from Coalbrookdale and Sheinton (Shropshire).

33. Lye Forge (Worcs) and Cannock Forge (Staffs) also lacked fineries but mainly drew out blooms from forges in the same ownership. **ibid** *and* **Johnson 1954,** *52.*

34. **Johnson 1950,** *42.*

35. **Shropshire Rec Off** *1396/1;* **Knight** *7157.*

36. **Knight** *7157.*

37. *as ref 35.*

38. **M D G Wanklyn, Industrial Development in the Ironbridge Gorge before Abraham Darby,** *West Mid Stud* **15,** *(1982), 6.*

39. *as ref 27.*

40. *see* **P Brown,** *above 44.*

41. The author's technical knowledge of tinplate manufacture is very limited. This section relies heavily on **Minchinton 1957** and **Gibbs 1950** and **1951.** He must also acknowledge considerable assistance from Prof R F Tylecote.

42. **Plot,** *374-5.*

43. *quoted by* **Gibbs 1951,** *36-7 from* **Diary of Robert Hooke,** *ed* **H W Robinson** and **W Adams,** *London (1935), 76-77.*

44. *as ref 42.*

45. *as ref 43.*

46. **Foley** *E12/F/VI/KT/8.*

47. **Gibbs 1951,** *116 citing* **W Rutty** *Phil Trans 1728,* **35,** *630;* also **Knight** *244, 1740, fo 13* 'salarmoniac'.

48. *as ref 46.*

49. **Schubert 1957,** *308.*

50. **Schubert 1957,** *305.*

51. Notably Hyde mill, built by Richard Foley in 1627, **VCH** *Staffs,* **20,** *146;* Cookley mill built by William Winchurst and others in 1648, **Parliamentary Survey of Worcester Cathedral, T Cave** *M* **R A Wilson,** *Worcs Hist Soc, 1924 and* **I Edwards, The Early Ironworks in N W Shropshire,** *Trans Shrops Arch Soc* **56,** *(1967-60), 158* where the mill is referred to as Wolverley Mill from the name of the parish. **Sir Thomas Middleton and his partners** held three shares out of twenty in Cookley Mill.

52. *as ref 43.*

53. **Schafer 1978,** *66* shows production of rod iron at Wilden, although not referring to it as a slitting mill.

54. **Foley** *E12/F/VI/KT/7.*

55. **ibid**/*6.*

56. **ibid**/*9.*

57. **ibid**/*1 & 8.*

58. **ibid**/*8.*

59. **ibid**/*7 & 10.*

60. **ibid**/*7.*

61. **Staff Ord Rec Off** *D(W) 1788/61/5, articles of 13 Dec 1667; compare agreement of 28 Dec 1665.*

62. **Foley** *E12/S, box 703, lease of 24 Feb 1715;* **VCH** *Staffs* **20,** *143.*

63. *as ref 7.*

64. *This first appears on* **Ordnance survey** *(one inch first edition sheet 55), (reprinted by David and Charles, Newton Abbot), based on a survey made in 1812 and 1813.*

65. *as ref 61.*

66. Thomas Foley was deputy governor of and a major shareholder in the Company from 1647. He and later his son Thomas Foley II were farmers of the Company's wireworks at Tintern and Whitebrook *(as ref 14);* **W Rees, Industry Before the Industrial Revolution** *(Cardiff 1968), 631;* Grants of shares in the Company subsequently held by Philip Foley are in the Foley Collection.

67. *see* **P Brown** *above 43.*

68. *see above page.*

69. **Worcester (County Hall) Rec Off,** Will of Peter Hussey; **Knight** *7157; Shropshire Rec Off 1396/1.*

70. **Knight** *141.*

71. *Birmingham Cen Ref Lib, Archives Z10.*

72. **Knight** *7142.*

73. After Richard Wheeler's bankruptcy, control of both Wolverley Old Forge and Wolverley Lower Mill seems to have been in the hands of the Jewkes family, who at various times operated the works themselves alone or with partners or let them to tenants **(Foley** *E12/F/VI/DFF series;* **Public Rec Off** *C33/3888, p278ff).*

74. *as ref 70.*

75. **Johnson 1952,** *324 & 339.*

76. **Kinver Parish register.**

77. *as ref 71.*

78. **VCH** *Staffs* **20,** *145; also* **Foley** *E12/F/VI/misc ironworks box 1107, case for counsel and opinion.*

79. **Kinver Parish Register;** the older John Cook died in 1736.

80. **Knight** *141-154.*

81. Gibbs 1951, *48 to 55; as to the name 'Capel' see also* **Burke's Landed Gentry,** *article* **'Hanbury-Williams'.**

82. **Knight** *244, 1740 fo 6:*
'paid on rolling mill account . . .
'John Cook's journey to Pontypool £2-10-0'
Knight *245, 1742 fo 15:*
'paid for information in tinning £36-15-0'

83. *as ref 80.*

84. **R L Downes, Stour Partnership 1726-36,** *Econ Hist Rev Ser II, (1), (1950), 90;* **Knight** *141-2 & 244-5;* **Downton** *431.*

85. **Knight** *244-268.*

86. **Downton** *323, 326-7, 424 & 163.*

87. Persistent rumours of a tinplate works at Wilden in or soon after 1740 seem to derive from **Brooke, 1944,** *130, citing Rhys Jenkins.* His source was probably a reference to Mitton Tinmill, which was a short distance below Wilden, but with an entirely different history from the Wilden works.

88. **Johnson 1954,** *32-33 and 49-51;* **Awty 1957,** *109;* **Nat Lib Wales** *Castell Gorfod 61 & Maybery 255.*

89. **Stafford Rec Off** *D593/1/3/20.*

90. **Knight** *141-2* (covering period 1729 to 1750). **Downton** *431.* An account between Richard Knight and his son Edward appears to show the latter paying his father in 1733: 'Cheshire partners by pig account £1040-12-6'. It is suggested Richard Knight was drawing his share of profit as one of the Cheshire Ironmasters in the form of iron sold to his sons' firm.

91. **Knight** *244, 1741 fo 7.*
'paid carriage tin from Rugeley 1 shilling'

92. **VCH** *Staffs,* **4,** *161;* **Johnson 1954,** *33;* **Nat Lib Wales,** *Castle Gorfod 61 and Maybery 255;* **Awty 1957,** *passim.*

93. **Foley** *E12/F/VI/KT/4 dated 6 Feb 1669[/9].*

94. **ibid**/*8* 'paid car[riage of] ye Swedish iron from Wilden to Stour[bridge]'.

95. **ibid**/*6* 'ye carriage to Stour[bridge] of ye 1-5 [t-cwt] (£) 0-7-6'.

96. Wilden forge was driven by the River Stour. Even carriage to a nearby wharf could not have cost so much.

97. Carriage of 15 tons from Brewood Forge to [Wolver] hampton cost £3-15-0 **(Schafer 1978** *45.* The distance is about $6\frac{2}{3}$ miles which works out at 9d per ton per mile. An agreement for carriage of goods from Wolverley **(Foley** *E12/F/VI/KE/9)* gives the rate of 12d per reputed mile but may refer to a cartload rather than a ton.

98. **VCH** *Staffs* **20,** *60.* The site is probably at about SO 88628482 where a mill is shown by *Wood's map of Stourbridge, reprinted by Dudley Borough Libraries.*

99. No direct evidence of this but the tinplate accounts **(Foley** *E12/F/VI/KT/series)* do not give credit to anyone else such as John Finch or Joshua Newborough for the use of the forge.
Ambrose Crowley was charged for use of the forge for 29 da[ys] *(ibid 8)* but who he was to pay is not indicated. It is noteworthy that the loss on the experiment ultimately fell on Philip Foley **(Schafer 1978,** *111);* apparently it was not even shared with Joshua Newborough as should have happened under the original agreement if all other partners withdrew *(as ref 61).*

100. **Foley** *E12/F/VI/KT/7, marginal note* 'ham[mer] at tinwork Jo[hn] Finch to allow'

101. No direct evidence but John Finch was limited by restrictive agreements to the use of Wolverly Old Forge and Cookley Forge only. It is suggested that Joshua Newborough received this forge in exchange, just as Philip Foley received Stourton Forge. This was a complicated transaction of which only part of the documentation **Foley** *E12/F/VI/KE/32-37)* survives. **Schafer (1971,** *30-1)* considers it to be a sale agreement contemplating genuine sales as a means of regulating prices: the prices are however so unrealistically low that the real object is far more likely to be to retrain John Finch from operating any other forges.

102. *as 8.* In 1686 'Jos Bradley & ptners' bought 20 tons of Bishopswood pig iron **(Foley** *E12/F/VI/DF/3).* Joseph (sic) Bradley's will of 1697 refers to his ironworks at Stourbridge *(cited by* **H E Palfrey** *in Trans Newcomen Soc* **8** *from probate records).*

103. **VCH** *Staffs* **20,** *60 with inferences based on* **Flinn 1962** *and others.*

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Wolverley Lower Mill — abstract

Andrew Yarranton and Ambrose Crowley were sponsored to visit Germany to discover the method of making tinplate. On their return they conducted experiments into the process at Wilden Forge and at King's Meadow Forge, the latter being shown to be at Stourbridge. This included rolling blackplate which was probably an innovation on their part. The process and its problems are examined in detail.

Nothing came of a proposal to build a tinplate mill at Halfcot; Wolverley Lower Forge (or Mill) is however shown to have been designed for use as a tinplate works, this being prevented by an unexploited patent held by someone else. The later history of each works and of the people involved is then traced.

The method of tinplate making was taken to Pontypool by Thomas Cooke who was probably son of the Thomas Cooke, who was the slitter at Wolverley Lower Mill. When it was sought to establish a rolling mill at Bringewood with a tinmill at Mitton, Stourport, this slitter's grandson obtained details of the process from his cousins at Pontypool. It is likely that the technology of Oakamoor tinplate works has the same origin.

Biography

Peter King after receiving a B Sc from Leicester University worked for some years as a solicitor, and is currently a Church worker engaging in evangelism. He has, for a number of years, been studying the histories of individual pre-industrial revolution ironworks, mainly in the Midlands.