THE MIDLAND WIND AND WATER MILLS GROUP

This Journal is published by the Midland Wind and Water Mills Group, which is concerned with the study of the history and technology of mills and with their preservation and restoration. Its area is the region loosely defined as the Midlands, especially the central counties of Staffordshire, Shropshire, Worcestershire and Warwickshire.

The group holds monthly meetings, with talks and discussions, during the winter, and arranges mill tours and open days during the spring and summer. Members periodically receive a Newsletter and the Journal.

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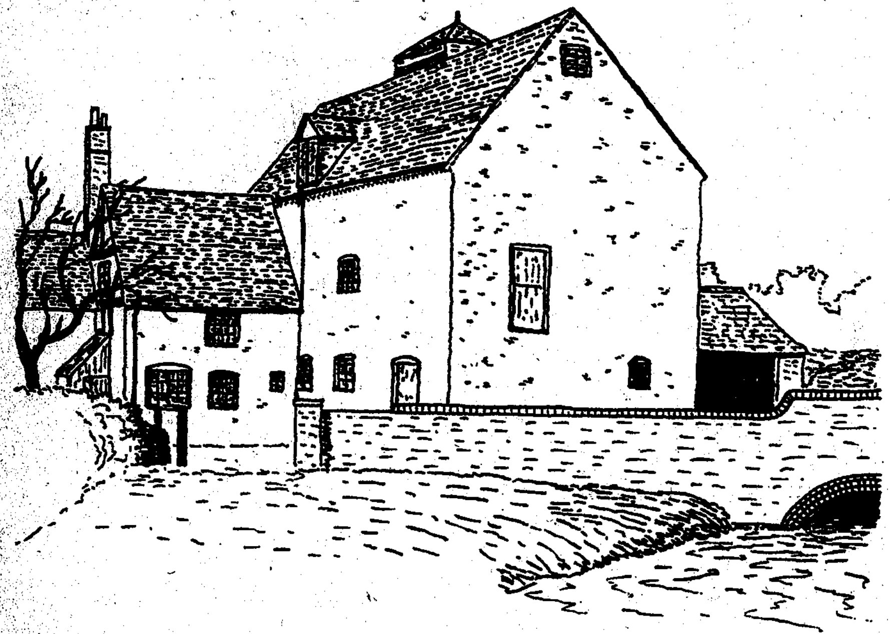
Wind and Water Mills

Number 17



The Midland Wind and Water Mills Group

Wind and Water Mills is the Journal of the Midland Wind and Water Mills Group and is therefore naturally concerned with the mills of the Midlands, but it is not intended to be narrowly parochial. Interesting and important articles relating to mill matters in other parts of Britain and the world will be included whenever available. In general, articles by members will have priority for publication, but submissions by non-members will be willingly included.

Cover illustration. New Hall Mill, drawn by Tim Booth (see pages 11 to 41)

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Contents

A MYSTERIOUS MILLSTONE FOUND AT BISHOP'S CASTLE, SHROPSHIRE

By Alan Gifford

In 1981 the Gifford family spent Easter searching for Shropshire mills, using basic information kindly supplied by Tim Booth. We used a campsite at Bishop's Castle as the base for our caravan and roamed the area. The trip was quite successful and was reported in Midland Mills Group Newsletter 9 (Summer 1981).

We returned to the area in August 1982 to complete the study. and at that time we had a cat who loved to walk on a lead. My daughter, Anita, took him for a walk one evening in a field at the back of the site. She returned very excited and reported 'I've found a mill stone in the field'. A first reaction of 'rubbish' was dismissed and we all went to investigate. There, almost lost in the grass and revealed only after some scraping around, was clearly a mill stone, of an unknown type but assumed to a be French burr! It was lying face side up and flush with the surrounding ground but was virtually buried. The chance of spotting it was very remote but having found it something had to be done.

We negotiated with the owner, who did not know it was there, and purchased the stone from him, although we did not really know what we were buying and, more realistically, how we would get it home. At a later date I returned with a friend, complete with tools to excavate and move the stone. Digging clearly revealed the stone to be a French burr runner stone, well worn and held together by a rusted iron band, buried face side up, flush with the soil level (Plate 1). When we tried to move it the stone started to break up into individual segments. We decided to break it up and to move it in small pieces, first making a sketch and number marking all the segments (Plate 2). We then transported it home, spread equally over the floors of two caravans, an operation which was, to say the least - interesting!

However, having successfully moved the pieces to Willington, in Derbyshire, for installation in my garden, I decided to fully record and document everything I could about the stone and then to try and solve the mystery of its origin. This report records the outcome of this effort. Note - The dimensional survey was primarily carried out in metric units, some significant imperial equivalents are given or used in the text note 25.4 mm = 1 inch.

The Location

The stone was found in a field rising up behind a property now known as the 'Brundells', just off the B 4385 road from Bishop's Castle to Lydbury North. The site is about 1 mile south-east from Bishop's Castle, (about SO 331875), approximately on the 183 metre contour line shown on the 1:50,000 Ordnance Survey Map, Sheet 137, 1979 version, directly behind the buildings on the map. (See sketch map Figure 3.). It is on a west facing hillside which would be well suited to a windmill.

Plate 1. Excavation of the millstone at the rear of 'Blundells', Bishop's Castle.

Plate 2. The millstone, on site, lying reverse side up.

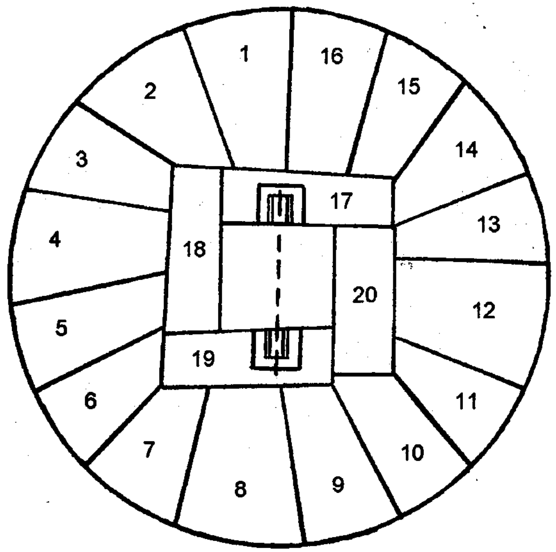


Figure1. Plan view of the face side of the millstone with all the segments numbered.

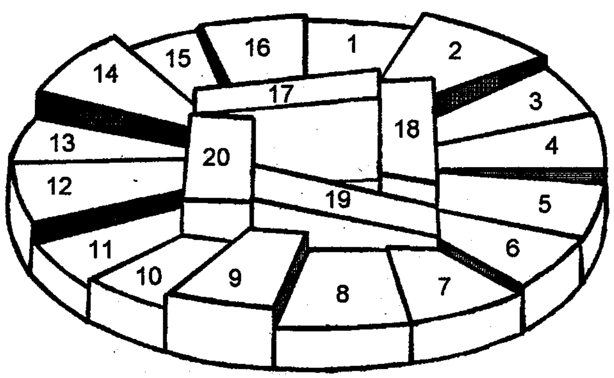


Figure 2. Reverse side of the millstone showing the relative thickness of all the burrs.

Description of the Millstone

This is a well worn French burr runner stone made up of 16 irregularly shaped burrs, disposed around a central core made up of four pieces of burr stone. Two of the these pieces contained half round, bearing journals, made of a magnetic metal, each set in non-ferrous metal. The stone is between 1220/1225 mm (4 feet) diameter, held together by a very rusty iron band, some 30 mm wide and between 4 and 5 mm thick (it was possibly 6 mm thick originally). There was no evidence of any backing material on the stone or in the excavation.

The burrs were identified by numbers 1 to 20 and the general layout is shown diagrammatically in Figures 2 & 3. These show both the stone viewed on its flat face side and also the relative variations in thickness of the various stones when viewed from the obverse side, i.e. when lying on the face side. The significant differences in the size and thickness of the burrs is readily apparent and these are recorded in Table 1. The thinnest is 65 mm (2½") and the thickest 140 mm (5½") - a difference of more than 100%!, The weight of the burrs shown in Table 2 also varied considerably, from 7.7 kg (17 lb.) to 18.14 kg (40 lb.) although of course, the sizes of the pieces are different.

The stones making up the central core of the millstone are equally irregular, although of similar weight, as noted below:-

Face Width from	105 to 135 mm
Depth (thickness)	100 to 165 mm
Weight	14.51 to 15.87 kg. (32 to 35 lb.)

Two of these central stones (i.e. those not containing the journals) are slightly recessed, in a conical shape, to a depth of about 35 mm (stones 18 and 20). On the face side of one of these stones (18) a large void in the stone has been filled with the non-ferrous material. The journal recesses are both 100 mm by 90 mm at the surface and 60 and 65 mm deep respectively. The 'U' shaped journals, or bearings which carried the rhynd, are set in the non-ferrous metal and are in line across the eye of the stone. The journals are each about 20 mm thick and have an internal bearing diameter of 30 mm, with a length of about 25 mm

The dressing of the stone is so well worn as to be almost invisible in places. Parts of the lands are virtually polished but the overall pattern appears to be 'the common harp', cut for anti-clockwise rotation.

Technical Examination of the Metallic Parts

Small pieces were cut from the ferrous journal material, the non-ferrous mounting material and from the metal strap which bound the stone.

a) The Journal

The material was strongly magnetic. A chemical analysis showed large amounts of Iron and Silicon to be present whilst Manganese, Phosphorous, Titanium and Sulphur were present in greater than trace amounts. Metallurgical examination revealed the material to be a flake type grey iron, with a large phosphorous eutectic content (an alloy of phosphorous and iron solidifying at a constant temperature, lower than either of the constituents), indicative of about 0.70% phosphorous in the metal. This represents a good quality grey cast iron, which would be quite fluid when casting. The micro structure, at a magnification of 200 times, is shown in Figure 5.

b) Non-Ferrous Mounting Material

This was a soft, easily cut, non-ferrous material and X-ray diffraction analysis showed that it consisted essentially of Lead (Pb) with Iron (Fe) and Tin (Sn) present as impurities. Whilst not tested, the melting point would be low, suggesting it was probably melted and cast into position. The means whereby the iron journals were held in an exact position whilst this was carried out was not clear. Possibly a dam was built on the open side of the bearing, the metal poured to part fill, and the journal inserted when initial solidification had occurred and pouring was then completed. Certainly it is difficult to believe that any machining took place in situ.

c) The Binding Strap

Metallurgical examination showed this to be wrought iron (almost pure iron), a material much more commonly available than steel during the eighteenth and early nineteenth century.

So What Facts do we have about this Millstone?

A stream, which joins the River Kemp some three miles south-east, flows fairly close to the stone location but is separated by the road to Lydbury North and is also some 25 metres lower. To get water to the stone site would have required extensive leats, but none are presently evident in the locality.

The stone itself is very well worn, down to a minimum thickness of 65 mm, but is equally made up of pieces of very irregular size and thickness and there was no evidence of any backing material found on the site. This may have fallen off before the stone met its final resting place. The irregularity of the thickness of the pieces led to the suggestion that it possibly represented an early French Burr stone to be imported into this country although other evidence indicated that it was assembled in England, since French assembled stones[1] normally have circular eyes. The square eye, coupled with the conical dressing, might suggest that it was originally made as a bed stone. If this was the case then problems associated with balancing the stone due to the irregular thickness of the burrs would not have arisen. The use of lead to fill large voids in burrs has been noted elsewhere.[2]

An examination of current maps of the area and discussion with members of the Midland Mills Group suggested that the stones might have come from Brocton Water Mill, about a mile and a half due south. A visit to this mill showed that there were still three pairs of stones in place, two of which were French burrs. Conceivably our stone had come from this mill, as a reject since it was well worn - but why should anyone carry it away at least a mile, take it up a small hill and just deposit it? Not really very plausible. The 1928 six inch map (based on survey carried out originally in 1882/3) shows no mills in the area, and it seems clear there were no other water mills in the immediate vicinity - so think again. In addition we were not able to identify any adjacent farm mills, perhaps animal powered, which might have represented the source of the stone.

I was fortunate to be able to discuss this problem at length with the late Bill Seaby, who was a member of Midland Mills Group and who was something of an

authority on Shropshire mills. By letter and phone we explored the subject. Bill favoured the idea that the stone had come from a windmill. He felt that this was an early French Burr stone and, in his view, the small diameter (4 feet) supported this idea. He identified an advertisement in the *Shrewsbury Chronicle* (Ist March 1754). This read as follows:-

> 'To let to the best bidder, at the Castle Inn in Bishop's Castle, County of Salop, on Friday next at 3 o'clock. A capital newly erected windmill near to the town of Bishop's Castle, with good dwelling house and garden adjoining. Premises let for 3 years from Lady Day next at which time the Tenant will be let into possession. Apply to Mr. Home, Bishop's Castle, for particulars.'

Close examination of the current 0/S map shows that there are in fact two buildings close to the stone site; could one of these, or possibly a successor on the site. be the 'good dwelling house'?

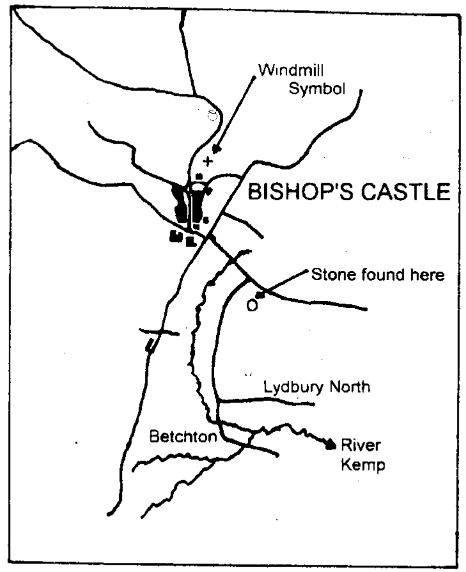


Figure 3. Sketch map based on Baugh's Map of Shropshire of 1808, showing the location of the windmill symbol on the map and the site where the millstone was found.

Consultation with early maps was an obvious route to follow. J. Rocque's map of 1752 was the earliest examined but there were no mills shown at all in the area adjacent to the stone site. Baugh's map of Shropshire of 1808 does show a windmill close to Bishop's Castle, in fact the symbol can just be seen on the fold of the map, a very short distance north of the town at about SO 314892. But this is at least one mile from the 'stone site' and again - why transport a heavy stone and dump it in a field? A sketch, based on Baugh's map, showing the location of both the stone site and Baugh's windmill is given in Figure 3.

However the windmill does not appear on Greenwood's map of 1825 nor on the 1833 Ordnance map of the area. so we still do not have a tie up.

It seems possible that the mill in the advertisement was a post mill, possibly moved from another location. This is supported by the wording of the advertisement which refers to 'newly erected' NOT 'new' or 'newly built' as is so commonly the case in such adverts. Also note that old advertisements tend to refer to '...of brick' or '...of stone' if a tower mill is involved. If the mill had more than one pair of millstones, again, it is almost certain the advertisement would have mentioned the fact, since the millstones represented a major cost in a mill at that time. We also know that French burr stones were common in England in the mid eighteenth century, Ward[1] noting that 'By 1758 the popularity of the French stones had become so widespread in Britain.......'

Conclusion

Investigating the origin of this stone has been a very interesting exercise from which those involved have learnt much about mill stones. It has served to make us realise how much more there is to learn!

We can still only speculate as to where this stone originated from, assuming it was, of course, from the Bishops Castle local area. On balance we (Bill and myself) favoured the concept that the windmill shown on Baugh's map of 1808, to the north of Bishop's Castle, had perhaps been moved from the 'stone location', as described in the 1754 advertisement, to the Baugh map location and that the old, worn, millstone had just been abandoned where it lay. In fact it is conceivable that the stone site described in this report may represent a new windmill site in Bishop's Castle, so far unrecorded. Or is there another explanation?

I will of course be pleased to invite anyone interested in examining the stone themselves to visit my garden and see if they can throw any further light on this mystery.

Finally, maybe in the year 2097 some molinologist, assuming they still exist, might find the stone in my garden at Willington and ask 'I wonder which mill this stone came from?'

Acknowledgment

Much of the work described in this report was completed in the early 1980s when I was fortunate to have the helpful comments of the late Bill Seaby. Robin Clarke has helped with map data and both he and Tim Booth gave very helpful suggestions and advice. I must also thank Mike Hilton who helped move the millstone and who drew the Figures for me.

Table 1.

Average Thickness of the Burrs from the Millstone

Stone Number	Inner Thickness (mm)	Rim Thickness (mm)
1	90	100
2	125	140
3	80	120
4	85	125
5	80	90
6	80	100
7	75	85
8	65	80
9	100	120
10	75	90
11	70	70
12	100	110
13	85	80
14	120	130
15	80	95
16	110	110

Table 2

A. Weight of Main Burrs

Stone number	Weight(Kg/lbs)	
1	12.24	27
2	18.14	40
3	8.61	19
4	12.29	28
5	10.88	24
6	10.43	23
7	7.70	17
8	10.43	23
9	9.52	21
10	7.70	17
11	7.25	16
12	16.23	36
13	9.97	22
14	12.69	28
15	9.52	21
16	14.05	31
Burr Weight	177.32	391

A. Weight of Central Core Stones

Stone Number	Weight (Kg/lbs)	
17	14.51	32
18	14.96	33
19	15.87	35
20	14.96	33
Core weight	60.31	133

Total Weight of the Millstone 237.63 Kg or 532 lbs

References

1. Ward, Owen, *French Mill Stones*, The International Molinological Society, 1993.

2. Tucker, D.G, 'Millstones North and South of the Scottish Border', *Industrial Archaeological Review,* **Vol VI**, **Number 3,** Autumn 1982.

A HISTORY OF NEW HALL MILL, SUTTON COLDFIELD

by Roger Lea

The first mill on the site of New Hall Mill was constructed late in the 16th century on the orders of Thomas Gibbons of New Hall. Thomas Gibbons owned other mills, for example at Kingsbury only a few miles to the east, and was a wealthy man with estates elsewhere in the country and the capital to develop his New Hall Estate in Sutton Coldfield.[1] He died in 1575, having been the owner of New Hall for some 40 years.

There is some evidence that New Hall had been the Earl of Warwick's Sutton headquarters in the previous century, used when he came hunting in Sutton Chase.[2] The Manor of Sutton reverted to the Crown after the Wars of the Roses, and was eventually granted a borough charter in 1528. This charter was secured by Bishop Vesey, a favourite of King Henry VIII, who probably also obtained the manorial demesne, including New Hall. The charter established a corporation consisting of a Warden and Society, equivalent to Mayor and Corporation, and the first warden was a nephew of Bishop Vesey, William Gibbons of Little Sutton. This William Gibbons was the owner of New Hall, and his wealthy son Thomas is credited with the lavish extensions to New Hall in anticipation of a royal visit.[3] Thomas Gibbons died in 1575, his son Thomas succeeding to the New Hall property.

The extent of the New Hall Estate at this time is recorded in a lease for three years of New Hall dated 1586. The document which survives is in the form of articles of agreement for Percival Willoughby of Wollaton, soon to succeed to the nearby Manor of Middleton, to lease the New Hall Estate from Thomas Gibbons of New Hall for £75 per annum.[4] The lease appears to include some land to the east of New Hall near one of the stone houses attributed to Bishop Vesey, now Warren House Farm, probably added to the estate by enclosing part of the common land in accordance with a clause in the Charter. This evidence of the expansion of the estate by one or both of the Thomas Gibbonses shows an interest in developing the property, and makes them likely candidates as the originator of New Hall Mill. Other land may also have been recently added to the estate judging from the field names, either by taking in former common land or by purchase, but one field name is particularly important - Mill Meadow.

The name *'Mill Meadow '* is sufficient evidence for the existence of a mill at New Hall in 1586, and it seems likely that Mill Meadow had been created out of existing small meadows and reclaimed marshy ground in a comprehensive development of this part of the New Hall Valley which introduced a proper drainage system and established New Hall Mill. The stream in the valley is the E Brook, and in order to channel it into a regular course a leat with a substantial embankment was constructed, leading the whole stream eventually to the Mill Pool, some 10 or 12 feet above the valley floor; the water then overflowed back into the original course of the brook. The New Hall Estate now had an extensive meadow properly drained and capable of being 'floated' (flooded) in the winter, and a water corn mill as a result of this investment.

The mill is not included in the lease of 1586, but neither are other assets owned by Gibbons, such as the woodland which supplied 40 loads of firewood or the coneygree producing the 40 pair of rabbits for the tenant each year. Gibbons lived at another house in Sutton called The Hollies at the time, and the lease presumably enabled Percival Willoughby to live in the style of a country gentleman to which he was accustomed (possibly during the construction of the present Wollaton Hall at Nottingham), while Gibbons kept control of the assets associated with the estate, such as woods, warrens and mills. These assets *were* included when Thomas sold New Hall to his brother William when the Willoughby lease expired. The first clear documentary reference to the mill is dated June 7th 1595.[5] William Gibbons, son of Thomas, had purchased New Hall from his brother, but when William died, £400 of the £1,000 purchase price was still outstanding. William's widow, Mary, paid this amount, but it was a time when the law of property was changing. Establishing title was important, particularly for a woman, so in addition to the conveyance Mary secured a Recovery in Sutton court, a fine in the King's Bench court at Westminster, a common recovery in the Court of Common Pleas, and an indenture of uses, all of which include 'those Two watermylls with the appurtenances'.

These two watermills would be two sets of machinery in one building using the same mill pond, but there is no evidence to suggest that any operation other than grinding corn was carried out. Other mills were constructed in Sutton in the 1580s and 90s, one of the developers being Simon Parratt, an associate of the Gibbons family and party to the 1595 deed. The Sutton Court Roll for 1594 records an order that 'Simon Parratt gent. either fill in his ditch in the Park next to the millpool called Blademyll Poole or alter it so that it is not a nuisance to the cattle in the Park'. This mill was near the headwaters of the E Brook, as was another, a fulling mill made in 1577 which used the existing reservoir of Bracebridge Pool. Further downstream from New Hall Mill, Penns Mill was built which had three waterwheels driving a fulling mill and a blade mill as well as a corn mill.[6]

This spate of mill-building in Sutton no doubt reflects the general growth of population and markets in Elizabethan England, and the presence of ambitious entrepreneurs in Sutton. For centuries Sutton had been served by the Manorial Mills in the town, which had a monopoly enshrined in the customs of the feudal manor. After the Borough Charter of 1528, the Corporation gave the town mill to Thomas Kene, a nephew of Bishop Vesey; he or his son sold it to his relative Thomas Gibbons in 1582.[7] The purchase of the town mill has sometimes been taken as evidence that New Hall Mill was built to supplement it, i.e. after 1582, but I consider it more likely that New Hall Mill was already in existence, and the purchase was made to consolidate Gibbons's milling interests and clear up any residual customary objections to private mills. Perhaps Thomas Kene had allowed his monopoly to lapse, or maybe Thomas Gibbons encouraged his friends to invest in mills after he became the owner of the town mill. Perhaps these new mills took away some of the business of the old mill, which may have been less efficient after 500 years on the same site, and was never fully rebuilt after being wrecked in a great flood in 1668.

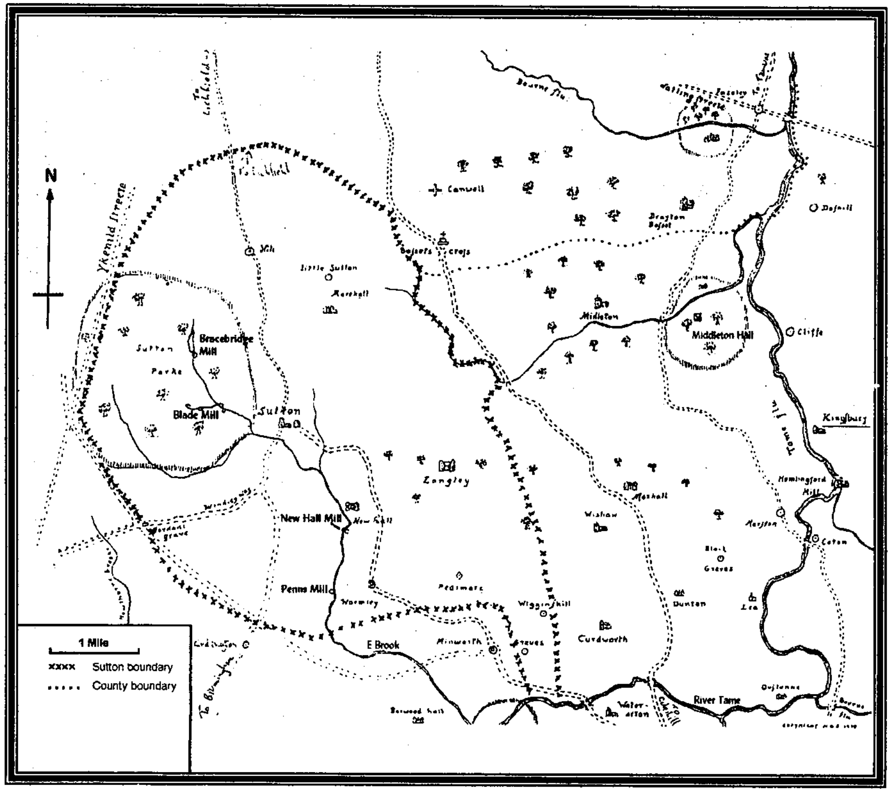


Figure 1. Sutton Coldfield 1656.

Based on a map by Norman Evans adapted from a contemporary survey by Robert Vaughan. Some of the places mentioned in the text have been added.

New Hall is built of stone, probably from local quarries, and many stone houses had been built in Sutton in Bishop Vesey's time, but at the mill, stone was probably only used as a base for a timber-framed structure and to buttress the earthworks, channels and culverts for the mill pool fleams and sluices. The substantial work of making the dam, wheel pits, and water-courses, was combined with building construction, one wall of the mill strengthening the dam and the watercourse structures providing solid foundations for the mill and the miller's house.

The mill continued in use throughout the 17th century. It was included in the sale of the New Hall Estate to the Sacheverell family in 1610 for £1880,[8] and the names of some of the millers appear in the Parish Register. A clearer idea of how the mill was managed emerges from a lease of 20th September 1709.[9] George Sacheverell of New Hall, Esquire, leased the mill to John Holloway and Robert Hicks, two Birmingham bakers, for 21 years at £30 per annum and a pair of capons at Christmas. The previous tenant was John Powers, who is mentioned in the parish register as being the miller at the Town Mills, and there is some evidence that he sub-let New Hall Mill to Samuel Twamley. Twamley continued to be the miller at New Hall under Holloway and Hicks, and there were Twamleys at the mill until at least 1830, presumably supplying flour principally to their immediate landlords.[10]

The lease refers to the mill cottage as 'Late in the occupation of John Powers', but it may have been some years since anyone lived there, as the cottage is described as 'lately pulled down'. The site of the cottage is described as a toft, meaning a platform where a building formerly stood, and the lease specifies that

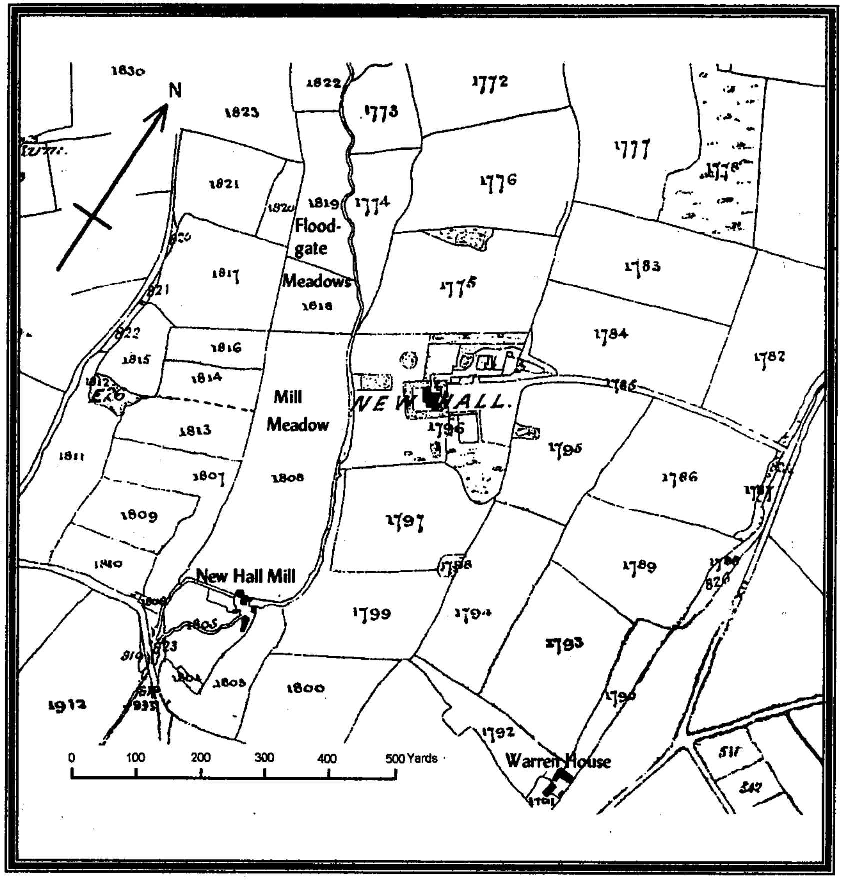


Figure 2. New Hall valley 1825.

The course of the E Brook past Floodgate Meadow (so named in the schedule) to the mill is effectively the leat. Land to the west of these meadows is outside the New Hall Estate; the fields south of the mill were usually included in the lease.

Sacheverell shall, before 29th September 1710 'cause to be erected and built and finished upon some place near the said mill a convenient dwelling house necessary and fitting for the use of the said mills'. This enables us to date at least the core part of the existing miller's cottage to 1710, probably the part with a stone plinth at the base of the wall. Many of the bricks in this part of the cottage bear a diagonal mould mark characteristic of local bricks of this period and their size also suggests a date between 1670 and 1750.

This lease also gives an idea of the mill. It had four pairs of millstones, three of them grey and one black, probably three Peak pairs and one Dutch Blue. Assuming that there were originally two water-wheels driving two sets of stones, the mill must have doubled in capacity, the four pairs of stones requiring four waterwheels. Introducing an additional wheel at the northern end of the mill was a relatively simple matter of enlarging the existing wheel-pit. But at the southern end, to preserve easy access to the mill, the external wheel parallel to the wall, or even an internal wheel there, may have been constructed. In the lease, Holloway and Hicks are to keep in good order the 'Millstones Millrinds Spindles Brasses Ropes Fleams Streams Watercourses Dams Stanks & Floodgates', and at the end of the lease, deliver up 'all the implements & utensills hereinafter mentioned that is to say a whitch (a large basket) three Pullis & Ropes an Iron Crow (i.e. a crow bar) a Sledge Hammer Sixteene Picks Two Chiswells for the dressing of the wheat mill'.

Further clauses in the lease stipulate that the tenants are to maintain the property, which included some land, according to good husbandry, and keep it in good repair with 'rough timber Quarrie stone & bricks', and 'Tinsell & underwood for the needfull repaire of the hedges & fences' supplied by the landlord. George Sacheverell reserved to himself the fishing, not only in the brook and pond, but also 'to draw the Floodgates belonging to the said Mills & to set & lay nets Leaps & Tonels for the takeing of fish there also at all convenient times when the water can be spared from the said Mills'. He retained the right to 'make use of the water in the said mill pool at all convenient times for the floating of the Great Mill Meadow when the same may bee spared & not hinder the mills from grinding and may also have free liberty if he or they please to set three gages in three several places in the Great Mill Meadow.'

These clauses show that the mill was closely integrated into the estate. The floating of the meadows, a practice which was invented in about 1600 and spread to this area in the middle of the seventeenth century, was becoming more scientific with the introduction of gauges. A meadow flooded in winter to a depth of 1 inch would give new shoots at least a month earlier in April, ideal for early lambing; flooded again for a few days and it would give a crop of hay two or three times as heavy as an unfloated meadow - nutrients would be deposited, and weeds and diseases kept at bay.[11] Well worth the investment, but even this was to be secondary to the needs of the mill for water power.

At the end of the century William Twamley was the lessee of the mill.[12] He is recorded in a valuation of New Hall Estate as paying £35 per annum, presumably under another 21-year lease. He was also renting over 30 acres of meadow land, totalling together with the mill £78-4s-2d per annum, and a marginal note reads 'These lands with the mill might probably be let at £84 per annum but the Tenant having been at great expense in repairs deserves consideration.' This invites speculation that the major alteration to the mill, in which the building took on its present appearance, had been undertaken in the 1780s by Twamley. These alterations would perhaps have included the installation of lay shafts driven by two more powerful waterwheels, in place of the old four waterwheel arrangement, though the disposition of these is problematic. The wheel at the southern end may have been internal in accordance with Figure 4, or it may have moved to its present position with wheelhouse. If the mill was reconstructed in the 1780s, this would explain the incorporation of the pre-existing wall of the miller's cottage in the west wall of the mill. The uniformity of the bricks in the building as it now stands suggests that the building it replaced had not been brick-built, otherwise many older bricks would have been re-used. A date much later than 1800 is unlikely, as 'In 1803 bricks larger than 10in. x 3in. x 5in. paid double tax, and after this the size settled down to 9in. x 4½in. x 3in.'[13], the bricks used in the mill being the 18th century norm at 2½in. high. On the basis of this highly speculative argument, dates for the buildings at New Hall Mill would be as follows:-

1710 Core of cottage, stable with hay-loft

1780 Mill, cottage extension, wagon shed and cowsheds.

William Twamley was one of a group of inhabitants of Sutton who accused the Corporation of misusing its income, and took their case to the High Court of Chancery. Chancery resolved the case after 39 years of deliberation, and elementary education for all Sutton children from 1825 was the result. Millers evidently knew their rights, and stuck to their guns.

The leasing and sub-letting of the mill continued, sometimes the lease being taken by a miller who operated the mill himself, sometimes by a dealer by whom the miller was employed. From the first, the mill had not been purely an estate mill grinding New Hall corn, but an enterprise to make a profit. Back in the 16th century Gibbons must have seen the need for greater milling capacity in the area as population and markets increased, when the decision to make the mill was taken. His purchase of the town mills in 1582 (in my opinion, some years after the building of New Hall Mill) rationalised the corn-milling industry in Sutton Coldfield by ensuring sufficient capacity and uniform quality. Whereas we have an image of the feudal mill as a place to which the subsistence farmer took his grain, receiving the same grain back again as flour to take home to bake his bread (less the miller's toll), by 1580 the miller was more often the middleman between farmer and baker; or even the client of a corn factor. Thus in 1709 Powers of the Town Mill was perhaps controlling the corn trade locally, with Twamley the miller at New Hall as his client, succeeded in this role by the Birmingham bakers. Although William Twamley in the 1790s appears to be at New Hall Mill as an independent miller, he had other interests, as his lease of Duddeston Mill in 1815 shows. Duddeston mill, on the edge of Birmingham, some 7 miles to the south of New Hall, had been a corn mill, but was now industrial, boring, rolling and grinding. William Twamley, of New Hall Mill, mealman, took on this lease for £180 a year, showing that he was a considerable businessman.[14]

The situation in 1851 was different again. Chadwick of New Hall was still the owner, according to the 1856 Valuation, William Dutton being his tenant at the Mill. William Dutton also leased nearby Warren House Farm, and more light is thrown on this in the census record for 1851. Then William Dutton lived at Warren House Farm, farming 150 acres employing three men, but described himself as 'Miller and Baker'.

Living at New Hall Mill was Henry Brockas, miller, and his wife Ann, daughter of Wiliam Dutton. Also at the mill were two journeyman millers, Robert Rochford and Thomas Raggens, as well as a house servant. This shows William Dutton at the head of a substantial family business, and a mill so busy as to provide work for three millers. 1851 perhaps marks the high point in the history of New Hall Mill, at its busiest and most productive, and with an apparently bright future under the Duttons - although William was dead by 1857, being succeeded as farmer of Warren House by his widowed daughter Ann Brockas, he had sons to follow in his footsteps.

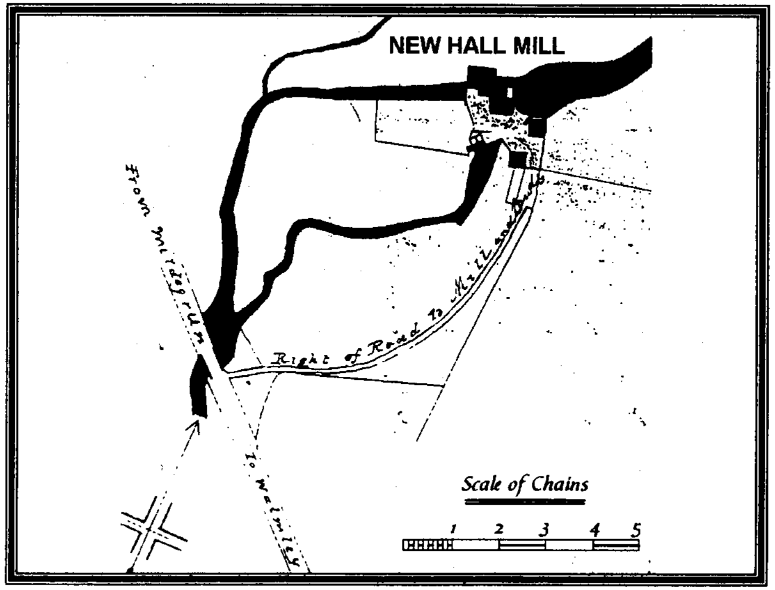


Figure 3. Plan from the 1861 lease.

This shows the mill pond with two feeders to the mill, presumably one for each waterwheel.

In 1861[15] Thomas and Joseph Dutton of Sutton Coldfield, farmers and millers, leased the mill for 21 years at £40 per annum from the owner of the New Hall Estate, John de Hely Chadwick Esquire. Thomas and Joseph Dutton are listed separately in the directory as 'farmer - Little Sutton', some 3 - 4 miles north of New Hall Mill, probably giving their name to Duttons Lane there. The lease contains a sketch plan of the premises, with the usual clauses about keeping it in good repair. The cottage, sub-let to Brighton (a miller born at Dovedale, according to the census) was singled out for the Duttons to 'substantially repair support glaze paint amend and keep', as though it had fallen into disrepair, and there is a clause requiring the mill to be insured. But the main interest of the document is the requirement on the Duttons to lay out 'at least the sum of seven hundred and sixty pounds in renewing and improving the said mill', according to a schedule which is worth quoting in full:-

'Two pairs first motion wheels to be made bevel or spur gear as may be decided upon one of the large wheels of each to be made suitable and fitted to each of the water wheel shafts as now fixed in the mill. One lay shaft to each made suitable to drive two pairs of stones with one prepared for three face wheels, with all chains, bolts and gear metal bearings to fit up the above. Also four sets of counter gear to drive four pairs of stones and one set to drive upright shaft fitted up with cast iron pillars, bridge trees, and bridging boxes fitted up with gun metal steps and lightener irons to stones, stone bushes cases hoppers, hopper stands fitted with silent feed motion with levers and regulating screws two pairs of new french stones four feet four inches diameter of best quality and two pair of best new grey stones five feet diameter. One new cast iron patent flour dressing machine barrel eight sheets long twenty inches diameter fitted up in wood case, with cast iron bridge trees brushes and shaft with gun metal bearings cast iron head and tail boards all turned up and bored, external brush with arms and rocking shaft all gearing to revolve and drive cylinder barrel with bottom stop and silent feed motion to regulate the feed of the same and all fitted up in the best manner elevator and smut machine one sack hoist with shaft chains bolts and barrel to suit the same fitted with pulleys and leather strap. One pair counter wheels and upright shaft with one cast iron chain with bridging box and set screws and face wheel and pinion to drive the flour dressing machine and sack hoist fitted with chains bolts and gun metal bearings to same one lay shaft and bevel wheels at top of upright to drive the sack hoist all the above shafting to be made of wrought iron.

All masonry and brickwork requisite to prepare shafts and wheels or with wood framing to receive the bedstones in mill floor and wood framing for upright shaft and lay shaft and sack hoist and large hopper in mill floor and fitted to silent feed hopper for the flour dressing machine.'

It should be possible to form an idea of the layout and appearance of the mill in 1861 from this schedule. The two waterwheels were probably at each end of the mill, with lay shafts parallel to the wheel axles. These shafts drove stone nuts turning spindles which caused the upper stones to revolve on the milling floor above. Grain was lifted up to hoppers on a garner floor, so the mill would have been roughly its present height. However, it is not clear how much alteration was done to achieve this; but if the 1780s date for the present building is correct, the installation seems to have been designed to fit into the existing building with minimum disturbance of the structure. No change was made to the position of the two waterwheels, as the new ones were to be fitted to axles already in place; the northern waterwheel was in a pit in what is now the diesel-engine room, but where was the southern wheel? I seem to be in a minority in thinking that it occupied the position shown in Figure 4, the majority view is that it was in the position occupied by the present waterwheel. The foundations for the northern lay-shaft can still be seen in the machinery floor, and the additional timbers to support millstones on the floor above are still there. Access to the mill was at the southern end, so the bay of building which now houses the

millstones may have been used for receipt and dispatch, office and shop, with the sack hoist at this end. One suggestion is that sacks of grain were unloaded using the sack hoist from carts where the present wheelhouse is, while sacks of flour were loaded onto carts through the door in the south wall at milling floor height.

An interesting piece of evidence from this period is the 1856 Parochial Valuation., which lists the buildings for rating purposes: Mill 23ft. by 51ft.; Lean-to 6ft. by 9ft.; Waggon House 22ft 3in. by 25ft. 6in.; Stable 20ft. 2in. by 21ft.; Barn and

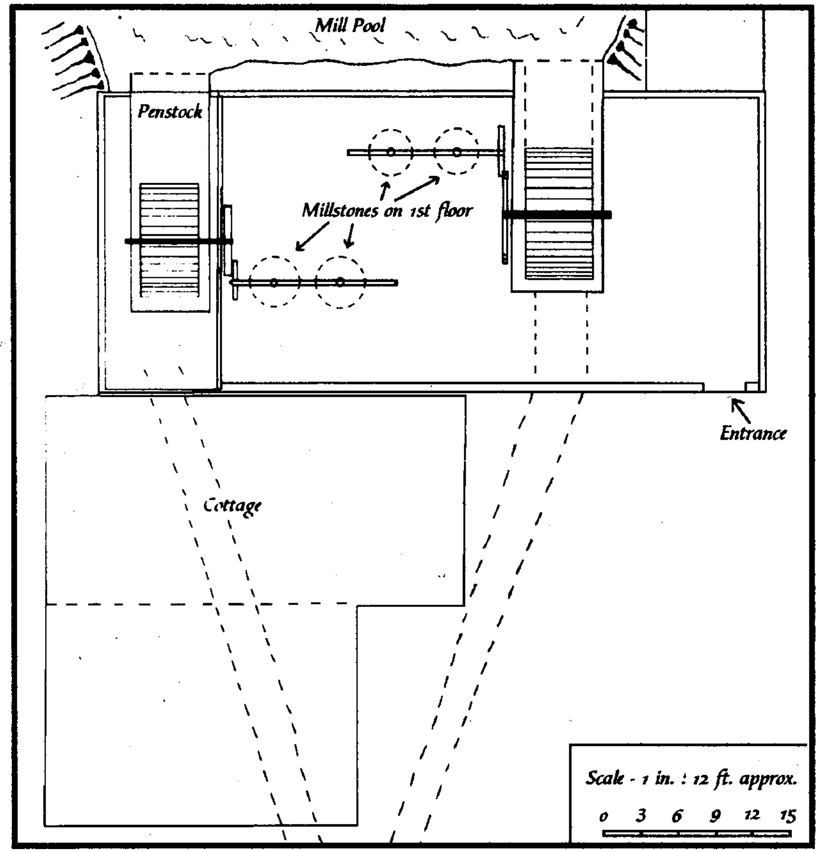
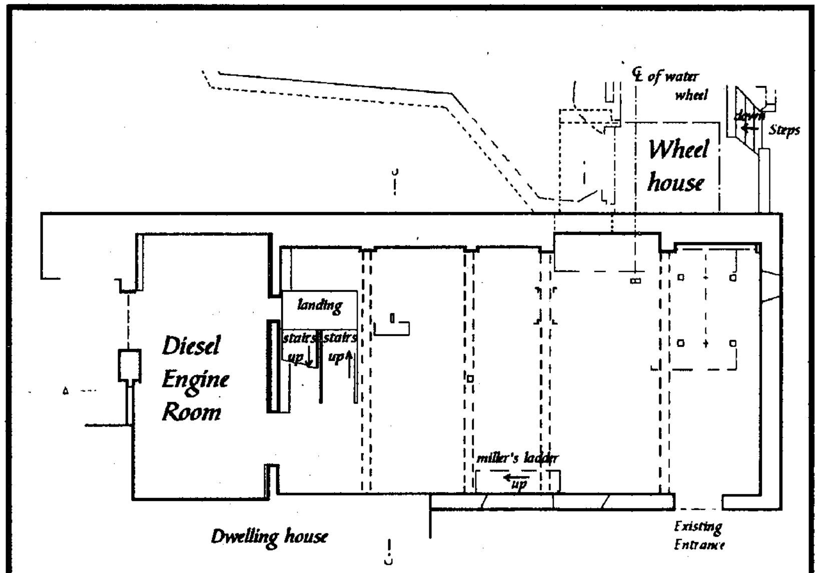


Figure 4. Plan of New Hall Mill to show a possible early arrangement of waterwheels and millstones. The two culverted tail-races are shown, which are still present; this diagram suggests the possibility that the original 16th century mill may have consisted of the central square area flanked by the two waterwheels which may then have been outside the building. This interpretation is hypothetical, and other possible arrangements have been suggested from the scant evidence available.



GROUND FLOOR PLAN (showing beams over)

Figure 5. The contract plan of 1972 shows the greater thickness of the walls in the central part. This is accounted for by a new internal wall constructed to carry the beams supporting the milling floor when it was raised to a higher level.

Cowhouse 16ft. by 50ft. 0in.; pigsty 8ft. by 17ft.; House (two storeys) 17ft. by 24ft. 3in. and 16ft. 3in. by 35ft. 3in.. This corresponds with the present-day ground plan. with the exception of the pigsty, the lean-to being now the wheel house. This survey normally gives the number of storeys in a building, but that column is left blank for the mill, which may indicate a one-storey building, but the column is also left blank for the nearby Penns Mills, which were at least two-storey buildings. The valuation was updated with pencil alterations up to about 1863, an entry at New Hall Mill being 'the mill is in an improved state'.

Another indication that the works specified in the 1861 lease were carried out comes with the transfer of the lease in 1866. Thomas Dutton died in 1865, and William and Henry Adcock, millers of Tamworth and Shustoke a few miles to the east of New Hall, paid Joseph Dutton £1,000 for the transfer of the remaining 16 years of the lease. The Duttons had thus recovered their investment, and the Adcocks had the mill until 1875. Henry Adcock had emigrated, and William sold the remainder of the lease to J.B.Tyler, a Birmingham corn factor, for £150, so nine years of use must have taken the shine off the new machinery.[16] We hear of Hutchinson brothers at the mill in 1878, and at the end of the lease, the New Hall Estate itself was up for sale[17].

The sale of the New Hall Estate in 1882 was brought about by the insolvency of John de Hely Chadwick, but as he is given as the proprietor of the New Hall Estate in 1892, the purchasers presumably had only a leasehold interest. The mill was bought by John McNee, miller, (New Hall became a school) and so ceased to be closely integrated with the New Hall Estate after some 300 years. However, the 1861 lease has no clauses reserving the rights of the owner to fish, use floodgates, etc., and the division of Sutton Parish transferred the Mill to Walmley Parish while the Hall remained in Trinity, so the links with the estate were already weakening. In 1887 the first edition of the 25 inch-to-the-mile Ordnance Survey map of the area was surveyed (published 1889), showing the same configuration of the mill as the 1861 lease (Figure 6), but shortly afterwards there were big changes at the mill. McNee (or Knee as he appears in the rate books) was still the owner in 1888, but Caldecott is given for 1889, so he had evidently bought the lease. Edward Caldecott was probably responsible for the last major alterations, (although Benjamin Styles, who took over in 1898, may have done it) which left the mill in more or less its present state.

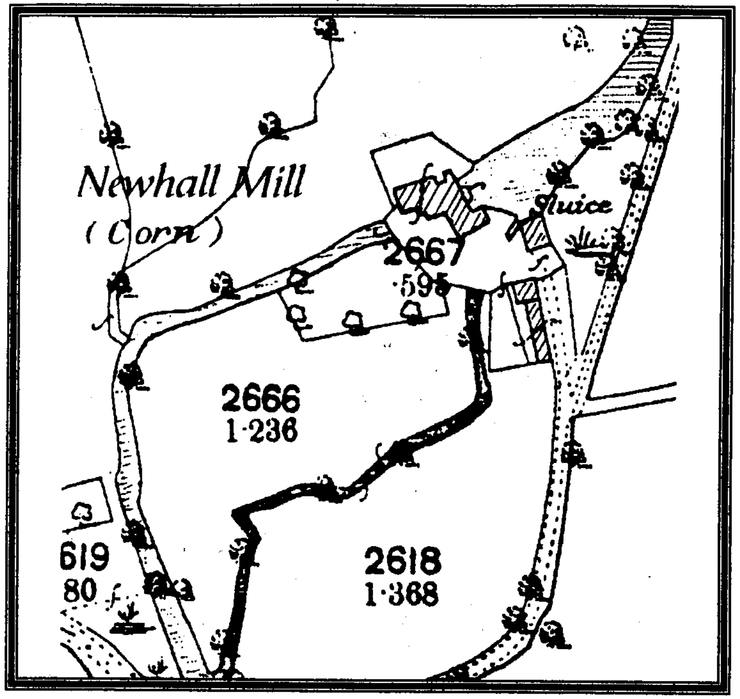


Figure 6. Ordnance Survey map 1889 (enlarged).
This shows the same layout as the 1861 plan, with the addition of a larger yard and a back garden to the cottage.

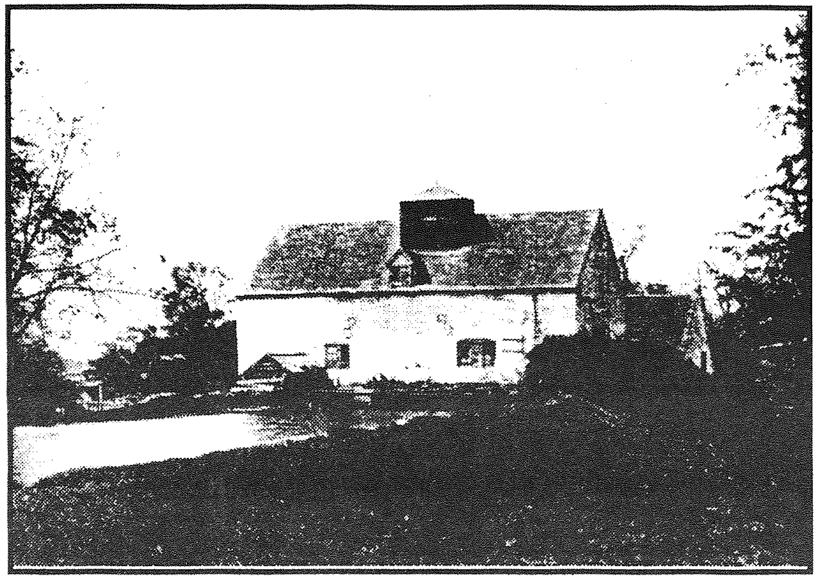


Plate 1. New Hall Mill, May 1895. This shows the mill pool with an inlet to the position of the old northern wheel (right-hand side), and what appears to be the wheelhouse of the present wheel at the south end.

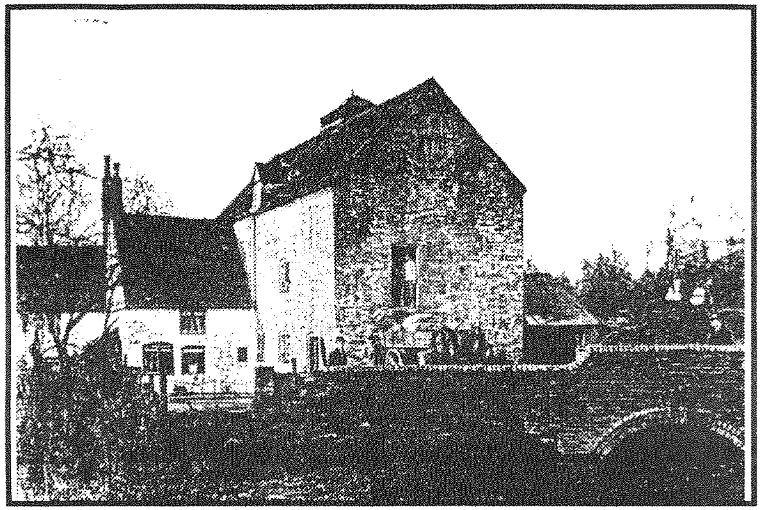


Plate 2. New Hall Mill at the turn of the century, cart being loaded from the milling floor.

If my guess about the 1861 layout is correct, the millstones were now (c.1895) moved to the southernmost bay of building against the south wall. At the same time the northern waterwheel was removed and a new floor made where the wheel-pit had been. The same was done for the other water-wheel, but by moving the wheel outside the building and at right-angles to its former alignment. It has been suggested that the old wheels had been breast-shot, while the present wheel is overshot. The re-alignment of the lay shaft inside the mill, and probable re-use of the cast iron supporting pillars may have necessitated the raising of the floor-level of the milling floor in this bay; at any rate it was raised by over a foot, and the old doorway

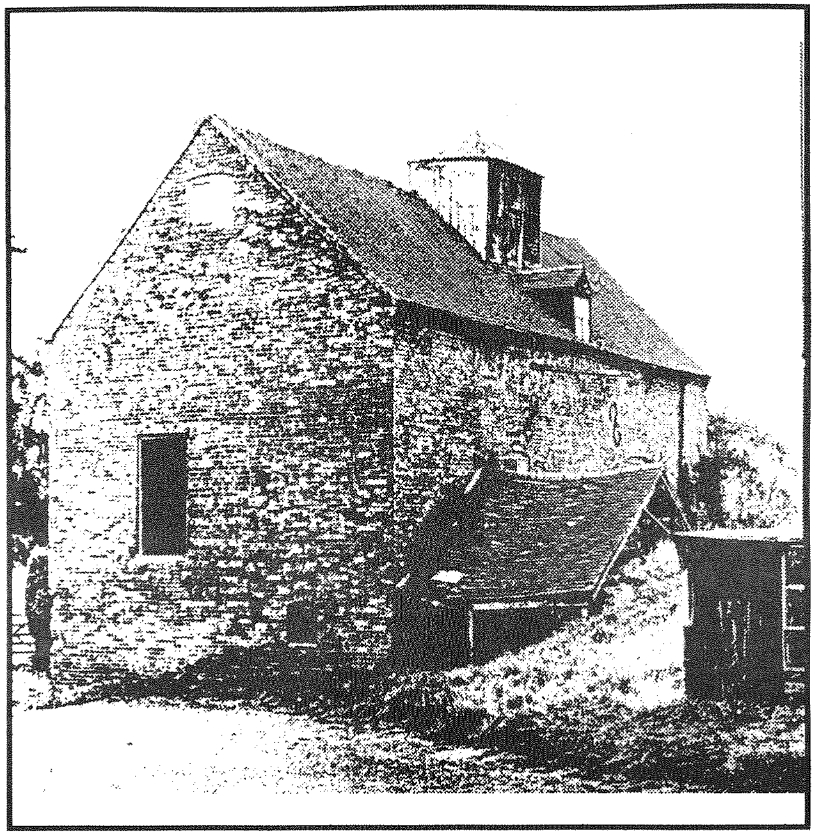


Plate 3. New Hall Mill immediately prior to restoration (c.1970).

This shows the infilled former doorway immediately to the left of the existing door. The bottom of the former doorway was five courses lower than the present door, showing that the interior floor level must have been raised. The bricks used to fill in the gap are larger than the original ones - there are five courses of the newer bricks to six of the originals.

blocked up. This old doorway would have been obstructed and useless as the millstones are now situated, so the opportunity was taken to construct a doorway at the new level, as shown in the early photographs of the mill. The old archway through which the chute feeding the northern wheel passed was blocked up, and a walkway along the poolside next to the mill wall was made - this remains one of the most attractive features of the mill today. The tail-races from the two waterwheels are still there under the mill, the southern one being adapted so that it drains the wheelpit of the present water wheel. As a result of these changes, a large area of the building was vacant, and this was probably done to allow for the installation of a range of machinery and plant suitable for the processing of animal feeds, which by then was becoming the only economically viable way of making a living from a small watermill. (The positioning of the southern millstones, the raising of the level of the milling floor, and the re-positioning of the doorway, could equally well be attributed to the 1861 alterations).

Flour mills at the end of the 19th century were still going concerns, as can be deduced from the census records. In 1881 Thomas Hutchinson, a 38-year-old master corn miller from Yorkshire, lived in the cottage with his wife and four children, with two domestic servants living in. In 1891, Edward Caldecott, 42 years old from Radnorshire lived there with his second wife and six children (another four were to be added) employing a carter who lived in. When Caldecott moved to Little Aston Mill, in 1898, he was succeeded as miller by Benjamin Styles, who had experience at mills in Oxfordshire. It was in 1899 that Mr. Styles co-operated with an Erdington baker and a Walmley farmer to convert a hundredweight of wheat growing in the field into 80 1lb loaves ready to eat between 10 a.m. and 6.00 p.m. on one August day.[18]

Benjamin Styles was something of a showman, and made the most of this feat, and the acceptance of two of the loaves by Queen Victoria. Verses in praise of the mill (and soliciting custom) were in circulation, and an advertisement in the *Sutton Coldfield and Erdington News* for 13th May 1911 reads:-

NEWHALL

YE OLD WATER MILL
AND STANDARD FLOUR

I grind wheat well, it's the real Standard Flour,
I can make you two sacks in less than an hour,
Please ask your baker for a written guarantee,
And if it's not forthcoming refer him to me. B. Styles

An earlier poem includes the line 'I have a good friend in the squire at the Hall', this being Walter Wilkinson, who had purchased the New Hall Estate in 1903. When Walter Wilkinson died in 1922, Benjamin Styles purchased New Hall Mill, but sold it back to the New Hall Estate (which had been purchased by Alfred Owen senior) in 1928. Benjamin Styles's descendants Charles Davis and Ben Davis were successively millers there until 1993, when Ben Davis died, and the Owen family remained at New Hall until 1981, retaining their interest in the Mill through the New Hall Mill Preservation Trust up to the present day.

The installation of milling machinery such as the Bamford combined machine required the provision of belt-drives to transfer the power from the water wheel, and the millers seem to have taken advantage of this to diversify into other belt-driven processes such as tool-sharpening and wood-sawing. There are still signs at the mill

advertising new-laid eggs, and these, with some livestock, a few beehives and a highly productive kitchen garden helped to make ends meet. In the Second World War the drive for home produced food gave a new economic lease of life to the mill, but afterwards the wheel proved insufficiently powerful and reliable. The present diesel engine was installed in 1949, but the decline in orders continued, as can be seen from the day book now kept at the mill.

With the diesel installed, the waterwheel fell into disuse, and was deprived of its main water supply by the drainage work on the E Brook undertaken in 1963/4. This relieved flooding upstream by channelling the brook in a new course along the bottom of the valley, leaving only a few springs to fill the leat and millpond. However, in 1971 Sir Alfred Owen decided to restore the water mill so that it could be shown to visitors, and extensive repairs and alterations were undertaken with a view to retaining its character, and this, essentially, is the mill operated by the Friends of New Hall Mill today. The New Hall Mill Preservation Trust was established and became the owner of the Mill, with Ben Davis as the miller until his death in 1993; in 1995 the Midland Wind and Water Mills Group prepared the Mill for its first Open Day, May 12th 1996. Since then it has been operated by the Friends of New Hall Mill, a voluntary organisation aiming to maintain and operate the mill in conjunction with the Trust, and to promote it as an educational resource and heritage centre.

References

Copies of all the following can be found in Sutton Coldfield Reference Library.

1. Fentiman, A. F., The New Hall Estate (notes), 1996, (unpublished).

2. Lea, R.M., Sutton Coldfield Bailiff's Account, 1433/4, (forthcoming).

3. *Victoria History of the County of Warwick*, **Vol. 4**, 1947, p. 231.

4. University of Nottingham Library, Ref. Mid 4525/1.

5. Staffordshire County Record Office, Ref. 50/B5/56.

6. Williams, K. J., *Bracebridge Fulling Mill*, 1985, (unpublished).
Penns Mill - Wire Mill, 1978 (unpublished)

7. Deeds in Sutton Reference Library.

8. Fentiman,A.F., *op.cit.*

9. Staffordshire County Record Office, Ref. 50/B29/56.

10. Williams, K.J., *New Hall Corn Mill.*

11. Thirsk, J., ed., *Agrarian History of England and Wales,* **Vol. 4,** p.181, 1967.

12. Lichfield Joint Record Office, Valuation of Mr. Chadwick's Estates, 28th.Feb. 1795.

13. Hudson, K., *Building Materials*, (Industrial Archaeology Series), 1973.

14. Sutton Library, Eddowes Perry & Osborne Deed 61.

15, 16. Nottingham Record Office, Ref. DDRL 52/2.

17, 18. Williams, K.J., *New Hall Corn Mill*, c.1980, (unpublished).

Reference has been made throughout to the Parish Registers, Corn Rent Schedule and map of 1824/5, Parochial Valuation of 1856, census enumerators books, rate books, Ordnance Survey maps, Directories, and sale catalogues.

NEW HALL MILL, SUTTON COLDFIELD,

An account of the existing machinery and some speculation about what might have gone before.

by Tim Booth

Any account of New Hall Mill will illustrate some of the problems which frequently face both historians and molinologists. Our predecessors repeatedly failed to appreciate the needs of future researchers by not recording their mills in sufficient detail! Many of the earlier references to mills in this region neither specify them by name or by site. Only a particular knowledge of the history of the area makes it possible to attribute some of these references to the present location. Even when some detail of the machinery is specified, as with the four pairs of stones recorded in the lease of 1709, the document fails to tell us how they were driven, just at a time when we suspect that major improvements in mill gearing were being made. Was New Hall Mill at the leading edge of mill technology or just another multi-wheeled, single-geared installation? Equally frustrating is a lack of detailed early maps and plans to locate watercourses, buildings and machinery. This article about New Hall Mill uses field evidence as its primary source of information in an attempt to tie in what the historical documents tell us. However, development of this mill site over many centuries has inevitably clouded the evidence and left room for much speculation about what might have been.

The overshot waterwheel is situated externally against the rear wall of the mill at its south-east corner and is protected by a wheelhouse. Its site is thought to be a late eighteenth century alteration, perhaps made to accommodate a wider, more powerful wheel. It has iron hubs, arms and shrouds and galvanised mild steel buckets and sole plates. Until their replacement early in 1997, the bucket risers and sole plates were of wood. However, the wheel is used infrequently and when not operating it sits for long periods partly in the tail water. Unfortunately, the mill lost the vast majority of its water supply when the E Brook was diverted in the 1960s and when the mill was restored, in the 1970s, the only way to restore water power was by means of a holding tank and recycling pump positioned in the tail race. Unless the pump is run continuously and expensively, the tank fills to above the bottom of the waterwheel so repeated partial immersion decayed the timber and unbalanced its motion. The waterwheel measures 11ft. diameter by 6ft. wide and has two sets of six arms and thirty-six buckets. Although it is marked on the shroud with the name T. Price, it looks like a typical product of the foundry of George Turton of Kidderminster, even having the characteristic fractures at the point where the arms meet the shroud. Turton did supply a Thomas Price of Witton Lane, Hill Top, West Bromwich with gearwheels, pulleys and even a horse wheel from 1866 but there is no mention of a waterwheel

by the end of Turton's surviving order books in 1877.[1] However, Turton continued to produce similar wheels until the end of the nineteenth century. An alternative suggestion for the maker is the firm of Thomas and Henry Price who were ironfounders at Bilston in the early nineteenth century.[2]

The wheel is fed from a wooden pentrough through a gate controlled by a roller and chain mechanism. During restoration in the 1970s, an outer gate was added to the pentrough which allows repairs to be carried out without lowering the pond. After flowing over the wheel, the water escapes through a culvert beneath the mill which is actually the wheel pit of an earlier waterwheel. In the rear wall of the mill, in line with the culvert, the blocked-up opening where the pentrough for this earlier wheel entered the mill is still visible. The size of this opening and the culvert below suggest the earlier wheel was about 3ft. wide, significantly narrower than the present wheel.

The waterwheel is wedged onto an iron shaft which appears too long, protruding more than 4ft. beyond the wheel at the outside end. Although it seems unlikely that it was the original, the wheelhouse appears to have been made or altered to take a long shaft when it would seem simpler to have cut the shaft to a shorter length. The additional length proved useful in 1980 when the shaft sheared. The miller, Ben Davis, had plenty of room to jack up the shaft and position a collar round it so that he could turn it to clean up the end. He then drilled and tapped the end before bolting on a new plate and journal. The shaft is 8in. square in section with a raised rib on each face and about 15ft. 6in. long. There is a suggestion of a hearth and flue in the

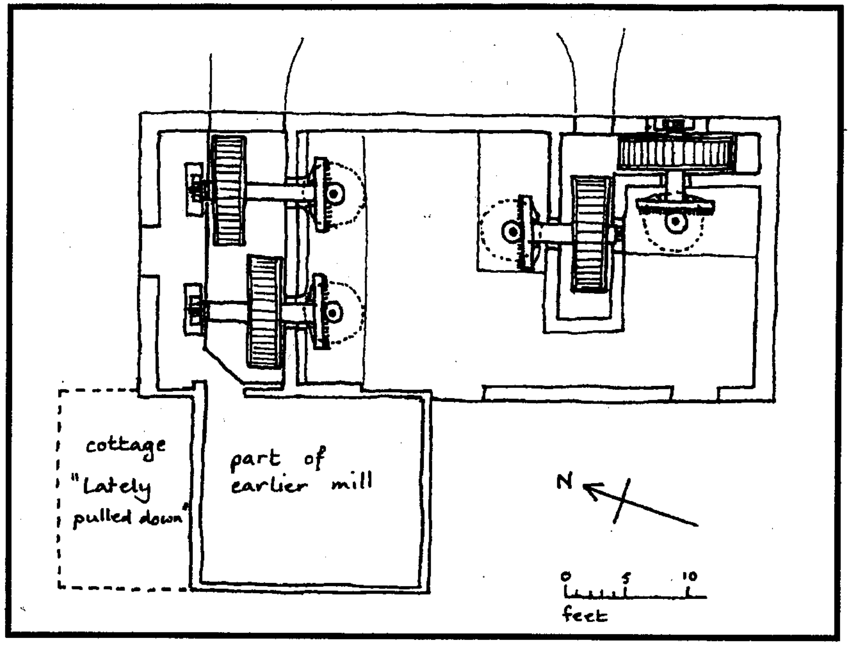


Figure 1. Conjectural plan of buildings and machinery in 1709.

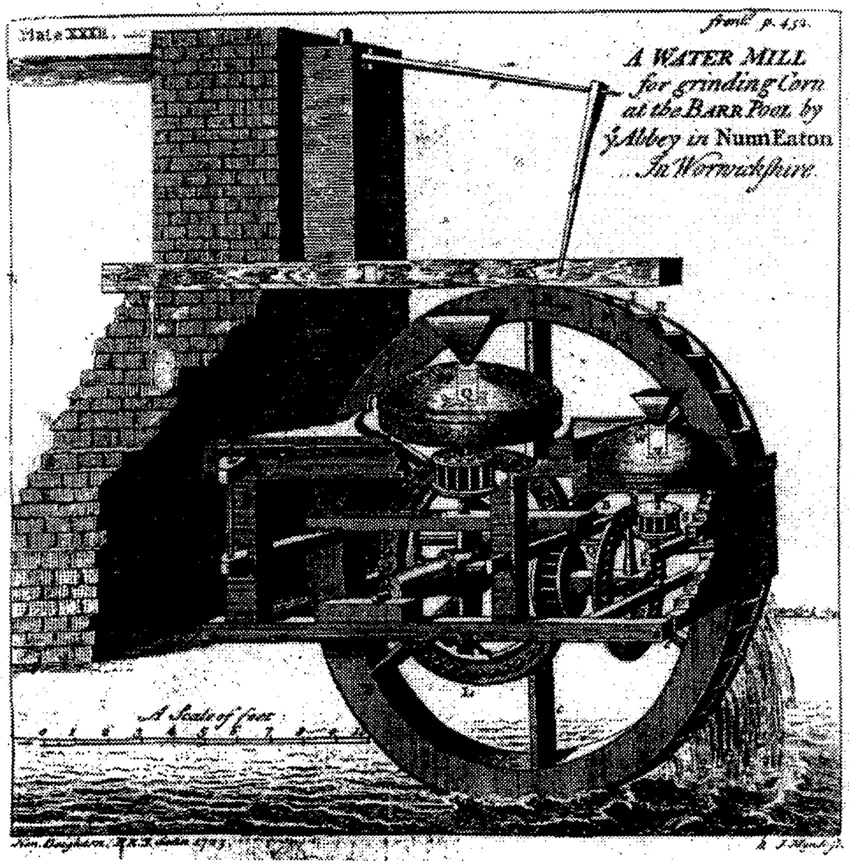


Figure 2. A drawing of the machinery in the mill at Barr Pool, Nuneaton, drawn by Henry Beighton in 1723 and published in ***A Course of Experimental Philosophy*** by J.T.Desagulier (London, 1744).

corner of the wheelhouse near the end of the shaft and what might be a flue can also be seen in a corner of the northern wheelhouse. Perhaps a miller here tried lighting fires near the waterwheels to prevent them from freezing up in hard winters, a practice certainly used elsewhere.

The heavy cast iron spur pitwheel is keyed onto the shaft near its inner end but is largely hidden behind a wooden casing. It is hung over a pit which is open to water below and, in part, over 3ft. wide. The narrower part of this pit is obstructed by reinforcing brickwork which has been built against much of the rear wall of the mill and appears to date from the mid-nineteenth century. The inner wall of the pit is partially capped with large blocks of sandstone. It seems unlikely that such a wide pit would have been constructed for the pitwheel, so it is conceivable that this pit once held a waterwheel. This may be the location of the fourth waterwheel needed to drive

the four pairs of stones mentioned in the lease of 1709, two others being positioned in the wide northern wheelpit and one in the culvert mentioned above (Figure 1). That each pair of stones should have its own waterwheel would be a reasonable assumption as the earliest definite example in the Midlands of two pairs of stones being driven by a single waterwheel is still the mill at Barr Pool, Nuneaton, drawn by Henry Beighton in 1723 (Figure 2 opposite). It is difficult to imagine the E Brook ever being able to power four waterwheels but presumably they would not necessarily all have been in use at the same time. Equally, although the expanse of water immediately behind the mill is now referred to as the pond, it is really only a widening of the leat as it approaches the mill. There is a low lying area of land right next to the leat some six hundred yards above the mill which would make an ideal storage pond of considerable capacity. It lies just across the leat from the fields called Floodgate Meadows and just above Mill Meadow. It would have been a lot easier to 'float' the 'Great Mill Meadow' from a pond here than from down by the mill. It might even be worth considering this site as a possible location for an early mill (see Figure 3). The present mill pond appears to have been increased in width as there is a bulge in its southern bank bringing it right up behind the cartshed where a spillway has been created. It seems unlikely that the cartshed, which dates from the second half of the eighteenth century, would have been deliberately built right through the pond bank although the lower part of the wall against the pond is battered as if to withstand increased pressure. However, the presence of a blocked-up doorway high up in this wall suggests there might even once have been a cartway between this building and the pond. Therefore, this increase in size of the pond may have been made in the late eighteenth or early nineteenth century, but certainly by 1825 (see Figure 4).

The present pitwheel is said to have been installed in about 1920 as its predecessor was badly worn and continually slipped on the shaft.[3] It has eight arms and is cast in two parts, measuring 9ft. 2in. diameter with 136 teeth. It shows signs of wear on the teeth, perhaps not surprising after being in regular use for about thirty years. However, worn teeth seem to have been a recurring problem for only five years after gearing of this type was first fitted here, the miller, Henry Adcock, was imploring the millwright, Robert Summers, '...please to come as soon as you possible can for I have an idea the pit & pinion wheels are injuring each other very much...'.[4] The pitwheel drives a cast iron spur pinion, 22in. diameter with twenty-six teeth, on a horizontal shaft. This shaft is about 8ft. 6in. long and 5in. diameter at the pinion reducing to 4in. along the rest of its length. It carries a 44in. diameter pulley with an 8in. face, which is connected by a belt to an overhead shaft, and two bevel gears to drive the stone nuts. Interestingly, the bevel gears are situated on opposite sides of their respective stone nuts so the stones run in opposite directions. The two bevel gears are 4ft. diameter and have seventy-two teeth while the bevel mortised stone nuts are each 23in. diameter with thirty-one cogs. Two 3in. diameter stone spindles carry the drive to the millstones above. The hurst frame is all iron with fixed bridgetrees and centre-lift tentering gear operated by handwheels above the meal trough (Figure 5). Despite this sophistication the hurst seems strangely incomplete as there is no built-in system for disengaging the stone nuts. They have to be lifted with a crowbar in a very awkward confined space and are then held out of gear by rough wedges or half cylinders of metal which can be tied to the spindles with string! Perhaps the lack of finish is a result of the new tenants in 1861 also being required to

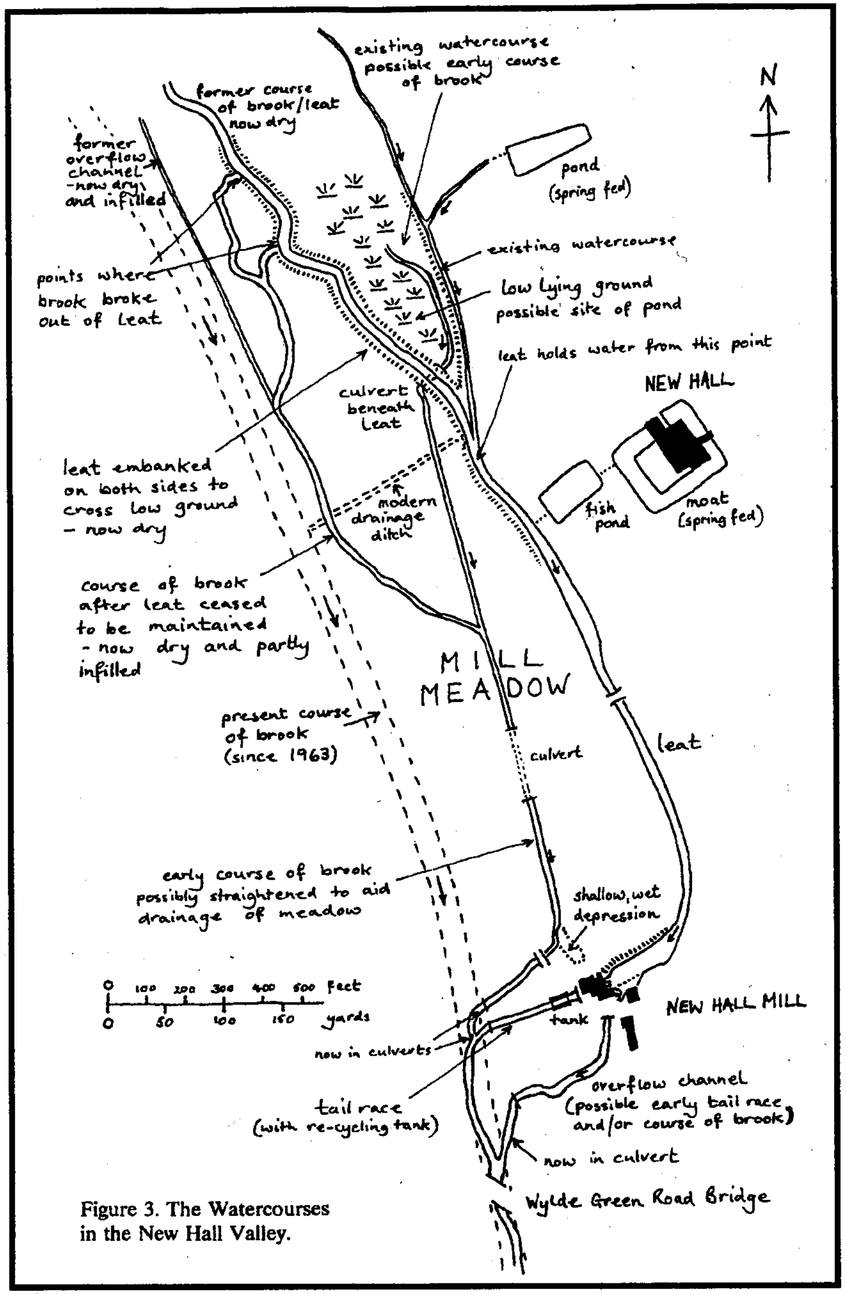


Figure 3. The Watercourses in the New Hall Valley.

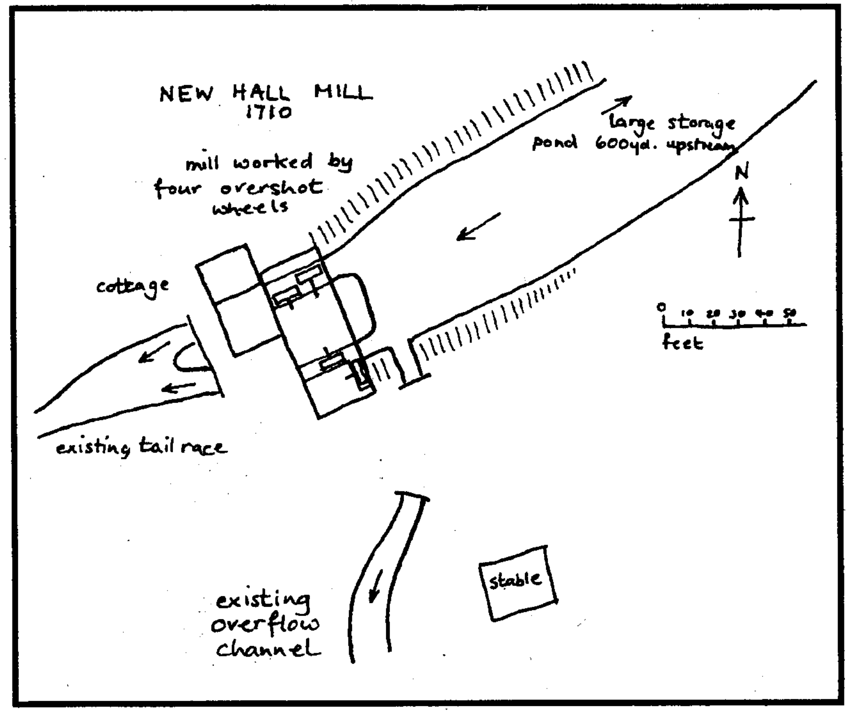


Figure 4. Conjectural site plan for 1825.

pay for re-equipping the mill. Above the hurst, carried on brackets on the south wall of the mill, is a 2½in. diameter layshaft driven from the pulley on the main horizontal shaft. The layshaft carries further pulleys, one to drive the meal creeper above the meal trough, another to drive a combined milling machine and a third which can be used to drive the sack hoist and another combined milling machine at the northern end of the mill, however current practice is to drive these last two by the diesel engine.

The diesel engine is situated in what was the wheelhouse of the waterwheel at the northern end of the mill (Figure 6). It has so far not been possible to determine just when this wheel was removed but it must have been late in the nineteenth century or even early this century. A photograph of May 1895 shows that the short head race carrying the water from the pond to the pentrough was still open. The blocked arch for the pentrough is about 7ft. wide, presumably the pit was a similar width, and the position of the shaft opening and a scrape on the wall suggest an overshot wheel of about 11ft. diameter, in fact, very much like the existing. Equally, on the machinery floor, the clear positions of the bearings for a horizontal shaft show that the last machinery here was much like the existing. Part of an earlier waterwheel shaft opening is also visible, somewhat lower and closer to the upstream wall which

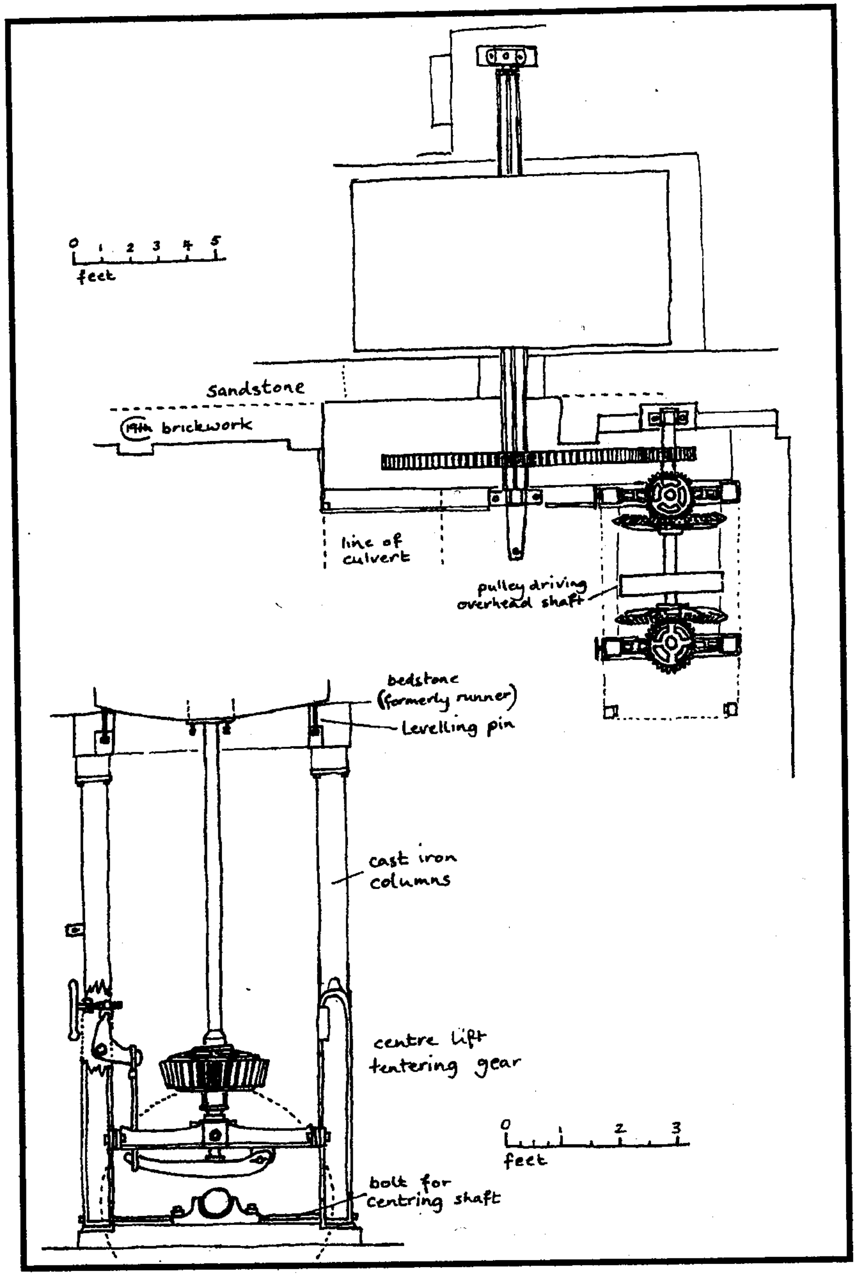


Figure 5. Plan and section of the existing waterpowered machinery.

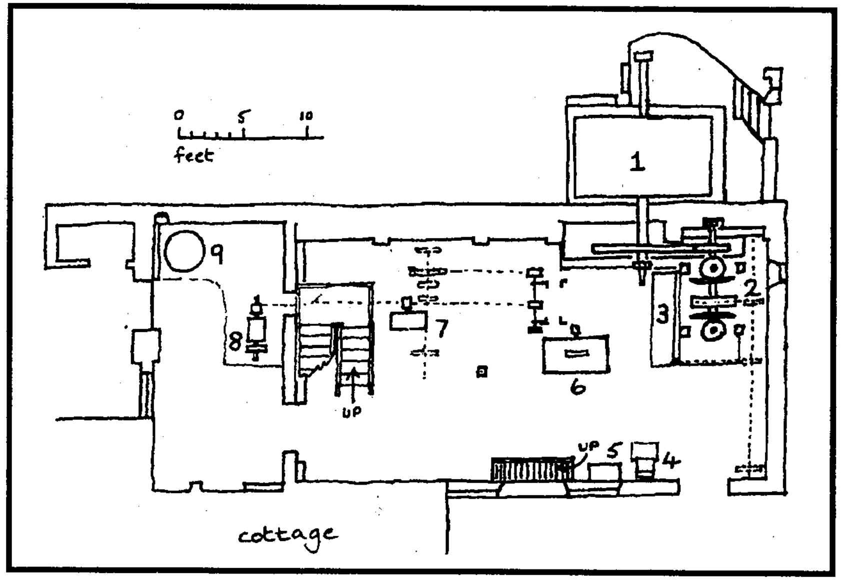


Figure 6. General arrangement of the machinery floor.

1. Waterwheel
2. Waterpowered machinery
3. Meal trough
4. Sack scales
5. Miller's desk
6. Saw table
7. Hammer mill
8. Diesel engine
9. Cooling tank

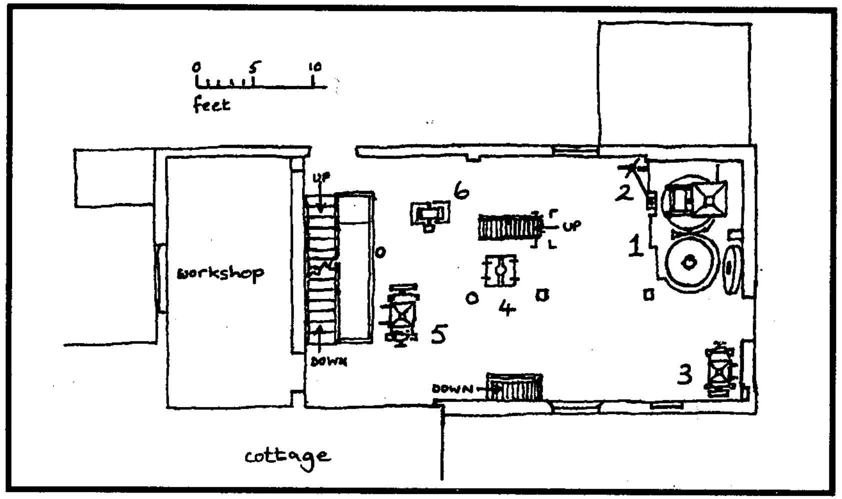


Figure 7. General arrangement of the stone floor.

1. Millstones
2. Stone crane
3. Harrison McGregor milling machine
4. Sack hoist trapdoor
5. Bamford milling machine
6. Grindstone

would mean a wheel of about 9ft. diameter. The tailrace from the northern wheelpit passed directly beneath the mill cottage. It seems odd that anyone would choose to build a cottage in a location so obviously prone to damp so it is possible that the oldest, half-timbered part of the cottage was never intended for domestic use and was actually part of an early mill on this site. The existence of three blocked openings in the wall adjoining the mill might also suggest this. There is a building adjoining its north wall which could have been the first cottage here. It is built of brick on a sandstone base, suggesting that it may have replaced an earlier timber framed structure, and has a steeply pitched roof. Many of the bricks have a raised diagonal mark which is said to date them to around the beginning of the eighteenth century. Perhaps this one-up, one-down structure is the cottage erected by George Sacheverell in 1709-10 on the foundations of the one which had been 'lately pulled down'. Of course, there are no plans which might substantiate this, nor any maps to show whether the existing leat dates from this time, so it is not even certain that the first mill had overshot wheels. Indeed, there is another watercourse which approaches the mill from the north, parallel to the leat, but in the valley bottom

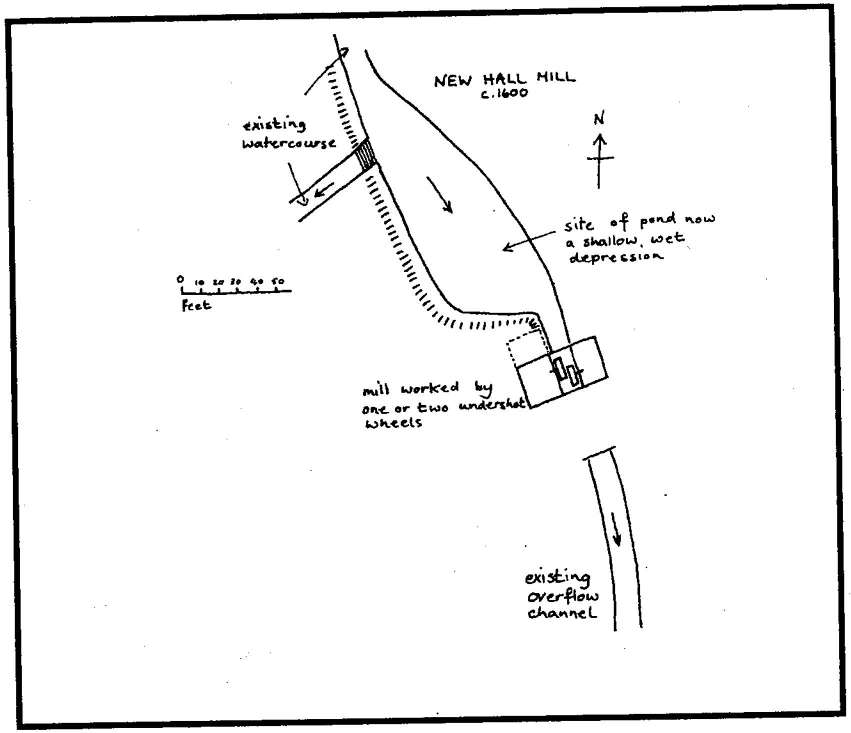


Figure 8. Conjectural site plan of New Hall Mill c.1600.

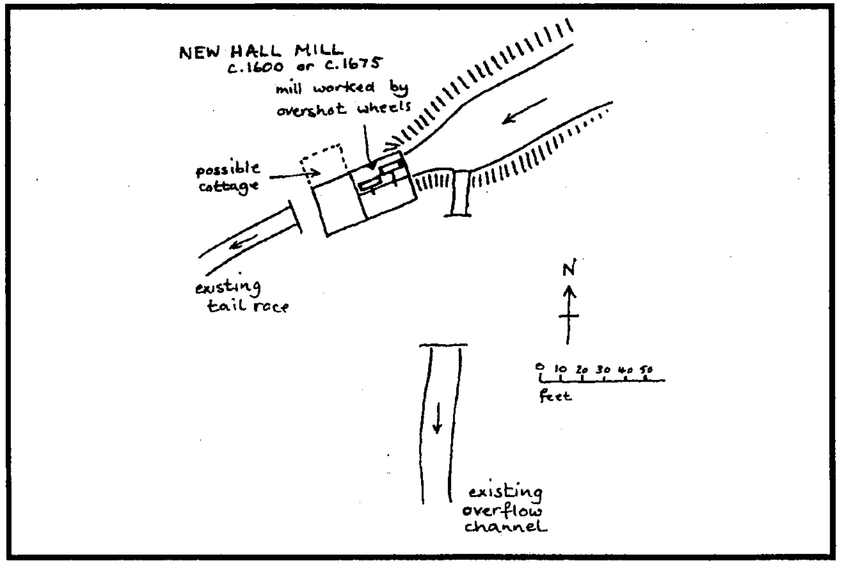


Figure 9. Conjectural site plan of New Hall Mill c.1600 or c.1675,

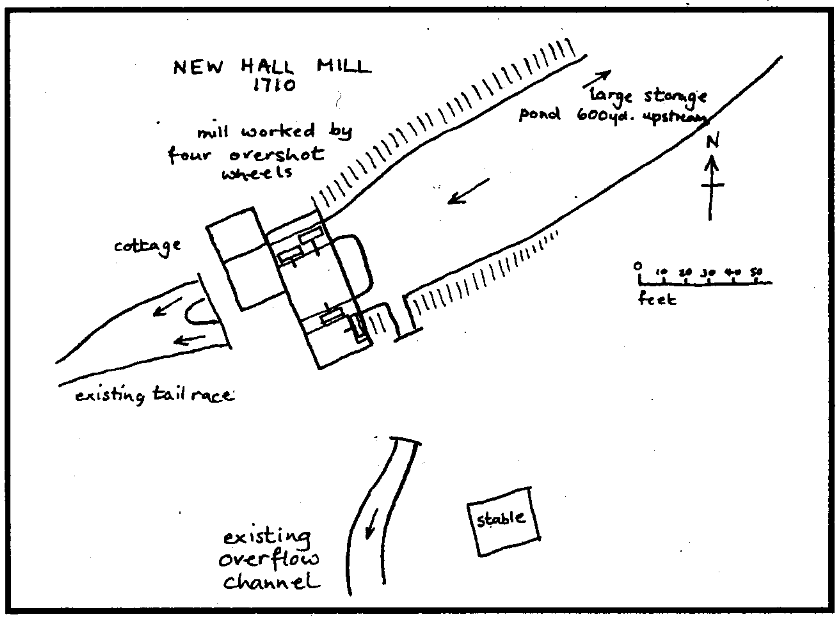


Figure 10 . Conjectural site plan of New Hall Mill in 1710.

(Figure 3). This looks to have been straightened, probably to aid drainage, but, after the leat fell out of use, the E Brook reverted to this course, so it is quite possibly the original course of the stream through the valley. About fifty yards north of the mill cottage the watercourse turns to the west but a shallow, wet depression continues almost to the back garden. It is possible that this was once a leat feeding one or even two undershot wheels, the tail water returning to the brook by what is now the overflow channel (Figure 8). There is no record of the damage caused in this area by the great flood of 1668. However, watercourses must have been left heavily silted even if buildings or machinery were not severely damaged, though the suggested site of the 'lately pulled down' cottage would have taken the full force of the flood. Perhaps this momentous event provided the incentive to construct a leat higher on the valley side, away from future problems.

The wheelpit has been filled in to ground floor level and now forms the bed for the twin-cylinder Ruston Hornsby diesel engine which Ben Davis bought at the Royal Show at Shrewsbury in 1949. Indeed, the engine was the 'show model' and was delivered from the Company's Boulton Works in Lincoln in September of that year.[5] The engine was installed so that its driving pulley was aligned with the old wheelshaft opening which, after suitable enlargement, enabled connection to be made to three pulleys on a shaft from where the drive was taken to the sack hoist, a combined milling machine and a saw table. Alternatively, a shorter belt could be used to connect the engine directly to a 10in. Feedmore Master Hammer Mill by Minneapolis Moline and supplied by F.H. Sims of 154, Moor Street, Birmingham in 1950.[6] This machine consists of rotating flails which beat the grain through a screen of chosen size. The product is blown by a fan into a cyclone and thence to the bagging-up point.

It is clear that the floor levels of the stone floor and the room above the northern wheelhouse have been raised at some time. This appears to have been done when the reinforcing brickwork was built against the rear wall and probably when the new machinery was fitted in 1861. Evidence for this is two blocked doorways, one at each end of the stone floor, the one in the southern wall being replaced by the existing loading door. It is also noticeable that the windows of the stone floor appear to be set rather low for the height of the room. In the room above the northern wheelhouse, now the workshop, the original window has been blocked and a new opening formed at an appropriate level. There is a small blocked opening high up above the waterwheel in the east wall of the stone floor but its purpose is not known.

The millstones are against the southern wall of the stone floor. Both pairs are French burrs, the eastern pair being 52½in. diameter, supplied by Ruston Proctor & Co. of Lincoln whose name appears on the eye of the runner. The western stones are actually far from being a pair as the runner has a diameter of 52in. while the bedstone is only 48in. diameter. Ben Davis purchased odd millstones that were in good condition from local mills when they closed down. The western bedstone clearly started life as a runner, with a domed back and balance boxes while the filled slots for the rind can be seen on the working face. There is a complete set of furniture for both pairs although the silent feed mechanism specified in the 1861 schedule was either never fitted or abandoned. There are now no twist pegs to adjust the angle of the shoes, however, brackets on the hurst frame above the tentering handwheels and holes in the floor timbers above show that some such control once existed. One of these brackets has long been used to support the meal creeper.

Although a silent feed mechanism delivered the grain directly to the eye of the stones without a damsel or a shoe, this arrangement would also have needed some form of control near the delivery spout to regulate the rate of feed. Millers at New Hall have had to climb the ladder to make any such adjustments for many years. In the 1970's restoration, a stone crane was fitted to replace Ben Davis's block and tackle. However, the lugs on the crane arms are too big for the holes in the western runner so that still has to be handled in the original way.

In the south-western corner of the stone floor there is a combined milling machine which can also be driven by the waterwheel. Before the 1970's restoration, it stood at the other end of the mill and was worked by the diesel engine. It was made by Harrison McGregor & Co. Ltd. and probably dates from the beginning of this century. It has a pair of steel rolls and an Albion Patent Grinding Mill consisting of a pair of grooved, conical steel plates. The gap between the rolls is controlled by two handles and that between the plates by a handwheel. Sliding gates allow the miller to chose the path of the grain, either dropped directly in between the rolls or along an agitated shoe to the grinding mill.

Until the 1970's restoration, it was possible to see the position of the other two pairs of millstones at the northern end of the stone floor. Although their outline was clear in the floorboards, the author failed to record their diameter. The subsequent insertion of a 'visitor friendly' staircase and reboarding of much of the stone floor means that it is not now possible to confirm whether they were the 5ft. diameter Peak stones as specified in the 1861 schedule. All that remains to show their position is some heavy timber framing beneath the boards. It may be significant that there was a stone crane fitted at this end of the mill, the locating pins being visible until the 1970s Perhaps a crane was necessary to handle the additional weight of such large stones. However, the worn-out Peak stones around the mill all seem to be about 4ft. 2in diameter. The other combined milling machine, which is currently driven by the diesel engine, stands on the site of one these pairs of stones. It was made by Henry Bamford & Sons but in age, arrangement and operation it is very similar to the one by Harrison McGregor & Co. Ltd. Other equipment on this floor consists of a small grindstone, a wooden cased fan and the drum of a dressing or cleaning machine. It is fitted with what appears to be perforated zinc sheet of a single gauge, so may last have been used for grain cleaning in conjunction with the fan. There is a complete set of brushes for such a machine kept in the workshop. The 1861 schedule specified the fitting of a smutter which, from the 1870s, usually meant one of the vertical cylinder machines imported from America. However, in 1861 it may have been the angled cylinder type with a fan below to remove the dirt and smut. Perhaps the items mentioned above were part of this machine. The schedule contains a very detailed description of the type of wire machine which was to be fitted but the surviving drum is not part of it. There is some evidence in the ceiling timbers at this end of the mill of a support for an upright shaft, and a chair set in the east wall would have supported a bearing carrying the end of a layshaft driven by the crown wheel. This layshaft would have been in the right position to drive a sack hoist mechanism in the 'hutch' which rises through the mill roof. There are other bearing positions in the walls of the stone floor which clearly have nothing to do with the existing machinery and are the subject of much conjecture as to their purpose. Perhaps the most curious are the single, substantial bracket on the south wall behind the millstones and an opening in the rear wall to the platform between the headraces.

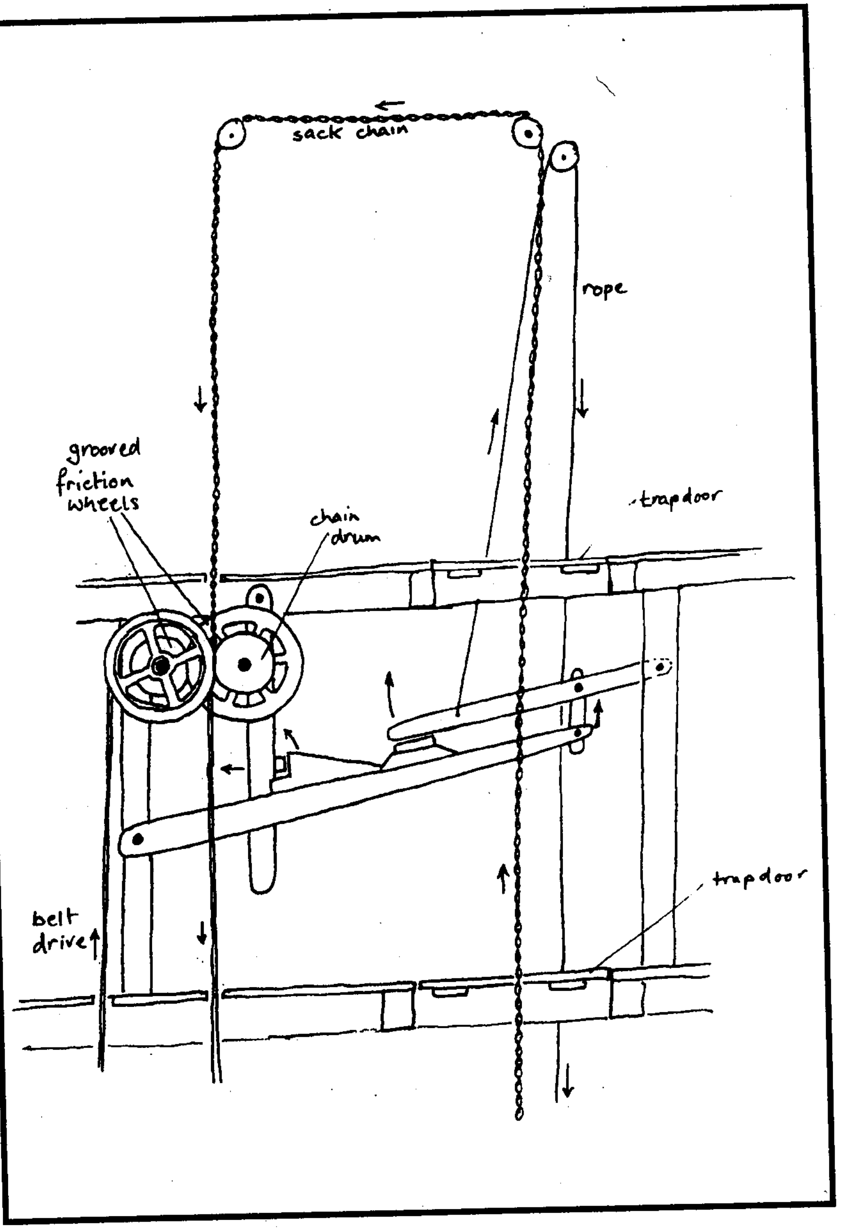


Figure 11. The sack hoist mechanism.

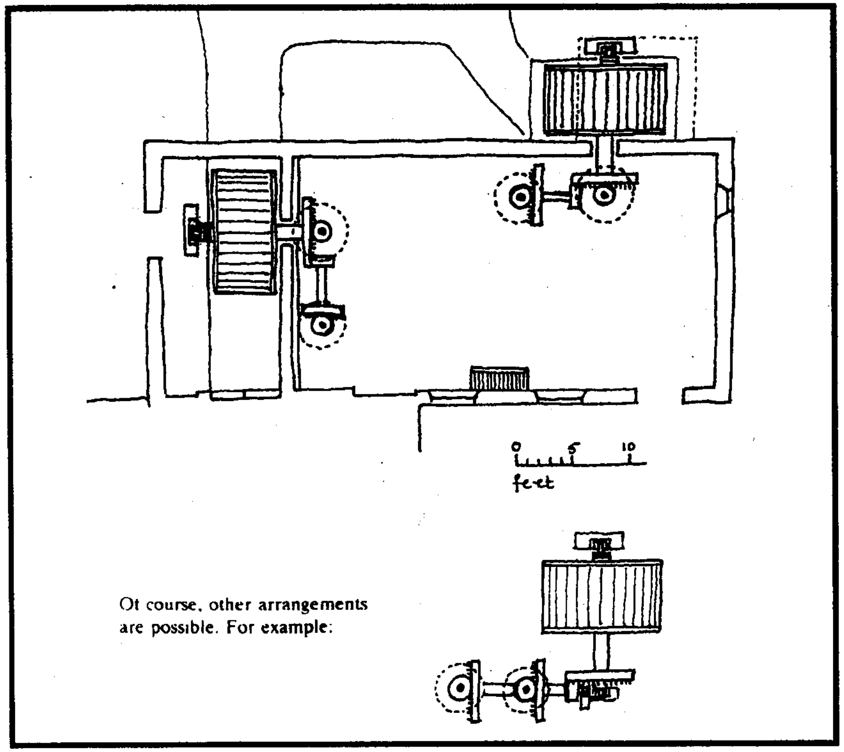


Figure 12. Conjectural arrangement of the machinery from c.1780 to 1861.

The only machinery above the stone floor is the sack hoist mechanism which is situated below the attic walkway. It is driven by a long belt from an overhead shaft on the machinery floor which in turn is driven by the diesel engine. The mechanism consists of two grooved friction wheels, one constantly driven by the belt and the other mounted on the same shaft as the chain drum. The friction wheels are brought into contact by a system of wooden levers and pivots (Figure 11 opposite). This mechanism is certainly a late replacement of the hoist which must once have been housed in the 'hutch', probably being installed when the water powered machinery was removed from the northern end of the mill. It could well have been second-hand as there is a bevel gear on one end of the belt driven shaft (not shown on Figure 11) which is useless in its current location. The hoist is certainly effective though the long belt tends to slip a little under heavy load. When driven by the diesel engine, it runs rather quickly and millers have to be aware to release the rope promptly when sacks reach the attic floor as there is no automatic stop system.

The turret-like 'hutch' is a prominent feature of the roof which was totally re-covered in the 1970s. One of the roof trusses includes a very fine pair of base crucks which must have been re-used from an earlier building.

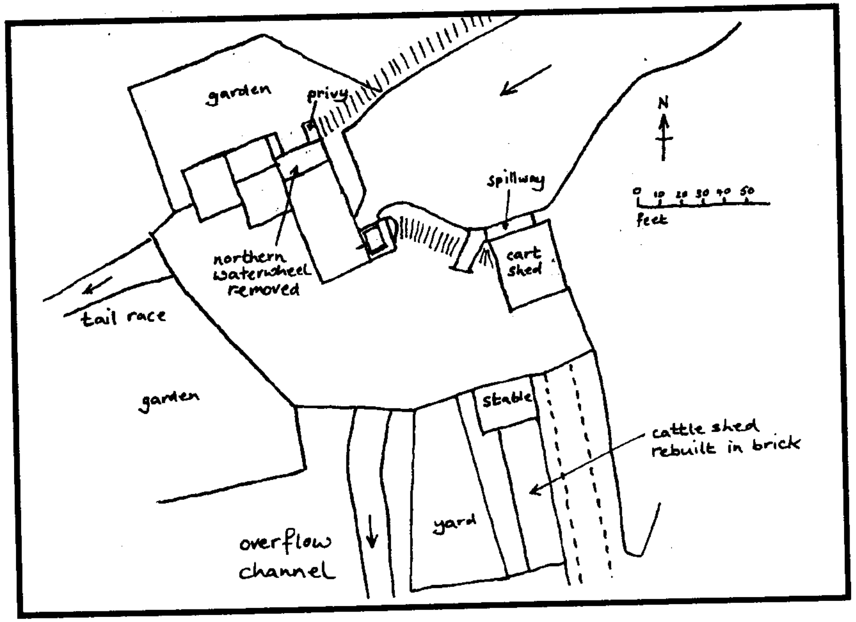


Figure 13. New Hall Mill in about 1905.

As with most mills, any attempt to describe the machinery raises almost as many questions as it answers. New Hall Mill is typical in that it has evolved over many centuries, responding to continually changing circumstances. Each alteration removes some evidence of what went before and this has continued right up to the repairs to the waterwheel early in 1997. Written records of many of these changes were either never made or are now lost, so inevitably this account is speculative in places. However, there are still many more important questions to consider and therefore many more opportunities for conjecture.

It is still not certain when the present mill building was erected. Some of the bricks have a raised diagonal mark which is supposed to date them to the period between 1690 and 1710 but the style of the building and its floor arrangement would seem to put it well into the second half of the eighteenth century. It is possible that some of these 'dating' bricks were re-used in a later structure as, despite some variation in the colour and bonding of the bricks, it appears to be all one build, probably keeping to the foundations of its predecessor. The alteration to the level of the stone floor has already been mentioned but there was no corresponding alteration to the floor above so presumably the mill was built with a lower machinery floor and a high stone floor. This may have been dictated by the kind of machinery that was then fitted as it is unlikely that the mill continued with a single-geared system right up until 1861. The popular choice for mill gearing in the second half of the eighteenth century was the vertical shaft and great spur wheel but there is no obvious evidence to suggest that this was ever fitted at New Hall. It seems likely that by then the mill only had two waterwheels, one in the present position and one in the

northern wheelpit. However, there is no sign of a central shaft hole from the northern wheelpit which would have made the standard set-up, with a stone nut either side of the great spur wheel, easier to fit. Equally, the present wheel position is not well sited for such a system. It is tempting to think that the new gearing installed in 1861 simply copied the existing, replacing wood with iron. However, if this was the case, it surely would have been specified as such in the schedule and besides, although the technology certainly existed, no other similar lineshaft gearing system is recorded in this region until well into the nineteenth century. It could be that New Hall did not progress beyond the kind of intermediate system as fitted at Barr Pool, Nuneaton, until 1861 (Figure 12). Certainly, this kind of gearing, with one pair of large diameter, slow turning stones and a smaller, faster pair, could easily have been accommodated at both ends of the building. Perhaps the millwright who drew up the 1861 schedule of new machinery was looking at just such a large pair of stones when he specified 'two pair of best new grey stones five feet diameter'. An excavation of the ground floor might provide some of the answers but, until then, speculation and conjecture will have to suffice.

References

1. G. (& R.) Turton, Kidderminster, Iron & Brass Founder, Order Books for 1837-45, 1849-63, 1864-77, held by author.

2. Williams, K.J., *New Hall Corn Mill*, c1980, (unpublished).

3. Letter from H. Adcock to R. Summers, millwright, dated May 26th, 1866, (author's collection).

4. Verbal information from Ben Davis.

5. Documents held by New Hall Mill Preservation Trust.

6. Documents held by New Hall Mill Preservation Trust.

THE TURBINES USED AT BOSLEY WORKS, CHESHIRE

By Tony Bonson

Bosley Works are situated in south-east Cheshire about half way between Macclesfield and Leek, and approximately three miles east of Congleton, at the confluence of Bosley Brook and the River Dane. Since their establishment in 1766 the works have had a fascinating history, having been used for brass and copper hammering and rolling, cotton spinning, silk throwing, flour milling, and wood flour milling. There are two distinct water powered sites at the works; the Higher Mill, with a fall of approximately 30 feet, derives its water supply from the River Dane via a long leat which culminated in a mill pool plus the waters of the Bosley Brook; the Lower Mill has a fall of about 16 feet derived from a high weir on the River Dane and a short leat to a small pool (see Figure 1).

In the 1880s the works were owned by the Thompstone family who used them for commercial flour milling. The trend in flour milling in Britain at this time was towards the use of imported grains for the production of white flour and so the milling business gravitated to large roller milling plants, operated by large joint stock companies, situated at the ports. The small local commercial miller was faced with either going out of business or investing in new plant to bring down their unit costs to a competitive level. By this time the Thompstones were extracting the maximum power from the water supply at Bosley that was possible using overshot waterwheels. To expand the capacity of the business meant either installing a steam engine or a water turbine.

The water turbine had been invented as long ago as 1827 by a Frenchman, Benoit Fourneyron. This device had proved to be very popular on the Continent and in the Americas. Many different variants of water turbine had been introduced due to scientific and mathematical development in Europe and practical experiment and testing in the United States. The advantage of water turbines over waterwheels was quite considerable:-

- They developed more power from a given head and flow of water (all the buckets of a turbine are full of water and always generating power, unlike only half the buckets of an overshot waterwheel).
- Most types of water turbine work with the whole turbine full of water so they can operate under water and are not affected by any flooding of the tailrace.
- They can utilise the whole head available, unlike a waterwheel which usually operates a few feet clear of the tail water.
- They are much smaller and cheaper to manufacture and maintain than waterwheels.

Unfortunately, in spite of these advantages, the water turbine was not as popular in this country as abroad. Its appearance as a fully developed product probably came

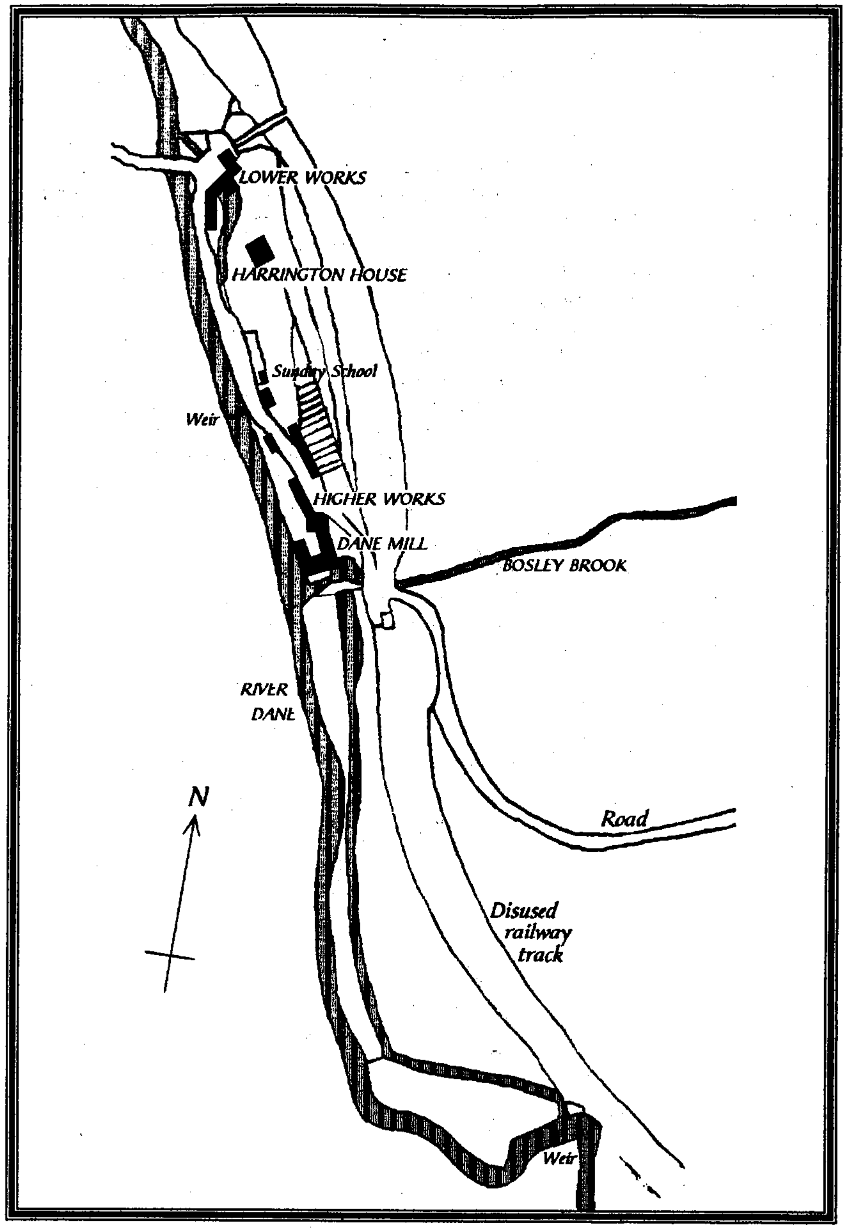


Figure 1. Map of Bosley Works showing the Higher & Lower Mills and the water supply arrangements to them both.

too late, after British industry had already changed to steam power earlier in the 19th century due to the abundance of coal in the British Isles and a widely available transport network of canals and railways able to deliver the coal to the factories for very low cost.

The Thompstones at Bosley were faced with a decision between the higher capital and running costs of installing a steam engine or trying to maximise the power output from their water supply by installing a water turbine. In 1888 they decided on the latter course of action and approached the firm of W.Gunther of Oldham (established 1881) who, in August of that year, provided a quotation '...to replace your present large waterwheel' of the Higher Works with a Girard turbine. The turbine was to have a wheel of 48 inch diameter and produce up to 125 H.P. from a head of 30 feet 6 inch utilising a flow of 2900 cu.ft. of water per minute delivered down a 36 inch diameter feed pipe. The total installation was priced at £349-0s-0d. This quotation was revised in September 1888 due to the realisation by the Thompstones that the head available was, in fact, 31 feet. The new specification used the same turbine but with a feed pipe enlarged to 42 inch, on a head of 31 feet, to provide 130 H.P. at a total cost of £375-0s-0d. One interesting item from the quotations was the charge for a man's time erecting the turbine, including travel expenses, of 10s-6d per day. All the available evidence indicates that this quotation was accepted and the turbine installed.

The specifications show that the Girard turbine was to be mounted with its wheel horizontal and hence its drive shaft vertical. The Girard turbine was of the outward flow type i.e. the water entered towards the centre of the machine and was exhausted from its periphery. Also the Girard turbine was an impulse machine utilising the kinetic energy of the flow of water rather than its pressure. The usual design of Girard turbine had a number of nozzles, spread around the inner circumference of the rotating runner which fed jets of water at the buckets in the runner (see Figure 2.). As the buckets were meant to operate with air in them a

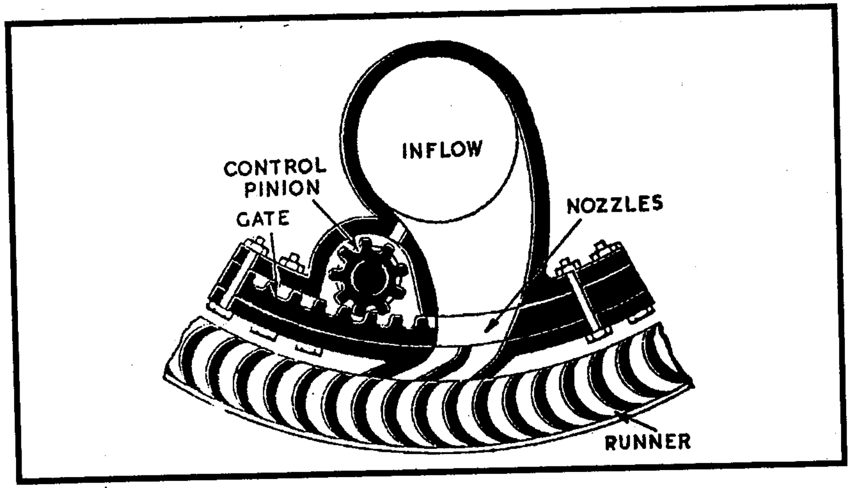


Figure 2. Part sectional plan view of an outward flow Girard turbine.

Girard turbine could not operate submerged, in fact it would sit slightly above the tail-water, spewing water out of its whole outer circumference. An impulse turbine is perhaps a strange choice for such a low head as the 31 feet at Bosley, however Girard turbines did not suffer from any great reduction in efficiency when operating with low water flows, a factor that was no doubt useful at Bosley.

In September 1894, the Thompstones obviously needed even more power because they asked for another quotation from W.Gunther for yet another turbine to operate on a 30 feet head (so for the Higher Mill again). This time the quotation specified a 30 inch diameter Girard turbine using 1180 cu.ft of water per minute to provide 50 H.P. at 155 r.p.m., inclusive of valves pipes and gearing for £156-0s-0d.

At about the same time the Thompstones were considering installing a sprinkler system into Bosley Works, no doubt at the instigation of their insurance company, to prevent any possible outbreak of fire from spreading. It was envisaged that the sprinkler valves would be fed by water stored in an iron tank situated on top of the Higher Mill building. In the event of fire the sprinkler valves would be activated and water would be released to douse the fire. The system was designed so that the drop in pressure due to the release of water from the main tank would activate a water turbine which would drive a pump to re-supply the main tank. In September 1895 Thompstones had received a quotation from Messrs George Mills & Co of the Globe Iron Works, Radcliffe near Manchester, for the supply and installation of their patented 'Titan' sprinkler system consisting of 705 sprinkler valves, piping, a 5000 gallon water storage tank, and piping to the Lower Mill all for the total price of £1128-13s-0d. Later, in October, W.Gunther quoted for the supply of a turbine and pump for this system. This was to consist of a 21 inch diameter, 18 H.P. Jonval turbine operating at 300 r.p.m. on a head of 30 feet using 425 cu.ft. of water per minute together with one set of double acting pumps with cylinders of 7 inch diameter and a 12 inch stroke capable of raising 17,000 gallons per hour to a height of 150 feet. The total of this quotation was to cost £294-12s-0d. A note on the quotation states that they cannot safely supply a turbine having less diameter than 21 inch as the spur wheels would be of very unfavourable proportions, even at 21 inch diameter the spur wheels would have a ratio of 1 : 6.

At this time there must have been a re-think by the Thompstones because they decided to order a sprinkler system for both the Higher and Lower Mills from Messrs Mills & Co. As well as the 705 sprinkler valves for the Higher Mill there was to be 507 in the Lower Mill and the main pump for the supply to the water tank was also to be supplied by Messrs Mills & Co.. This meant that W.Gunther had to re-quote for just the supply of the turbine which they did later in October 1894. This time the quotation consisted of a 15 inch diameter, 20 H.P. Jonval turbine using 470 cu.ft. of water giving a speed of 385 r.p.m. for a price of £96-18s-6d. The Thompstones were now happy with the specification of the system but not with the price as they obviously wrote to their suppliers in complaint. The reply from W.Gunther is worth reproducing in its entirety (bearing in mind that it concerns the supply of both the 50 H.P. Girard turbine and the 20 H.P. Jonval turbine)

> 'We duly received your favour of yesterday, and in reply wired "Two hundred forty five pounds is lowest we can accept as our quotations are exceptionally low" which we herewith confirm. Your telegram "Don't consider deductions enough" also came to hand. We regret that you

consider our estimates high, but we have again gone very carefully through them and find that our quotations to you are very low throughout.

We are anxious to meet you as far as we possibly can, but there is a limit below which it would not be worth our while to undertake the work, and we have just received several foreign orders and expect more to follow, we are not prepared to undertake work, which we can see before hand will allow no margin of profit.

In consideration that you have already two of our wheels, we will meet you so far as to reduce our offer for the two to £240-0s-0d nett, reserving the right to make the cast iron bellmouth pipe of the 50 H.P. turbine in the form of a taper steel pipe, if we think fit. This offer is the lowest we are prepared to trade; the price you name in your letter is quite beyond our acceptance.

Awaiting your early reply, and trusting you will accept our final offer.'

Thompstones wired back 'Accept your offer, please push on with same'. One intriguing item in the letter is the reference to **TWO** previous turbines supplied by W.Gunther, although documentary evidence has only been found for the 150 H.P. turbine of 1888.

The whole system was installed in both mills between March and July 1895. The sprinkler system was undoubtedly the latest technology incorporating an automatic fire alarm which consisted of a brass hammer attached to the shaft of the turbine, if the shaft rotated (i.e. the sprinklers had operated) the hammer would strike a steel gong once per revolution of the turbine shaft. The Jonval turbine, however, was designed prior to 1850 and had largely been superseded by 1894. It was an axial or downward flow design (see Figure 3) where the water entered at the top passing down through the guide vanes to and through the wheel to discharge into the tailrace

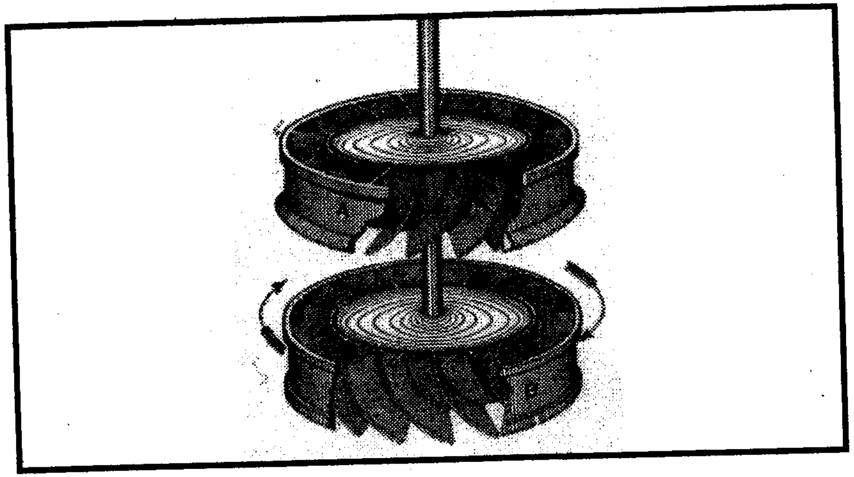


Figure 3. Interior sectional view of a Jonval turbine.

below. In this sprinkler system its main drawback of a large drop in efficiency at part gate would not be applicable and its small size and low cost would recommend it for such an intermittent application.

When the Thompstones came to consider converting the Lower Mill to operate by turbine, in 1901, they found that their turbine supplier, W.Gunther & Son, had been taken over by Gilbert Gilkes & Co. Ltd. who had been in existence since 1853. Not surprisingly Gilbert Gilkes quoted for the installation of a 'Vortex' turbine. This was a type of turbine designed by Professor Thomson of Belfast in 1850 and was the mainstay of the Gilbert Gilkes product range. The Vortex turbine was a double discharge, inward flow, reaction turbine with adjustable guide vanes, and normally contained provision for a spiral casing and suction draft tubes. The water moved inwards through the wheel along a certain continuous spiral course from the entrance to the exit orifices, hence the name 'Vortex' turbine (see Figure 4). The movable guide vanes enabled a good efficiency to be maintained with flows of water much smaller than that for which the turbine was designed; the double discharge arrangement balanced the hydraulic axial thrust; and the use of suction tubes enabled the total head to be utilised while not having to run the turbine submerged.

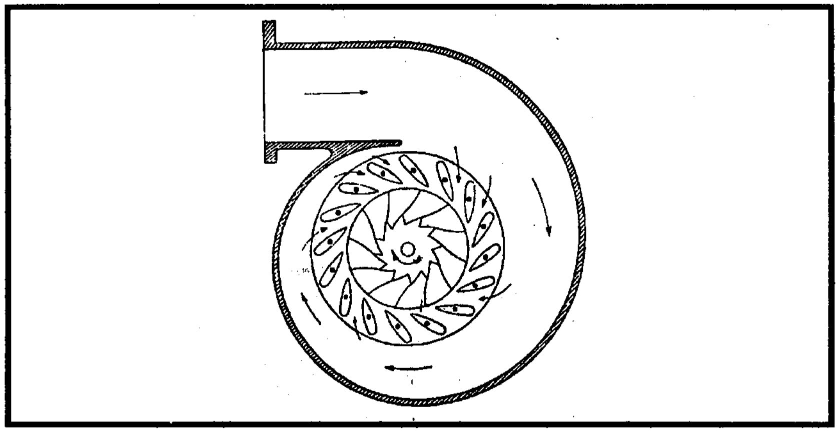


Figure 4. Inward flow Vortex turbine with spiral case.

The quotation to the Thompstones in 1901 was for a 25 H.P., horizontal shaft, double Vortex turbine adapted for a fall of 16 feet and designed to use 1103 cu.ft. of water per minute, making about 154 r.p.m. at a cost of £222-10s-0d. This turbine (see Figures 5,6 & 7) was duly installed in the Lower Mill.

For the following years up to 1924 Bosley Works got on with the job of flour milling with two (or possibly three) main power turbines of the Girard type in the Upper Mill, and the Vortex turbine powering the Lower Mill. Also there was a Jonval turbine in the Higher Mill to power the pump for the sprinkler system for both mills. In 1924 it was decided to modify the Vortex turbine in the Lower Mill in an effort to

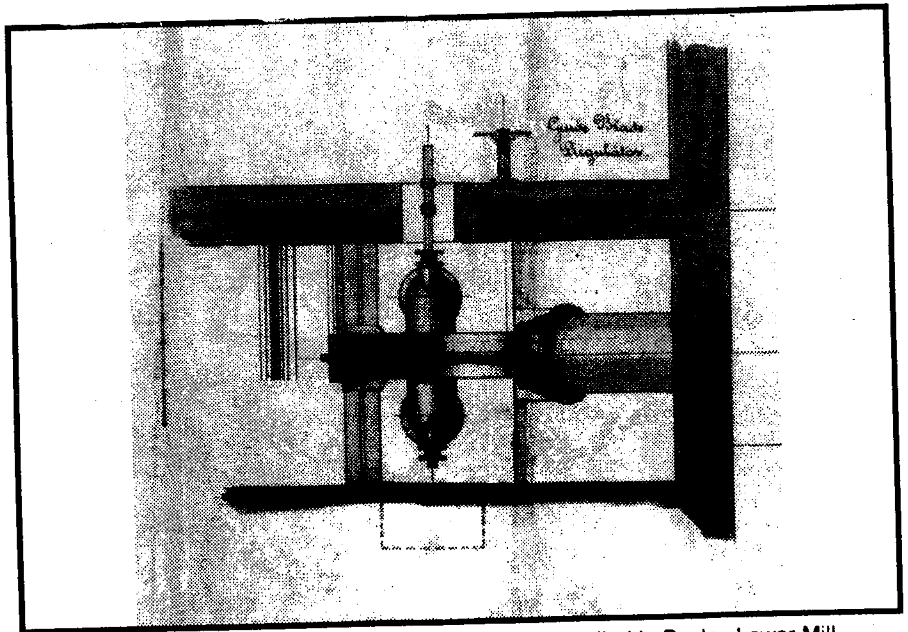


Figure 5. Plan view of the 1901 Vortex turbine installed in Bosley Lower Mill.

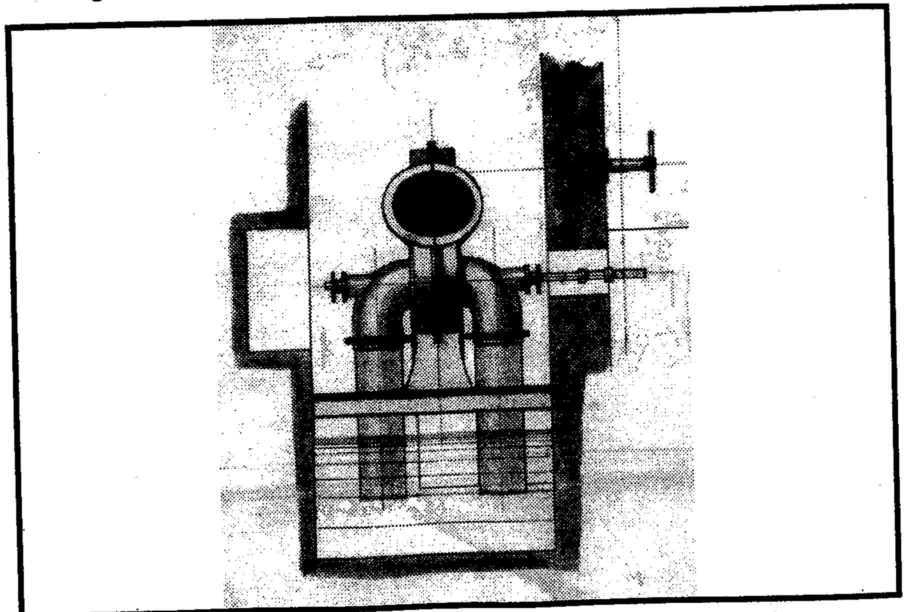
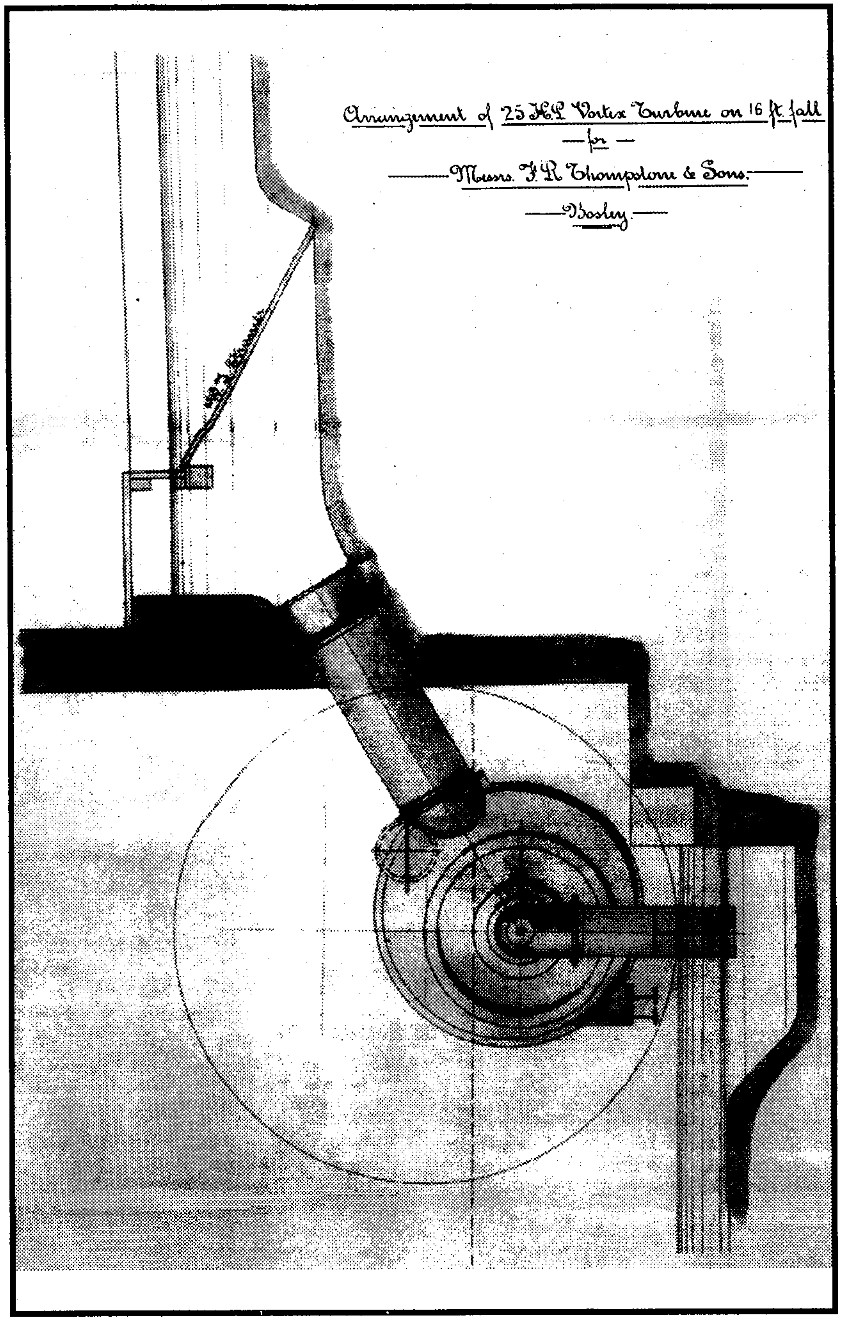


Figure 6. Elevation view of Vortex turbine in the Lower Mill at Bosley



increase its power output. This involved fitting two intensifier nozzles and supply pipes, deepening the tailrace by a couple of feet, together with two new draft tubes of a flared design. The supply pipes containing the intensifier nozzles led from the top level of the head into the top of each draft tube which had the effect of creating extra vacuum pressure in the draft tubes (i.e. the flow into the draft tubes tended to drag the water through the turbine). The rate of flow through the intensifier nozzles could be varied under manual control.

By the end of the 1920s it was becoming obvious that the competitiveness due to the investment in turbines, etc. was being overtaken by the large millers. Consequently it was decided to close down the flour milling operation in favour of entering the business of wood flour milling. This process enabled the Thompstones to utilise a lot of their existing machinery in so far as the grinding and grading the product was concerned. However it must have been obvious from the start that more power was going to be required so it was decided to upgrade the turbines in both mills with new power plants.

The turbine chosen for the Higher Works was a 33 inch Series 'R' turbine from Gilbert Gilkes & Gordon Ltd of Kendal which developed 268 H.P. on a 30 feet fall using 5750 cu.ft. of water per minute running at 230 r.p.m. This was installed with a horizontal shaft in 1933 at a cost of £479 (contract 3940, see Figures 9 & 10). The Series 'R' turbines were in fact based on the inward flow Francis turbine named after J.B.Francis, a well known American hydraulic engineer based at Lowell, Massachusetts in the middle of the 19th century who was involved in the development of this type of design (see Figures 8). Also in 1933 two schemes were put forward by Gilkes for re-equipping the Lower Mill. These both involved the Series 'R' Francis turbine but in one case mounted horizontally and in the other case mounted vertically. It is obvious from the drawings prepared at the time that whichever turbine was finally to be installed would be used to generate electricity rather than drive the plant directly as at the Higher Mill. As well as these two proposals, Gilkes also prepared a design utilising a 50 H.P. propeller type turbine on a 30 feet head for the Higher Mill, possibly to replace the Jonval turbine on the sprinkler system, but no more was heard of this proposal.

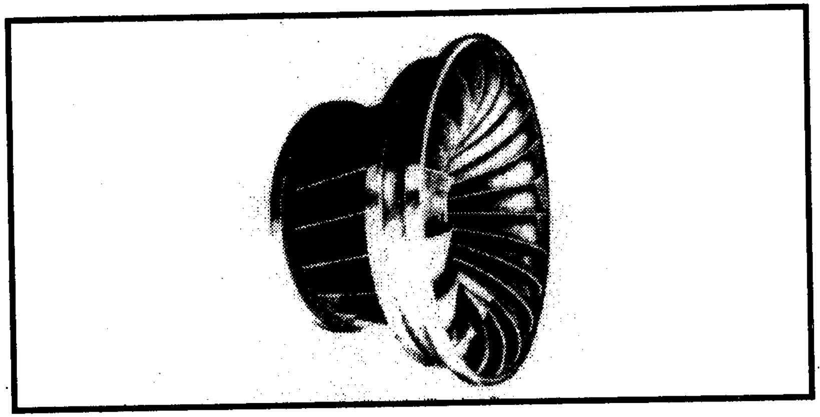


Figure 8. The runner of a Francis type turbine as used in the Gilkes series 'R'.

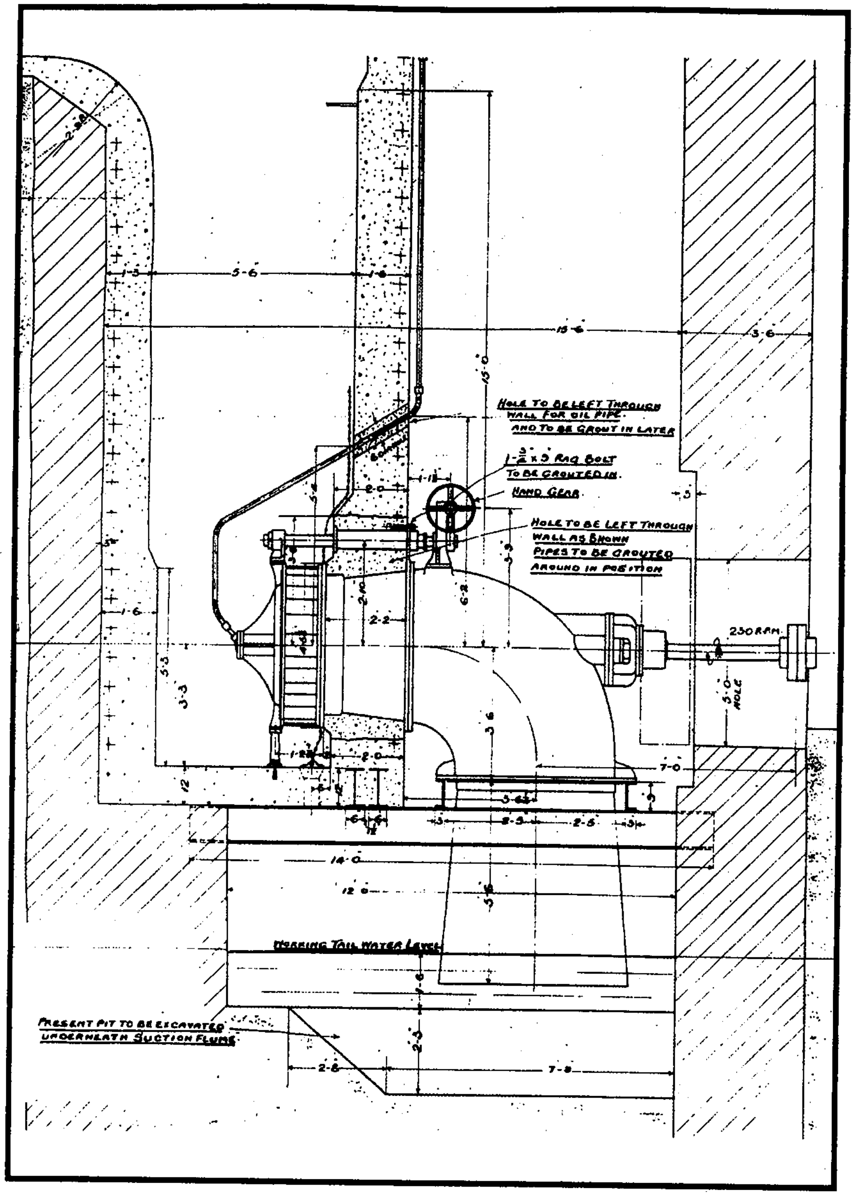


Figure 9. Gilbert, Gilkes & Co. Ltd. drawing of the 268 H.P. Series 'R' turbine installed in 1933 at the Higher Mill, Bosley. The turbine is fitted in an open chamber (on the left of the drawing) without a spiral case. (The strainers, etc., have not been shown at the top of the chamber.)

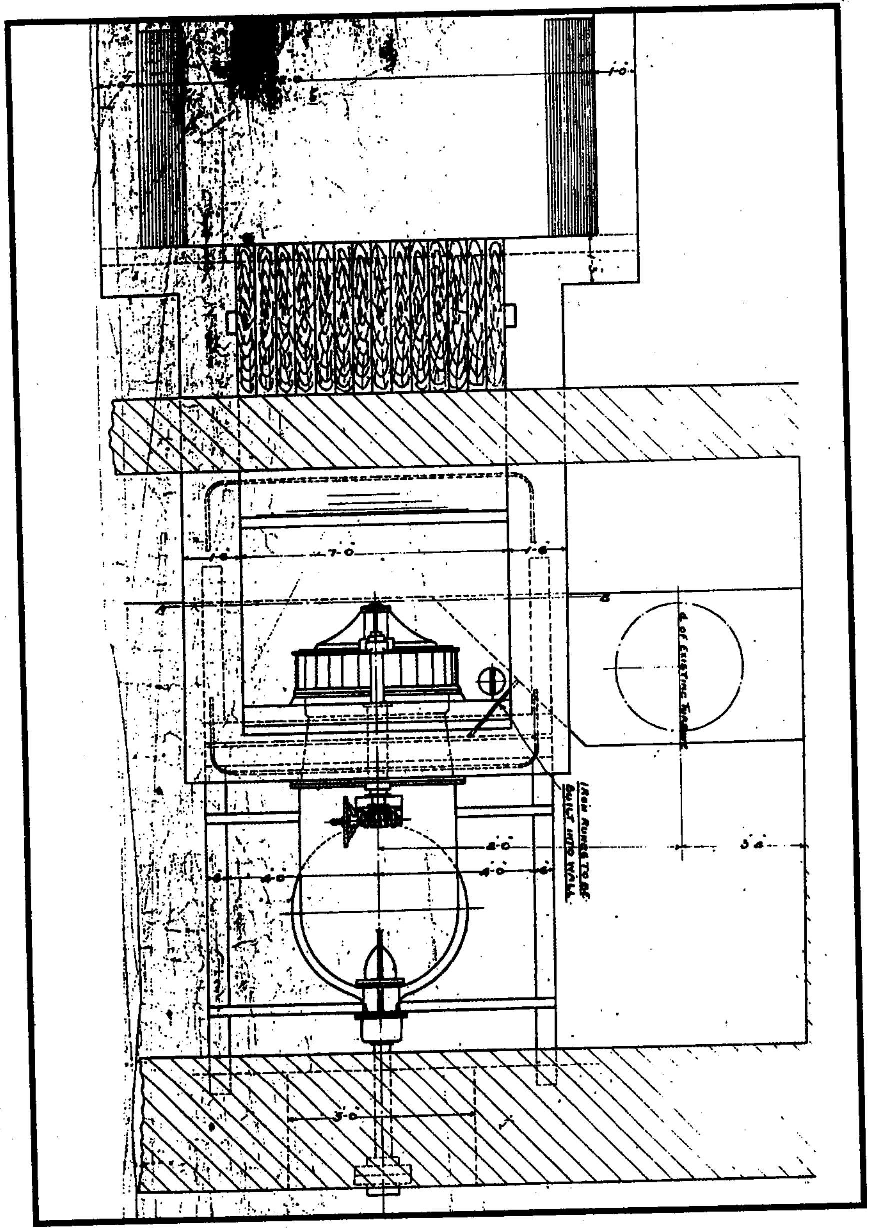


Figure 10. Plan view of the 268 H.P. Series 'R' turbine installed in 1933. The strainers are shown at the top of the drawing. Note the position indicated of an existing turbine on the right hand side.

The re-equipment of the Lower mill did not proceed until 1936 when it was decided to install a vertical shaft 30 inch Series 'R' turbine of 110 H.P. on a head of 18 feet using 3910 cu.ft. of water per minute at 197 r.p.m. (see Figure 11) similar to that specified earlier in 1933. As this turbine was going to be used to generate electricity it had to be supplied with a governor in order to maintain a constant speed, so the quotation also included a size 'C' hydraulic governor. The total contract with Gilkes (contract 4173) cost £536 (without the generator). This installation must have been successful because two years later, in 1938, Thompstones were enquiring about fitting a governor to the 268 H.P. turbine in the Higher Mill. They had been offered a second hand governor by Harland Engineering Co. and so they enquired of Gilkes about its suitability. Unfortunately Gilkes's records showed that this governor, supplied in 1920, did not have sufficient power to operate the guide vanes on the 268 H.P. turbine and was unsuitable. There the matter rested and the Second World War intervened.

After the war, in October 1946, Thompstones revived their interest in fitting a governor to their main turbine in the Higher Mill and received a quotation of £487 from Gilkes for a 'D' size hydraulic governor, although the delivery quoted was 12 months from order. However in 1947 they were considering buying two new turbines altogether; they arranged for an engineer from Gilkes to visit the works to determine possibilities; and they initiated measurements of water flow to determine the low water situation in the summers. However no orders were forthcoming. In 1949 they had a long correspondence with Gilkes about the wear on the shaft bearings on the big turbine in the Higher Mill, they fitted new bushes but were unhappy with having to change the bearings every few years.

Having successfully used turbines at Bosley for nearly 70 years disaster struck in 1957. The oil filled governor used on the vertical turbine in the Lower Mill caught fire and new parts had to be ordered from Gtilkes for repairs to take place. During the repairs of this governor the main turbine in the Higher Mill broke down with a damaged thrust bearing on the main shaft. This caused the whole question of excessive wear on the shaft and bearings to be examined. Presumably they had been unwilling to stop the plant for any length of time previously but now it was forced upon them. The outcome of this exercise was to order a new shaft from Gilkes and a re-arrangement of machinery, etc. to allow frequent inspection and automatic lubrication to take place. In June 1959 expansion of the company meant that more factory space was needed so it was decided to fill in some of the mill pool/head race at the Higher Mill in order to build on the land created. The main turbine in the Higher Mill was still being used at this time because a 200 feet pipe had to be laid through the concrete to bring the water supply under the new buildings. Gilkes calculated that one pipe of 60 inch diameter or two pipes of 48 inch diameter passing the flow necessary for the turbine (5750 cu.ft./min) would reduce the effective head by 3 inches.

Even in 1966 waterpower was still being used at Bosley because enquiries were made of Gilkes concerning a second hand Series 'R' spiral cased turbine of 32½ H.P. on a head of 20 feet which they wished to use at Bosley on a 30 feet head (i.e. at the Higher Mill). They were also asked to quote for a new turbine working on this head with and without a governor. The reply from Gilkes quoted for a Series 'C' turbine developing 33.2 H.P. on a 20 feet fall and 62 H.P. on a 30 feet fall. The cost without a governor would have been £3400 and with a governor £4750. The Series

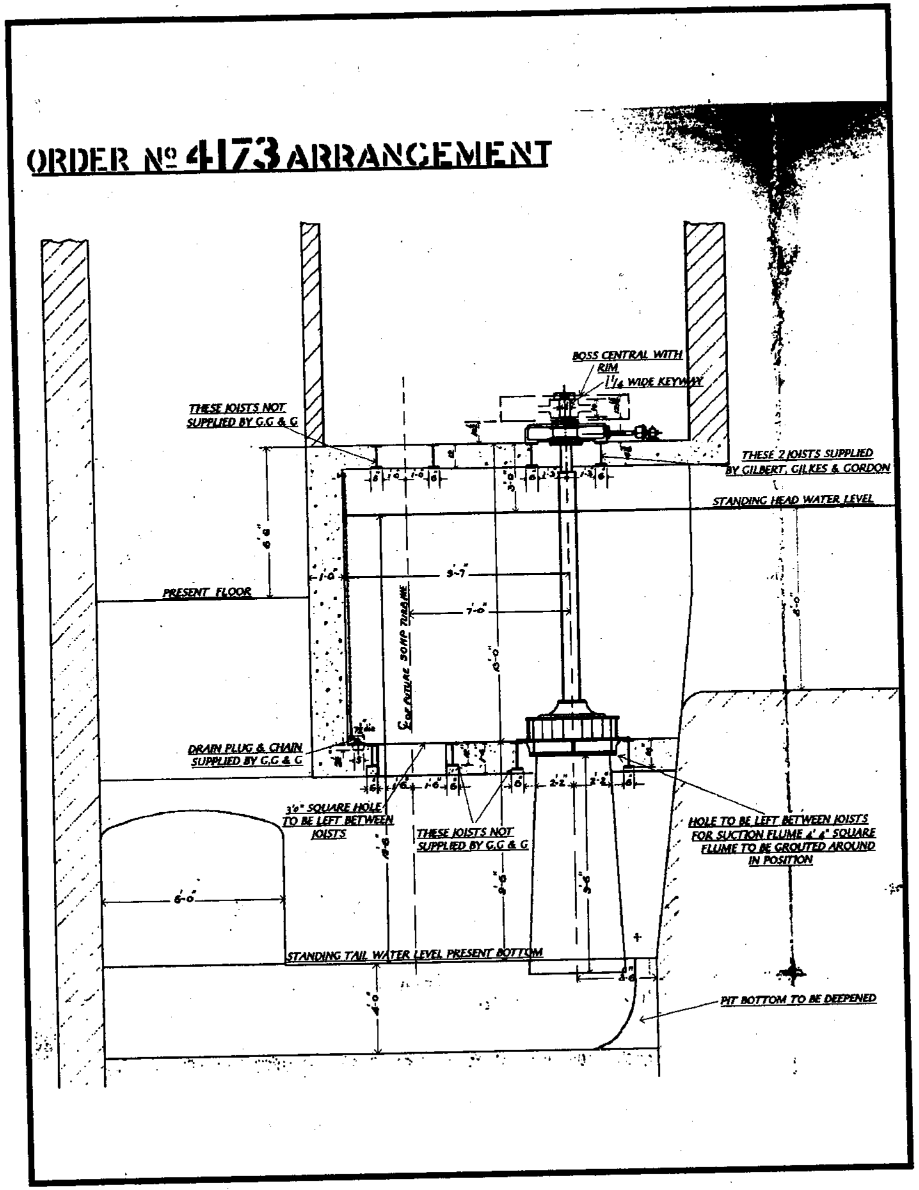


Figure 11. Sectional drawing of the 110 H.P. vertical turbine installation in the Lower Works at Bosley in 1936.

'C' is similar to the Series 'R' but designed for a different speed range. This enquiry had been initiated by the possibility of purchasing a second-hand turbine from Messrs. R. & W. Callender Ltd., Minningaff Saw Mills, of Newton Stewart, Wigtownshire in Scotland. This was a 32½ H.P. Series 'R' Francis turbine with a horizontal shaft using 1042 cu.ft per minute giving a speed of 414 r.p.m. intended for use on a 20 feet head. To adapt this turbine and fit it with a governor was quoted at £2000. Undaunted the Thompstones duly bought the turbine from the saw mills intending to install it themselves. Unfortunately before this turbine could be got working other factors reared their ugly head.

It was at this time that the water authorities decided that they were going to charge users of waterpower for the use of the water at the same rate as those that extracted water for other uses, in spite of the fact that the water was not consumed but returned in entirety to the river. Protestations from the National Association of Water Power Users were to no avail and so the Thompstones decided to abandon the use of water power at Bosley.

Today the firm uses even more power but it is all electrical power from the grid. The large horizontal Francis turbine of 268 H.P. is still *in situ* in the Higher Mill as is the 110 H.P. vertical Francis turbine in the Lower Mill. The spiral cased turbine from the Minningaff Saw Mills is also to be seen installed at the Higher Mills but it has never worked at Bosley. Also it is thought that some of the older turbines from the early days of turbine power are still to be found in the depths of the Higher Mill.

As stated earlier the application of the turbine was not widespread in this country. It was a foreign invention and most of the development of the turbine took place on the Continent or in America. It became government policy that turbines could not be usefully deployed in Britain because they needed very high heads or large rivers which were not provided by the geography of the country. This view seems to have seeped into the nation's soul as a universal truth, however nothing could be further from the actual truth. Turbines can be designed to work efficiently on heads as low as three feet and on quite low flows of water. Certainly a turbine needs to be specifically designed for its application in terms of head and water flow to produce the optimum results. Also it is true that the efficiency of turbines, in general, falls away quite steeply if conditions very from those for which it was designed. This is why attempting to use second hand turbines is rarely successful.

At Bosley it is possible to see the effect of utilising turbines in a business setting. By the end of the 1880s the Thompstones' flour milling business was facing extinction from the competition of the big milling combines using steam powered mills situated at the ports of entry for imported grain. The investment in turbine technology allowed their business to flourish for approximately another 40 years. Even so they were still overtaken by the big firms but by investing in larger power turbines they were able to enter a different sphere of business, that of inert fillers based on wood flour. This proved to be a shrewd move and the business greatly expanded in terms of product lines and power requirements. The use of water power, with its low running costs, continued to be attractive, so much so that as late as 1966 they were actively engaged in increasing the numbers of turbines in use. The use of water power at Bosley was only curtailed by the stupidity of the water board's decision to class using water power as extraction so making it uneconomical. Today the power consumption at Bosley is so great that reverting to water power is not an option, the whole works being electrically powered from the grid. However the fact that this company is one of the world's leading suppliers of inert filler materials is due in no small amount to the successful deployment of turbine technology over nearly 80 years of business.

Bibliography

1. Glynn, J., *Power of Water*, John Weale, London, 1853.
2. Mead, D.W., *Water Power Engineering*, McGraw publishing Co., New York, 1908.
3. Daugherty, R.L., *Hydraulic Turbines*, McGraw-Hill, New York, 1920.
4. *On the Development of Water Power*, Gilbert Gilkes & Co. Ltd., 1920.
5. Wilson, P.N., *'Early Water Turbines in the United Kingdom'*, Transactions of the Newcomen Society, **31**, 1957/9.
6. Wilson, P.N., *'Gilkes's 1853 to 1975, 122 Years of Water Turbine and Pump Manufacture'*, Transactions of the Newcomen Society, **47**, 1977.
7. Bonson,T., *'The History of Bosley Works, Cheshire'* Wind & Water Mills, **14,** 1995.

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