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Paddington Mill, Abinger: a survey of a derelict corn mill

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Paddington Mill, in the Tillingbourne valley near Abinger Hammer last ground grist and flour at the end of the 19th century. After a hundred years of neglect and decay very little milling equipment survived. However, a detailed survey of the derelict building, carried out in 1996, enabled the layout of the milling and associated machinery to be established and revealed several phases in the development of the mill and its site. The results of the survey are presented and discussed in terms of available information on the history of the mill.

Introduction

In late 1995 a planning application was submitted to convert Paddington Mill (TQ 100 472), a derelict water-powered corn mill on the Tillingbourne 500m upstream from the village of Abinger Hammer, into residential accommodation. This prompted a detailed survey of the mill to be carried out, mainly in the spring of 1996. The results of the survey are presented in this paper and discussed in terms of the findings of a related research project on the history of the mill (Corke, in prep).

Paddington Mill is referred to in the Domesday survey of 1086 but it is not clear whether it was located at the present site or 400m downstream. Indeed, the first explicit documentary evidence for the mill which has been discovered is in a 21 year lease, dated 12 March 1757 (SHC Evelyn). In this Sir John Evelyn leases to John Furlonger of Abinger, miller, 'all that water mill sometime since erected by John Byde situate upon Paddington pond bay... lately in the tenure of Thos Wicks'. Byde, or Bide, was the tenant of both Paddington Mill and Abinger Mill, which is 1km upstream (TQ 110 471), from at least 1721 until his death in 1732. Also, in the early years of the 18th century work was carried out at several mills on the Evelyn estate including Abinger in 1704, Milton, on the Pipp Brook near Dorking (TQ 150 492), in 1705 and at 'the new pond', which might have been Paddington and included eight loads of stone, in 1720–1. Thomas Wicks, or Wickes, was at the mill in about 1740 and in his will which, was proved on 6 December 1779, John Furlonger left his brother Thomas 'my bolting mill in the Lower Mill at Paddington and all my sacks which are pitch marked and my seal, all weights, millstones, mill bills, tools and other implements whatsoever in both the mills now occupied by me' (Corke, in prep). Thomas Furlonger was at the mill until 1792, to be followed by Thomas Turner until 1802, Frederick Wells until 1804 and Arthur Wells until 1814 (SHC QS6/7).

During the 19th century the mill was run by the farmer at neighbouring Paddington Farm. This arrangement started with Arthur Wells in 1808 and continued with George King until his death in 1828, when the mill wheel was repaired by his executors. He was succeeded by his widow Sarah and in 1840 the property was held by her executors (SHC Tithe). Then Charles and Mark King worked the mill but their partnership was dissolved in 1849. Charles continued until 1866 and then Mark King, who was described as a 'Miller (water) and Farmer' in 1887 but as a 'steam miller' in 1891, was at the mill until 1895. It was then rented by the Coe family, who operated the adjacent watercress beds and, according to local directories, they were active as millers until 1915. However in July 1915 the mill was being used as a stable and in 1941 as a store for watercress containers (Corke, in prep; Simmons 1940s). In practice the King family employed a miller to operate the mill. In particular in 1841 John Newman, miller, was living at the Hammer and in 1871 Henry Bowles, miller, was living in one of the dwellings near the mill known as Paddington Mill Cottages, to be replaced by 1881 by Joseph Martin, journeyman miller, and by 1891 by Thomas Parkhurst, miller (Corke, in prep).

Paddington Mill is named on Rocque's map of Surrey which was published in 1768. It may also be present on earlier maps, including Norden's Surrey of 1594 on which there are six waterwheel symbols between Wotton to the east and Gomshall to the west, but the sites are not clearly defined. On later larger scale maps it is possible to compare the size and shape of the building portrayed with that of the existing mill but it is not until the OS 1:2500 maps of 1870 and 1892, where it is marked as a 'flour mill', that a definite correspondence can be established. If it is assumed that the representation of the mill on the tithe map is accurate, then the present building must have been built after about 1840 (SHC Tithe).

Unfortunately, available historic illustrations of Paddington Mill provide little useful information to complement the survey. They include paintings of the millpond with Paddington Farm in the background (Waite E W; Waite E) and one with a small building, which is probably the mill, in the distance (Adams 1886). All three feature a punt on the water and in the Adams painting this is clearly being used to collect reeds and to move eel traps. Of more interest is an early postcard (Redhill Photo Co) showing a photograph, taken from the south-east, of skating on the frozen pond with the mill in the background. Regrettably the photograph is very faded. Also of interest is a 1931 drawing from the north-east (Reid 1989, 5); the accompanying text states that the mill is 'a small but not unattractive Victorian building'.

Three other descriptions of the mill are available. The first, by Simmons (1940s), reporting a visit in 1941, is the most important and will be referred to several times in the present account. It notes that the date 1867 is cast on the iron penstock and claims that this is probably the date of the erection of the building, which is said to be 'not a thing of beauty'. It mentions small lattice windows, a dismantled iron overshot waterwheel, the interesting shaft of which was *in situ*, and a pit wheel which was the only machinery surviving inside the mill. Hillier (1951) describes the mill as 'an insignificant little building', mentions weighty timbers, projecting eaves and broad moulded barge-boards, windows with metal casements protected by iron bars and the axle of the waterwheel. Finally, Stidder (1990) notes that the building is 'rather unattractive', but typical of the early Victorian period, and that the interior is empty.

Hence when the present survey was carried out in 1996, it was not anticipated that much would be discovered about the equipment and working life of the mill. In practice, however, it has been possible to deduce a great deal from the traces of information that survived and this report presents the results. The millpond and the water courses leading to and from the mill are discussed first. Then the mill building is described, starting with the exterior and continuing with the three floors of the interior in turn. Next, the surviving equipment is described and an interpretation is given of the equipment which was missing. In particular the waterwheel shaft, the upright shaft, the hurst frame and millstones, the hoist and the cleaning and dressing machines are considered in turn. Finally the information presented is discussed and conclusions reached.

The millpond and water courses

The water of the Tillingbourne was harnessed to provide power for Paddington Mill by constructing a massive dam, about 150m long, 5m wide and 4m high (fig 1). This dam or bay created a millpond with an area of about 0.93 ha (2.3 acres) of open water on its east side and a further area of up to 2.4 ha of marshy land upstream. Regrettably, the pond was drained in 1965 (Abinger Hammer 1977, 7). A lane leading to Paddington Farm, immediately to the south of the pond, runs along the top of the dam and this has been raised by about a metre since the mill closed. The mill is located at approximately the centre of the dam and the bypass sluice is at its northern end. Underneath the lane there is a stone culvert which led water to a cast iron tank or pentrough on the north side of the mill.

The pentrough fed a near-horizontal sheet of water into the buckets at the top of an external overshot waterwheel. Remarkably, it survives in only a slightly damaged condition, as shown in the photographs of figures 2–5. The iron trough is 2.67m long, 1.83m wide and 0.48m deep and it is parallel to and 0.67m distant from the north wall of the mill. Its first 0.31m is supported by the

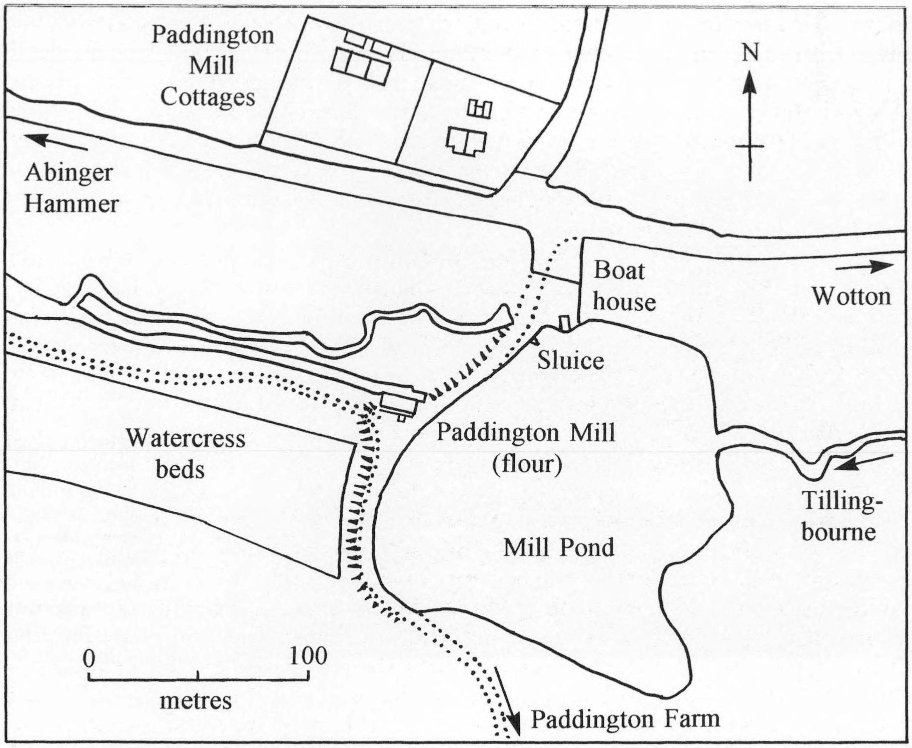


Fig 1 Map showing Paddington Mill with its pond and tail race based on 1:2500 OS maps, particularly that of 1892.

mill dam and it is crossed 0.55m from its end by a vertical plate 0.28m high (figs 3, 4). Beyond this plate the upper sides of the trough slope downwards in attractive ogee curves (fig 4). The top of the plate is level with the top of the trough leaving a 0.20m gap at the bottom. This gap could be reduced by a sluice gate or penstock, 0.20m high, located immediately on the inside of the plate (fig 3). The mechanism to do this consists of two iron bars rising from the gate with 0.23m long racks containing seven teeth at their upper ends. These engage with 11-cog pinions on a horizontal rod which could be turned from inside the mill. The penstock and its control mechanism are held in place by a timber framework which is in a very decayed state (fig 3).

The pentrough was supported, 0.70m from its end, by an iron structure which lies dismantled on the bank of the stream. It consisted of an H-section beam, 3.62m long and 0.15m high, fixed at its south end in a recess in the mill wall (fig 4) and at its north end on an iron stanchion 1.42m high at the side of the wheel pit. As a result of its absence, the end of the pentrough is sagging and the side away from the mill is cracked adjacent to a join in its plates (fig 5). Part of the ogee extension on the mill side is missing (fig 4).

The west facing side of the crossing-plate of the pentrough bears the inscription 'W J EVELYN / 1867' between well designed 'WIE' monograms (fig 4). William John Evelyn was the owner of the Wotton estates which included Paddington Mill (*VCH*, **3**, 156, 162). Also on the outer face of the north side of the trough, just before the crossing-plate, is the cast inscription, 'THOMAS SPENCER / MILLWRIGHT / GUILDFORD' (fig 5).

An analysis of the former waterwheels at Paddington Mill will be provided in the section of this report dealing with the equipment of the mill, but the pit which housed the wheel and the tail-race will be discussed here. The wheel pit is 3.15m wide, about 3.15m deep and about 3.5m long, after which it broadens on the north side. During the period of the survey the depth of water at the bottom of the pit varied from about 0.34m to 0.45m. On the south it is bounded by the wall of the mill and on the north by a 1.5m high cement-rendered brick wall, which supported the

Fig 2 The wheel pit at Paddington Mill from the west, showing the pen-trough at the top and the shaft of the water-wheel at the bottom. Note the stone and brick sections of the west facing wall of the pit in the background, the eroded bricks of the mill wall at the right and the keyways for the hubs of the waterwheel spokes on the shaft (April 1996).

Fig 3 The control gate or penstock at Paddington Mill viewed from the south-east. The gate, which is the narrow iron plate at the bottom of the two vertical iron bars, was raised or lowered by means of the visible rack-and-pinion gearing operated from inside the mill, which is at the left (April 1996).

Fig 4 Detail of the pentrough at Paddington Mill from the north-west, showing the inscription W J EVELYN / 1867 and two WIE monograms, highlighted in chalk. Note also, at the bottom right the recess in the wall of the mill which held the end of the iron beam which helped to support the pentrough (April 1996).

outer bearing of the waterwheel shaft. Of considerable interest is the vertical east wall of the pit which is built against the dam. This reveals three building phases as indicated in figures 2 and 6. The earliest of these is a section adjacent to the mill measuring 2.29m wide and 2.40m high, from the bottom of the wheel pit, and constructed from large blocks of stone. These are more likely to be from quarries in the Tonbridge or Hythe Beds than from more local sources, and are dressed in a manner which suggests a date before 1750 (Kenneth Gravett, pers comm; John Potter, pers comm). The next phase is in brick, some of which is heavily eroded. This extends the wall to the full width of the present wheel pit and upwards to a height, at the sides, of 3.15m, which is level with the bottom of the pentrough. However, immediately beneath the pentrough there are three courses of different bricks which are not eroded and these bricks have also been used on both sides of the trough. It would appear therefore that the stone section indicates the size of a pre-1750 wheel pit 2.29m wide and 2.40m deep. This was later extended, with rather poor quality bricks, to create a wheel pit of the present size. Then, in 1867, when the pentrough was installed, a new foundation for its base was created by replacing some heavily eroded bricks and the wall was raised at the sides.

The water channel flowing away from a mill is known as the tail-race. Its function is to remove the water from the wheel pit as quickly as possible whilst retaining the maximum head of water at the mill. Straight, wide, tail-races are particularly effective and the one at Paddington Mill has these characteristics. It flows westwards from the mill and is joined from the north after about 50m by the bypass channel, which meanders across a neighbouring field. This confluence corresponds with that shown on the 1:2500 OS map of 1916 but on earlier maps, dating from about 1790 to 1892 it occurs about 100m west of the mill as shown, for example, in figure 1. The full 100m is essentially straight and clearly represents an artificially cut tail-race.

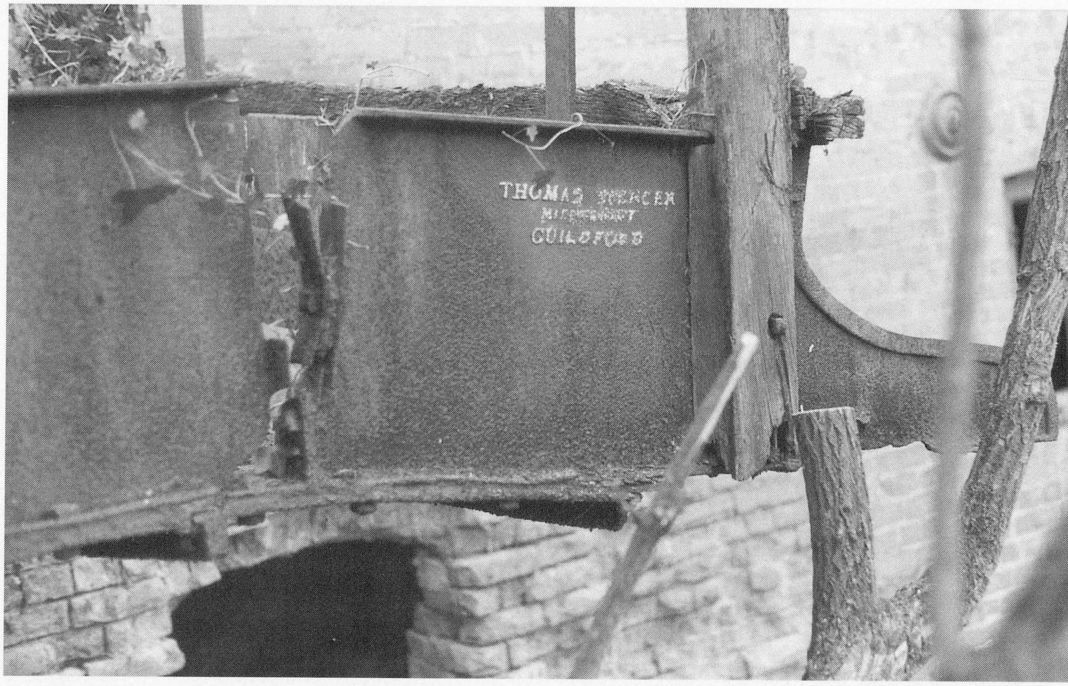


Fig 5 Detail of the pentrough at Paddington Mill from the north-east, showing the inscription THOMAS SPENCER / MILLWRIGHT / GUILDFORD, highlighted in chalk. The opening in the mill wall, which appears in the photograph to be below the pentrough, housed the shaft of the waterwheel (April 1996).

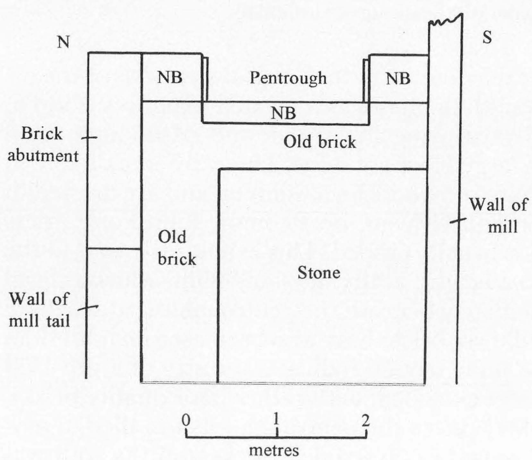


Fig 6 Elevation of the east wall of the wheel pit at Paddington Mill showing the three phases of construction in stone, old brick and new brick (NB) which are discussed in the text. A photograph showing this wall is given as figure 2.

The mill building

THE EXTERIOR

Paddington Mill is a simple, gabled, brick building of three storeys (fig 7). Most published sources (Simmons 1940s; Reid 1989, 6; Stidder 1990, 56) suggest that it was built on a pre-existing mill site some time in the early Victorian period up to 1867, the date cast on the iron pentrough. There are no later extensions. Its external dimensions are 10.85m long, 4.75m wide,

Fig 7 Paddington Mill from the north-west. The doorway is the west entrance to the pit floor, the window above is on the stone floor and the window in the gable is on the bin floor. Note on the west wall the change from English to Flemish bond above the level of the doorway. The roof has the replacement tiles of March 1996 but the bargeboards are original. On the north wall, at the left, can be seen two windows, four tie-plates, the stump of a stove pipe and a bracket to support this pipe (April 1996).

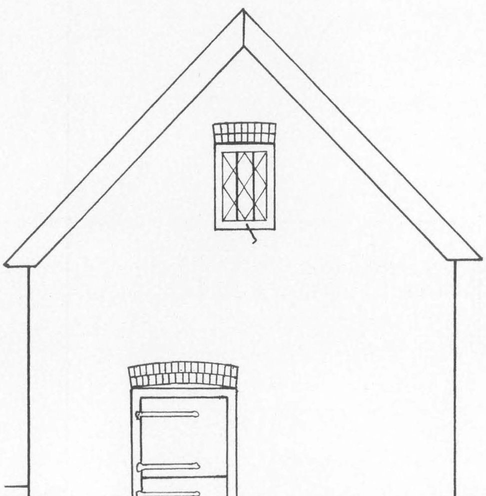


Fig 8 Paddington Mill: east elevation

5.65m high to the eaves and 8.40m to the ridge of the roof. It is oriented approximately east–west, parallel to the Tillingbourne valley, and the east end of the bottom or pit floor is built against the dam of the millpond. This means that there is convenient direct access from the dam to the middle or stone floor. The walls are intact but the tiles and some of the timbers of the decaying roof were replaced in March 1996, while the survey described here was in progress. The doors are more or less complete but the glass of the windows has gone. Unlike most water corn mills, Paddington Mill did not have an external hoist which raised grain to an overhanging dormer, known as a lucam, projecting from the top floor (Reid 1987, 6; Hillier 1951, 227; Reynolds 1970, 187).

The four principal external elevations are given in figures 8–11. The walls are built from orange-red bricks, without frogs, of standard size (220 × 110 × 70mm). They vary in colour and it has been suggested that they were made locally at the end of the 18th or in the first half of the 19th century (Kenneth Gravett, pers comm). Generally the walls are one-and-a-half bricks thick and of English bond, each course having stretchers on one face and headers on the other, the arrangement alternating between courses. The walls of the upper two floors at the west end of the building, which is remote from the site of the waterwheel, and both gable ends are only one brick thick and are of Flemish bond. Significantly, the thinner west wall has a long vertical crack joining the windows and door. In general the standard of the brick-

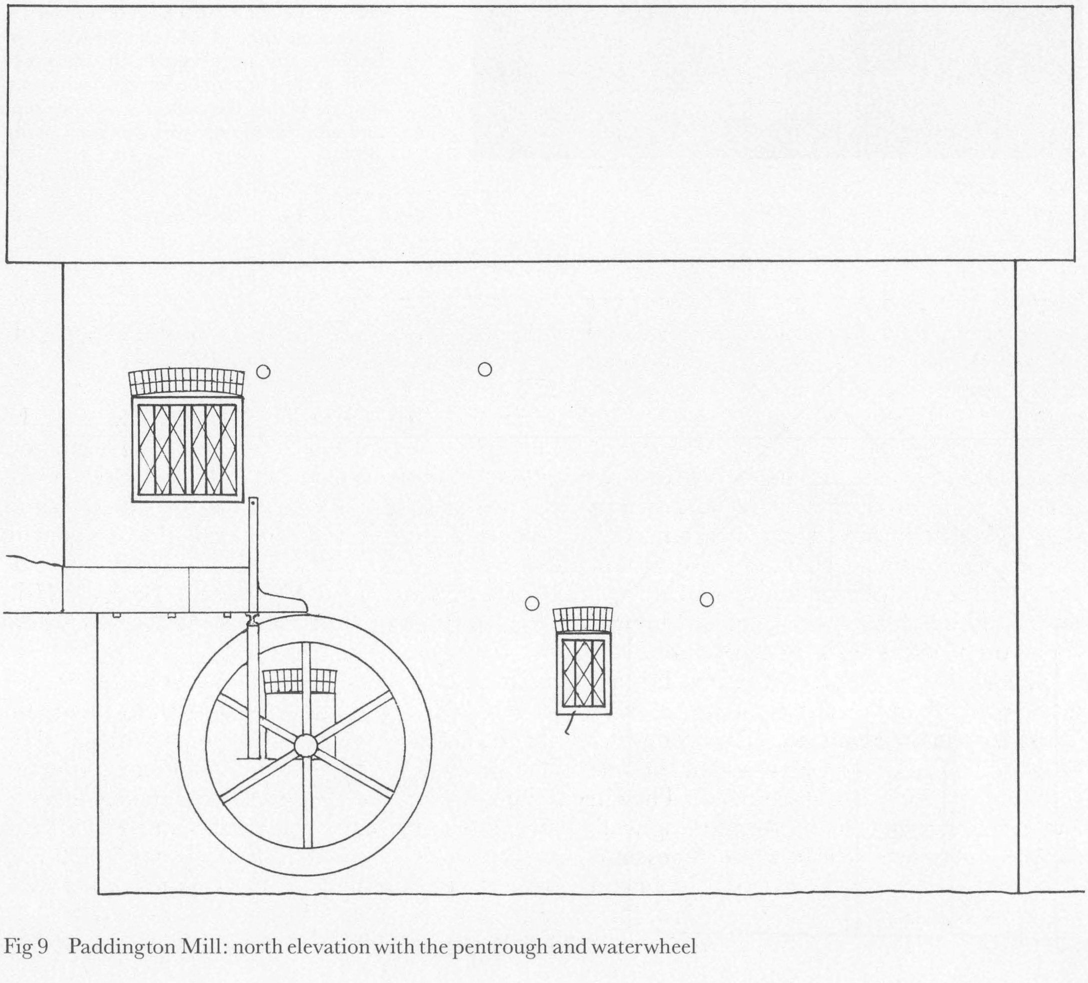


Fig 9 Paddington Mill: north elevation with the pentrough and waterwheel

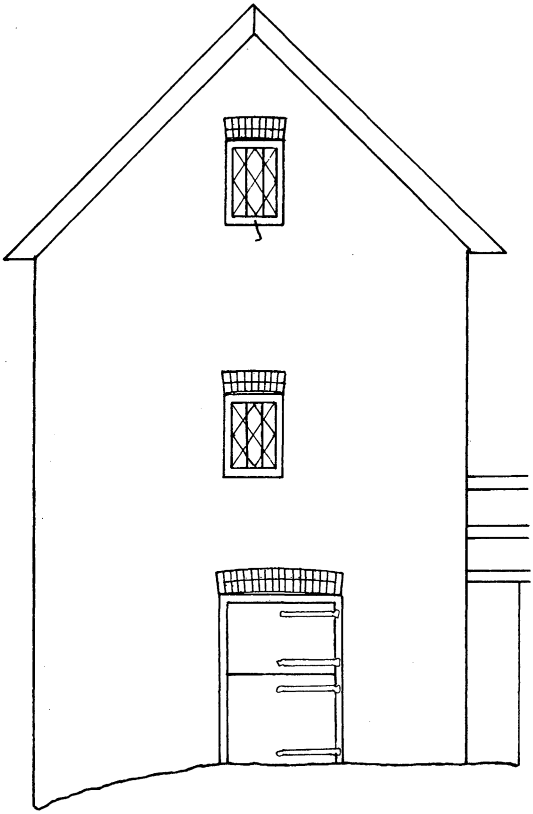


Fig 10 Paddington Mill: west elevation with the passageway and bridge at the right

laying is not perfect, the vertical joins between bricks, for example, not lining-up correctly. The openings for the doors, windows and wheel shaft have low cambered arches of double rows of bricks placed on their sides. Again the quality of the workmanship is not high, the bricks not being shaped to form voussoirs. There are four circular tie plates, 0.25m in diameter on the north wall and four opposite these on the south wall. However, the corresponding tie rods do not cross the building. They are only about 0.60m long and their inner ends are bent and fixed to transverse timber beams inside the mill. It should be noted that tie plates are not normally an original feature of a building but were added at a later stage when strengthening was required. The original roof was of light red tiles measuring 260 × 150 × 10mm, with pairs of peg holes about 15mm across. They have been replaced by rather darker modern hand-made clay tiles manufactured by Keymer of Burgess Hill, Sussex. The roof projects about 0.30m at the eaves and about 0.65m at the gable ends where there are broad moulded bargeboards.

There are four doors, all of which open outwards. Two of these are to the stone floor, one from the dam on the east side and one, across a bridge with two rails on each side, from an embankment on the south side. This bridge is missing but its presence and location are revealed by holes in the brickwork below and at the sides of the door. The other two doors give access on the west and south sides to the pit floor. The one on the south side opened into a narrow passage between the mill and the stone retaining wall of an earth embankment. This passage is filled with rubbish but it seems clear, from representations of the mill on the 1:2500 OS maps of 1892 and 1916, that steps giving access to the door came down the embankment from the south rather than along the wall of the mill from the east. The door in the south wall of the stone floor is in one piece but the other three are stable-doors, being divided into upper and lower opening halves. At many mills, worn-out millstones were used as doorsteps. This does not appear to have happened at Paddington Mill.

There are two double windows in the side walls of the stone floor and a total of five single windows in the two gable ends of the top or bin floor, the west wall of the stone floor and the side walls of the pit floor. These windows had iron casements, with diamond shaped panes, fixed to the outside of the timber frames and a few broken fragments of these have survived. Some of the casements opened outwards and had a spring catch in the frame opposite their hinges, to keep them closed or slightly open and a hooked stay about 250mm long fixed to the bottom of their timber frame, to keep them wide open. Inside the casements, the double windows had four vertical iron security bars and the single windows two, but some of these are missing.

There are several additional features in the north wall. First, the foundations, which are just visible above the water level, are of stone at the east end but of brick farther west. Then, the shaft of the waterwheel enters the building near the sill of a damaged rectangular hole in the wall of the pit floor. The bricks around this opening have eroded badly through scouring by water splashed from the wheel. Above and to the left of the opening there is a recess which held the H-section iron beam which supported the pentrough. The control rod for the sluice or penstock emerged from a brick-sized vertical slot near the bottom right-hand corner of the window of the stone floor. Also, there are two iron, brick-sized, horizontal ventilation blocks below pit floor level. A small stove-pipe emerges through the north wall of the stone floor, near its west end. Most of this is missing but an iron ring which supported it survives. Finally above the waterwheel shaft there is an OS bench mark which is shown on the 1:2500 maps of 1871 and 1892 as being 308.6 feet (94.06m) OD.

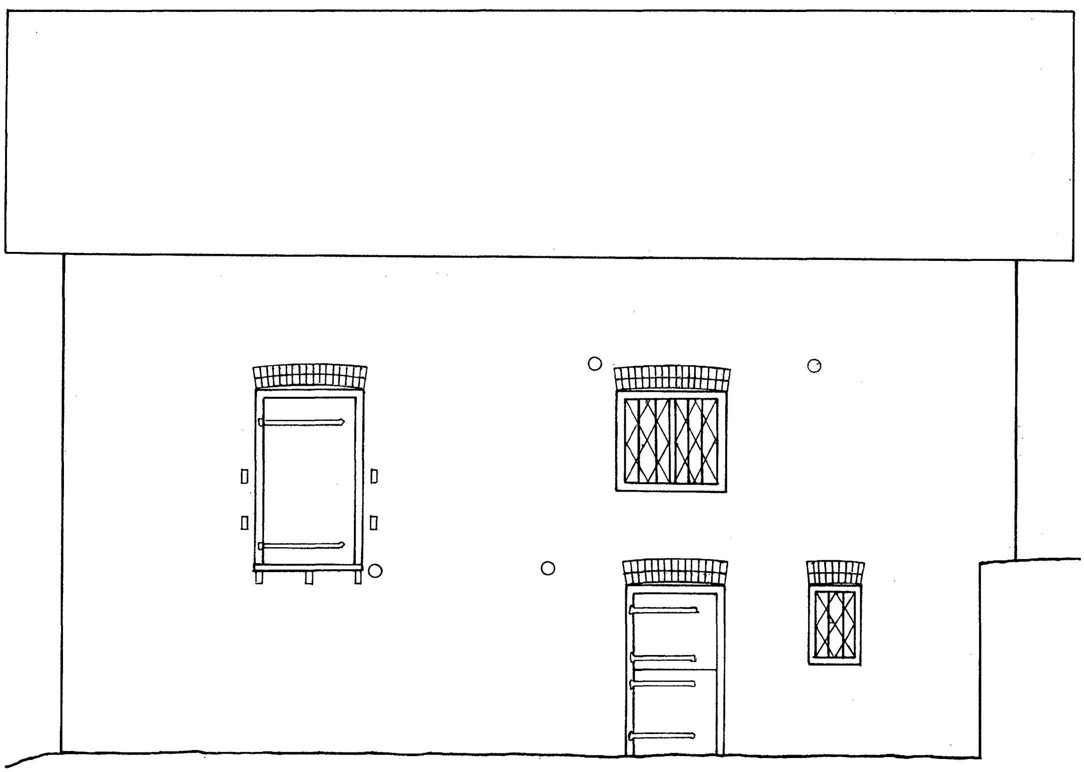


Fig 11 Paddington Mill: south elevation

THE INTERIOR

Introduction

Plans of the three floors of Paddington Mill and the two principal sections of the building are given in figures 12–16. Most of the transverse beams and longitudinal joists of the upper floors are sound but in places the floorboards and the two staircases are in a dangerous condition. The main defect however concerns the floorboards at the north-east corner of the stone floor which are unsupported by beams and joists and have sagged by about 0.5m. These floorboards are not original but replaced the area of the floor occupied by the millstones when the mill went out of use. The stones and the surrounding floor were supported by a massive timber structure, known as a hurst frame, located on the bottom or pit floor. In order to avoid vibrations from the stones damaging the walls of the mill, the hurst was not fixed directly to the walls. Although most of it survives, its footings have decayed so that it has partially collapsed causing the floor above to sag (fig 17). A description of the hurst will be provided later in this report, together with an account of the equipment of the mill. Other features of the interior of the building will however be described here for the pit floor, stone floor and bin floor in turn.

The pit floor

This floor is named after the pit (fig 17) occupied by the lower part of a large cog-wheel, known as the pit wheel, fixed to the shaft of the waterwheel near its inner bearing. Its plan and principal sections are shown in figures 12, 15 and 16. The walls are of brick apart from the one at the east end which is built of large blocks of stone (fig 17), surmounted by two or three courses of brick. This is the same structure as the adjacent part of the east wall of the waterwheel pit and the stonework clearly predates the brick structure of the rest of the mill. There are doors in the west and south walls and small splayed windows in the north and south walls. In addition there is a damaged opening for the shaft of the waterwheel in the north wall. This is much larger than is necessary for the present iron shaft and presumably had specially fitted doors. There is no subdivision into separate rooms.

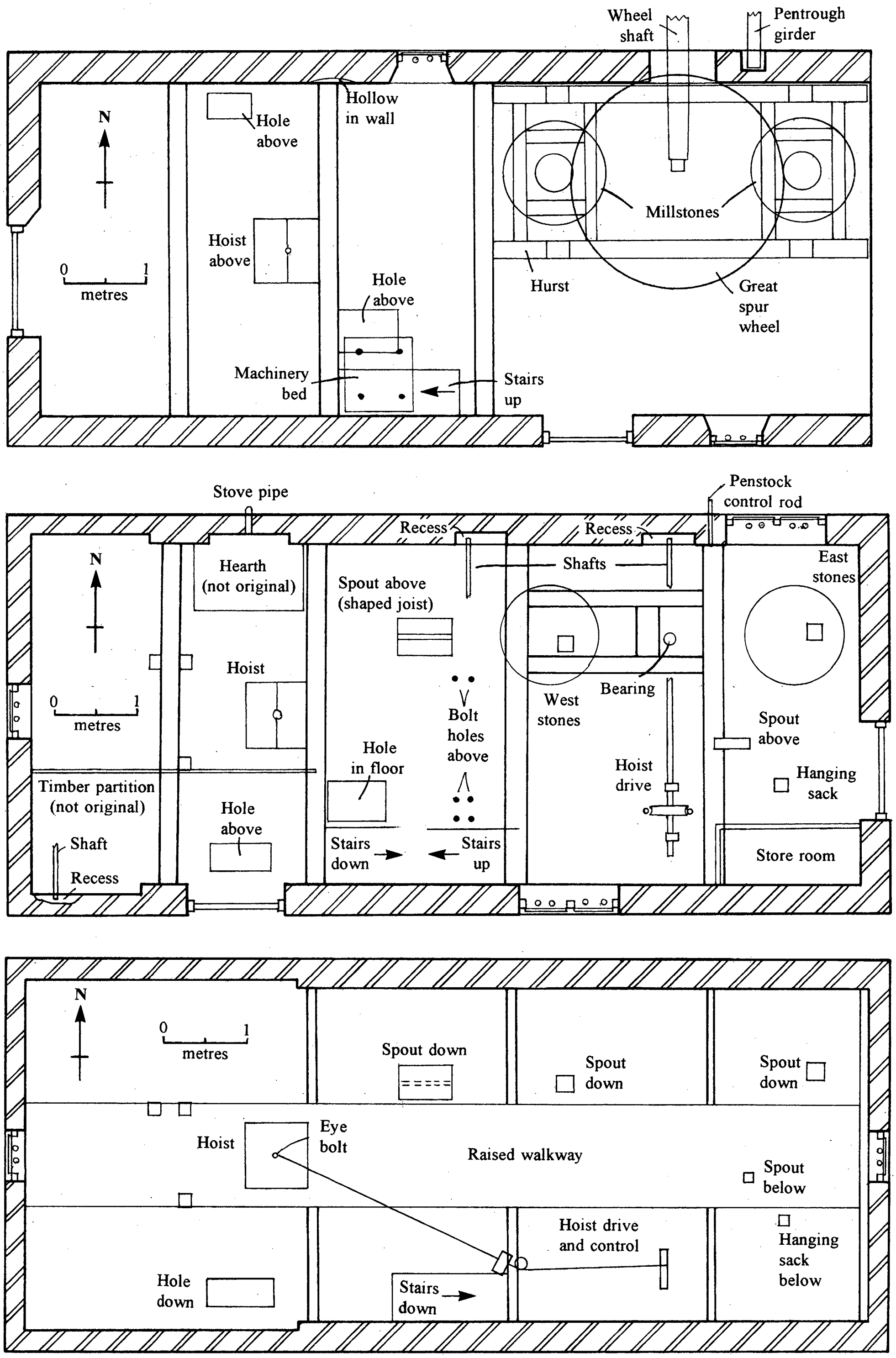
The floor was not boarded in the north-east quarter as this was the location of the waterwheel shaft, the pit wheel, the bottom of the upright shaft and the hurst. The boards of the rest of the floor, much of which has collapsed, are supported by a central longitudinal beam and transverse joists. There is a shallow depression in the north wall, just west of the window. This stretches upwards for about 1.00m from the floor and is up to 0.50m wide. Against the south wall, standing on a concrete plinth, is a rectangular stone block with four studs in its upper surface forming an approximate 0.50m square. This was probably the bed for machinery powered by a belt coming down from the stone floor above.

Three transverse beams and longitudinal joists support the west half of the floorboards of the stone floor above. There were three significant holes in these boards. In particular, along the centre of the building there was an opening for the sack-hoist which is described in detail later in this report. Then there is a large rectangular spout adjacent to the north wall and finally an open rectangular hole directly above the machinery bed mentioned above. The floorboards above the south-east part are supported by joists linking the south wall to a beam at the top of the hurst.

The stairs to the stone floor had eleven treads, three of which are missing, and ascend facing westwards along the centre of the south wall. They have partially collapsed and their backing boards rest against the machinery bed.

The stone floor

This is the floor where the millstones were located. Its plan and principal sections are shown in figures 13, 15 and 16. All the walls are of brick and there are doors to the south and east, large windows to the south and north and a small window to the west. There are two oil-stained rectangular recesses in the north wall to support transverse shafting and an irregular one in the south wall, near the south-west corner. The end of the control rod for the penstock can be seen near the



Figs 12–14 Paddington Mill. Fig 12 (top), plan of the pit floor; Fig 13 (middle), plan of the stone floor; Fig 14 (bottom), plan of the bin floor

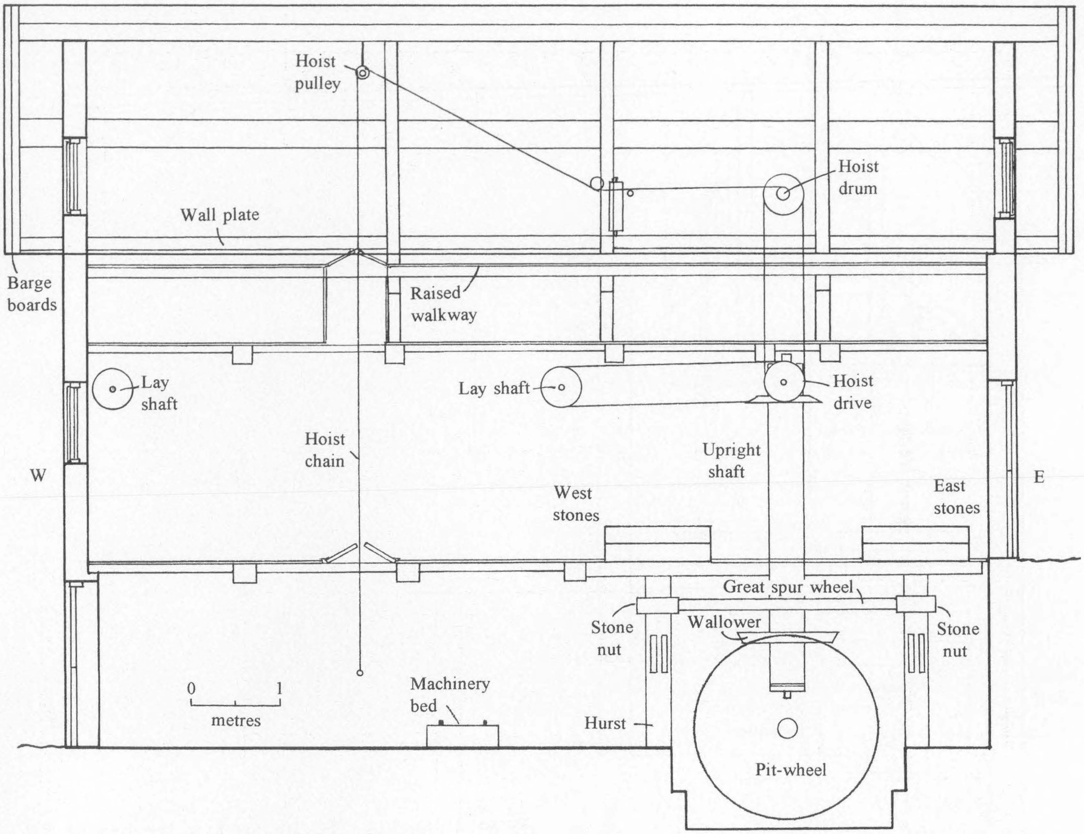


Fig 15 Paddington Mill: longitudinal section looking north

north window. There is a small storage room or office with three shelves in the south-east corner. Also, after the mill stopped grinding, it appears that a larger room incorporating the west window was created in the north-west corner. The longitudinal partition of this, incorporating an internal window, survives but the transverse partition, apart from a door post, has gone. The room was provided with a stove conveniently located in a shallow alcove in the north wall which lies between two overhead beams. Although the stove has gone, its hearth and an opening for a stove pipe remain.

The floorboards of the west half of the room and those of the sagging cover to the hurst in the north-east run across the mill. Those at the south-east are longitudinal. The blocked opening for the hoist is interesting as it reveals that the hinges of the flaps were on the east and west sides. The spout-opening against the north wall is hidden beneath the hearth of the stove and clearly pre-dates it. Finally the opening above the machinery bed on the pit floor is found to be located very inconveniently at the head of the staircase and interferes with the route from the south door to the interior. After the room partition was erected, it could not have been used at the same time as the door.

Five unequally spaced heavy timber beams support the joists of the bin floor above. These are supplemented by additional longitudinal beams in the north-east quarter to support the top bearing of the upright shaft (fig 18). Three large covered rectangular holes are visible on the underside of the floorboards of the bin floor above. One of these is for the hoist and is naturally immediately above the one below. A second is near the centre of the floor and is divided by a

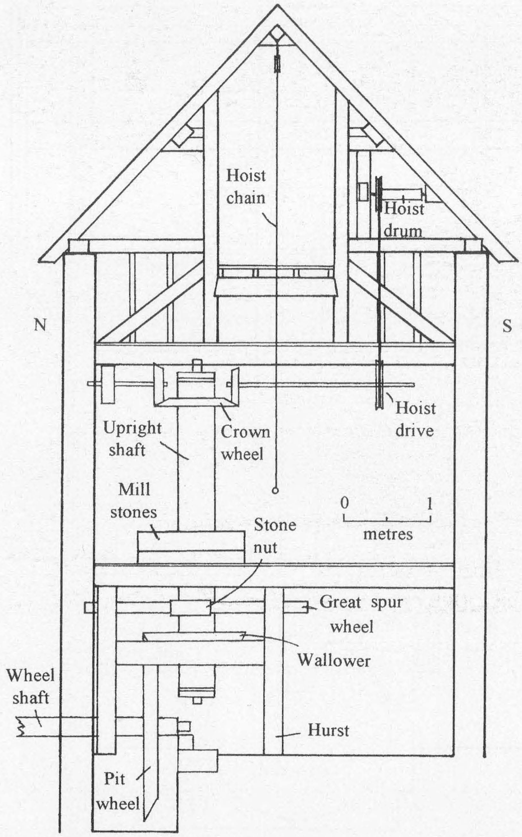


Fig 16 Paddington Mill: transverse section looking east

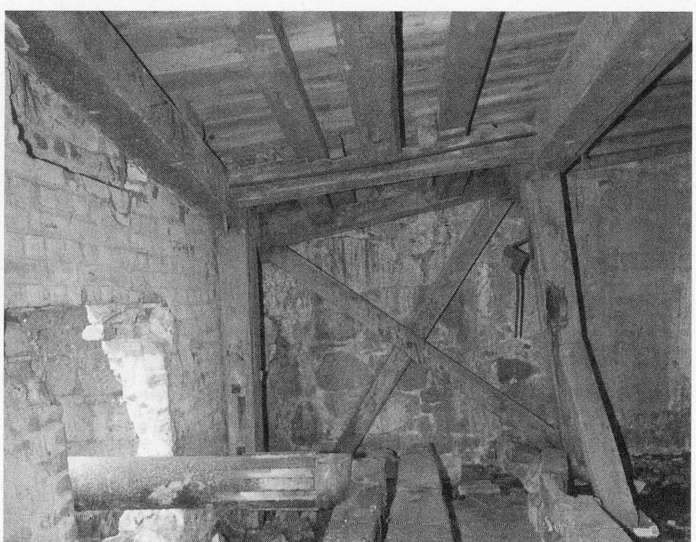


Fig 17 The inner bearing of the waterwheel shaft at Paddington Mill, supported by a small timber beam resting on a much larger beam. Note the key-ways for the hub of the pit wheel, near the end of the shaft, and the pit below this to accommodate the wheel. Note also the eastern part of the hurst frame, which with its cross-brace and transverse iron strengthening rod has partially collapsed, the tentering mechanism attached to the right-hand post of this frame (see fig 25), the recess in the wall at the top left, which indicates the position of the great spur wheel, and in the background parts of the stone wall of the pit floor and the waterwheel pit (April 1996).

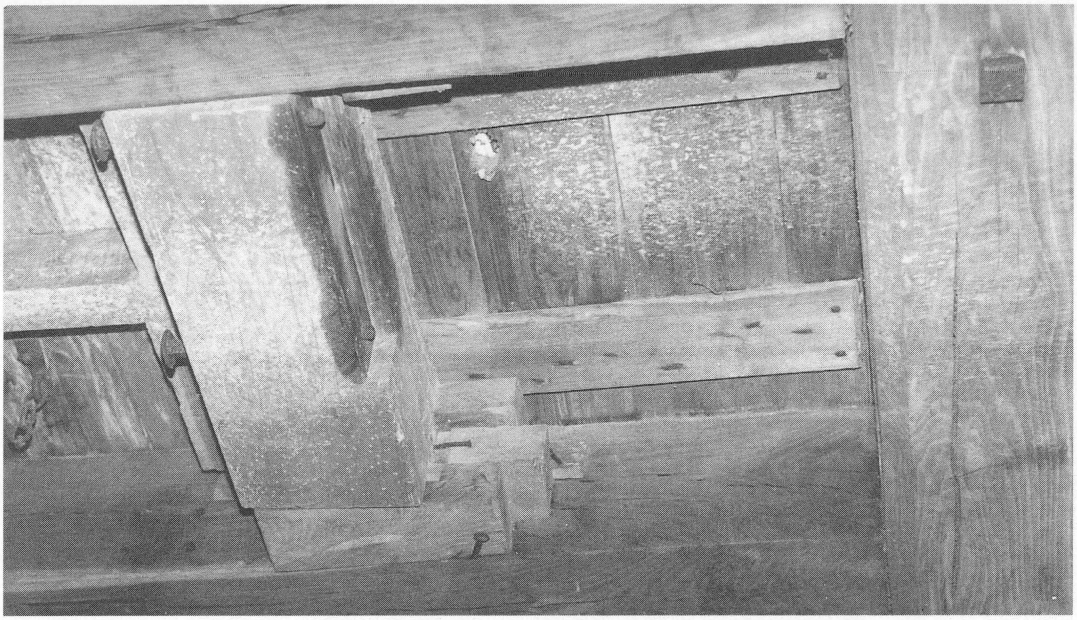


Fig 18 The beams on the stone floor at Paddington Mill which supported the bearing at the top of the upright shaft. The view is from below looking north. The beam at the right is the most easterly of the four main transverse beams, those at the top and bottom are additional heavy longitudinal beams and the one at the left is the cross-member to which the bearing was attached. Note the pair of bolt heads protruding from the left side of this beam and the oil-stained depression on its right side, where the bearing was fixed by means of the bolts. This short beam has been wedged into position using several blocks of timber in a rather crude way. Also the bearing was not mid-way between the two longitudinal beams, which suggests that the original upright shaft was 0.13m farther north (June 1996).

joist which has been carefully shaped to make the descent of granular material easy. The third is a crude hole immediately inside the south door and is clearly not original. Six small square holes all about 0.19m across and covered, are also visible. One of these is just inside the east door and has attached to it a twill sacking chute, about 0.70m long, tied in a knot and apparently still containing grain (fig 19). Then there are two holes over the sagging floor at the north-east. Finally, adjacent to the first beam at the west end of the room, beyond the hoist, there are a further three or more of these holes. Also, near the hole with the sacking, fixed to the first beam, there is a beautifully shaped wooden spout facing west. Finally, near the corner of the small storage room, there are two blocked small holes on either side of two hanging posts of a missing transverse lay-shaft (fig 19). These were for a continuous rope which powered the hoist mechanism.

The stairs to the bin floor had fourteen treads, five of which are missing, and have no backing boards. They are parallel to those from the pit floor and start near the south window.

The bin floor

This floor (fig 20) housed the large bins used to store the grain. Its plan and principal sections are given in figures 14–16. The low side walls and the gable ends, which have small windows, are of brick. The roof has three open, interrupted tie-beam trusses (Brunskill 1985, 65, 136) dividing the space into four unequal bays and creating four compartments on either side of a central raised walkway which linked the windows. This walkway has been removed but its presence is clearly revealed by notches in the posts of the trusses, which supported beams, and holes in the end walls which supported joists and hence the raised floorboards. It enabled sacks of grain to be emptied into the bins without having to be lifted. However, it prevented high-level cross-beams from

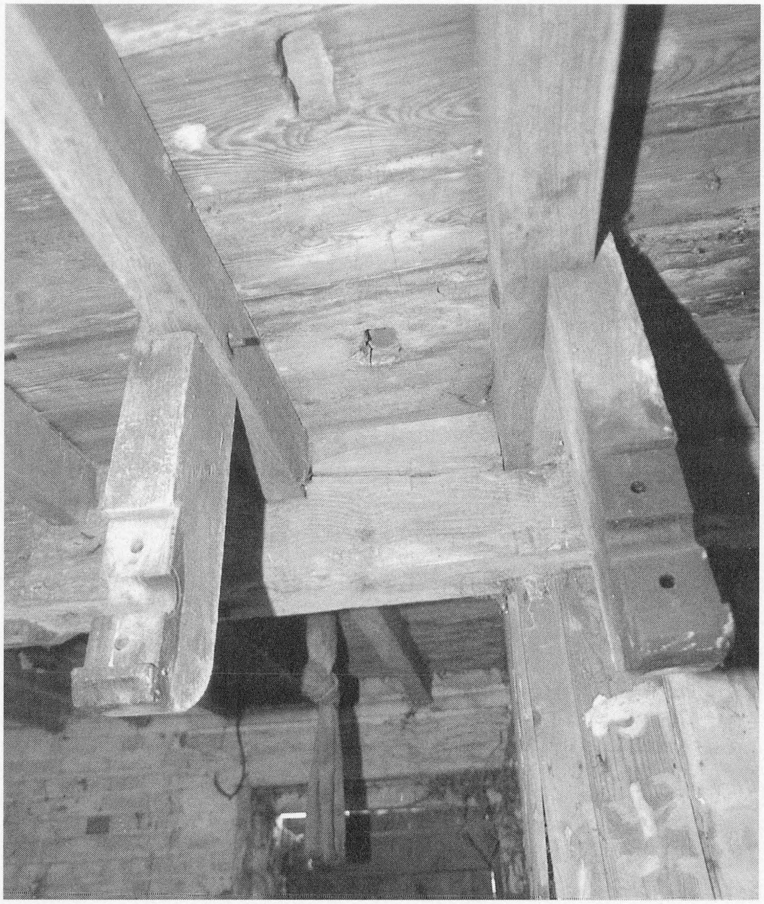


Fig 19 The pair of hanging posts on the stone floor of Paddington Mill, seen from below looking east. They supported in the grooves near their bottom ends, the lay shaft which operated the hoist mechanism. A pulley wheel turned between the posts and carried an endless rope which passed through the holes in the floor-boards above and, when tight, drove a second wheel in the bin floor. Note also the tied twill sacking grain chute in the background (April 1996).

being used and the principal rafters are simply joined by collar yokes (Brunskill 1985, 186) upon which rests the ridge beam, set diagonally. The interrupted tie-beams are linked to the wall-plates by single dovetail halved joints (Brunskill 1985, 140–1) and are tenoned into the posts. Below each one, a diagonal brace runs from near the end of the floor beam to the post. The under-side of the roof was covered with lath and plaster but this has largely collapsed and survives as a thick layer of debris on the floor.

On the south side, the west-central compartment is occupied by the head of the stairs from below, which has a covering trap door, and would also have housed steps to the walkway. The adjacent east-central compartment was used for the drive and control mechanism for the hoist, most of which is missing. The other compartments were occupied by bins. This is indicated by the fact that their brick walls were covered with vertical matchboarding and some of this survives. They were separated by longitudinal boards fixed to the lower parts of the trusses between the bays. The holes in the floor, noted in the description of the stone floor, have been located and are all neatly sealed. Most of these enabled grain or meal to descend in chutes to the stone floor below. However, no evidence has been found of the bins having sloping sides to facilitate this. The hole for the hoist is clearly visible but did not have hinges attached to its sides. This is because it did not have flaps but was joined by vertical timber panels to a further opening with flaps in the missing raised walkway. The panels would prevent grain in the bins from falling though the hoist opening. After the mill closed the large bay at the west end of the floor was converted into a separate room with its own doorway.

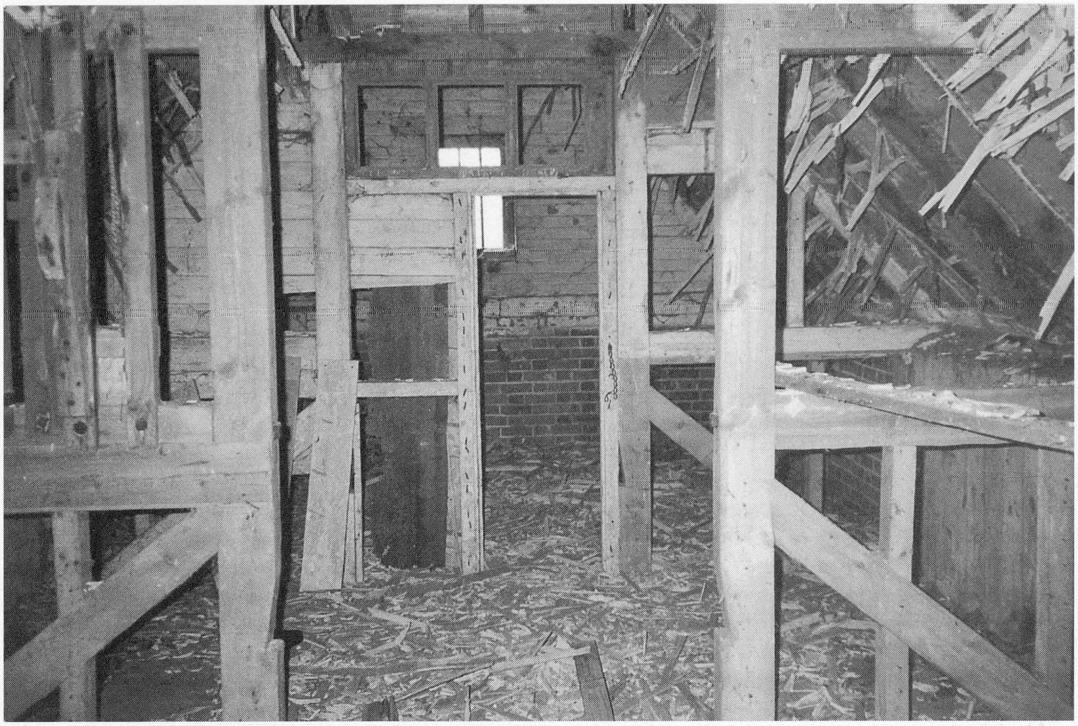


Fig 20 Photograph of the bin floor at Paddington Mill looking west. One of the interrupted tie-beam trusses is in the foreground and has notches in its posts which carried a beam to support a raised walkway. The additional posts at the left are part of the hoist control mechanism. The doorway and panels across the truss in the background were inserted after milling ceased (April 1996).

The equipment of the mill

THE WATERWHEEL SHAFT

All that survives of the waterwheel at Paddington Mill is the magnificent cast iron shaft shown in figures 2 and 21. This rests on bearings on the north bank of the wheel pit and on a longitudinal timber beam, supported by a larger timber beam resting on brick foundations, inside the mill (fig 17). It is interesting that the ends of the smaller beam are shaped into ogee curves which suggests that it is contemporary with the cast iron pentrough, which has similar curves at its ends. The shaft is 4.86m long including gudgeons or pivots protruding at each end and a further extension of square cross-section at the north end. The main part, which is 4.49m long, is 0.25m in diameter near the centre but tapers gracefully down to 0.20m at the north end and 0.22m at the south end. Cast on to it are four sets of iron strips or splines which acted as guides for wedge-shaped wooden keys used for tightening wheel hubs on to the shaft. These are labelled I–IV in figure 21 and, surprisingly, they are all unequally spaced.

The first three sets of splines are located on the section of the shaft outside the mill building, each set containing six splines which are 300mm long and 50mm wide. Their thickness is about 20mm for set I and 10mm for sets II and III, resulting in the overall diameter being 0.27m in all three cases. The splines are equally spaced around the circumference of the shaft and the three sets are all aligned in the same way as indicated in figure 21. The three sets of splines must correspond to three sets of spokes for the waterwheel but their locations are puzzling. One would assume that set II would be central to the pentrough and sets II and III equally separated from the walls of the wheel pit. As shown in figure 21, this is not the case. It appears therefore that the hubs

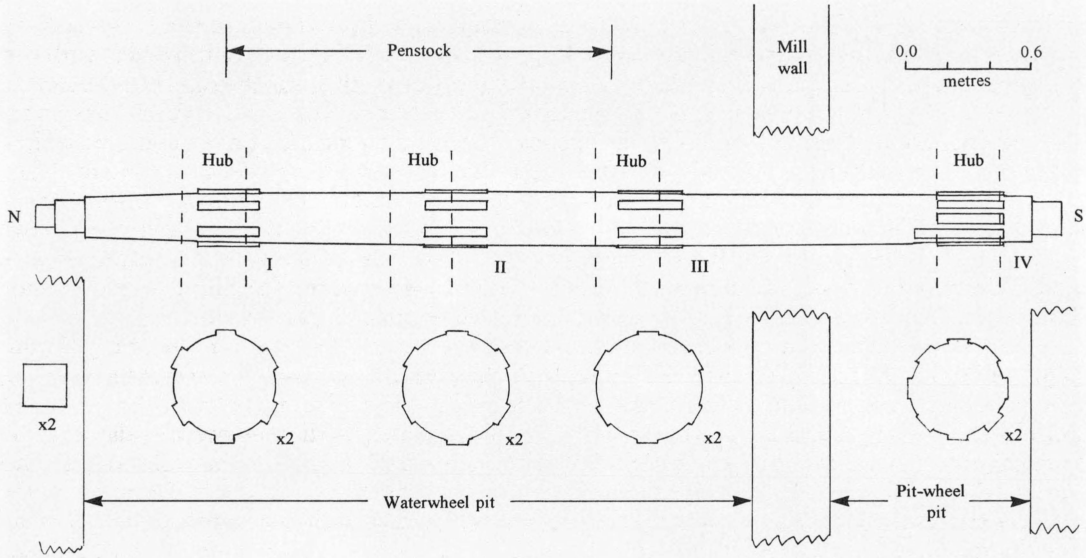


Fig 21 Scale drawing of the surviving horizontal shaft of the waterwheel and pit wheel at Paddington Mill, including cross-sections (x2) of its non-circular elements. Also shown are the suggested positions of the three hubs of the waterwheel and single hub of the pit wheel and the widths and horizontal locations of the penstock and the pits for the waterwheel and pit wheel.

and spokes of the waterwheel must have only partially overlapped the sets of splines. A possible compromise arrangement, which assumes that the hubs were 300mm wide and then maximizes the overall overlap, is indicated in the figure. No plausible explanation of the irregular spacings of the sets of splines has been discovered, other than it being a mistake at the foundry.

In May 1941 it was stated that 'the iron overshot wheel, of the 3-set spoke variety and 10 feet wide, is dismantled, the spokes laying where they were deposited some years ago and now partly hidden from view by a tangle of undergrowth, and the remains of the rust eaten buckets are to be found not far away' (Simmons 1940s). Unfortunately there is now no sign of the spokes or buckets but the information confirms that there were indeed three sets of spokes and suggests that the wheel was entirely of iron. Normally, however, overshot waterwheels have their outer spokes at the sides of the wheel and are only marginally wider than their penstocks. If this was the case at Paddington Mill the wheel should have been, as indicated in figure 21, about 2.13m or 7 feet wide and not 10 feet. In any case the width of 10 feet quoted in 1941 must have referred to the width of the wheel pit and not the waterwheel, which was dismantled. If the iron waterwheel was indeed only 2.13m wide it is necessary to explain why it occupied a wheel pit 3.15m wide. The simplest explanation would appear to be that it replaced a timber or composite timber and iron wheel which was about 3m wide which itself replaced, as explained in the above description of the wheel pit, an earlier wheel which was about 2.2m wide and located close to the wall of the mill building.

The diameter of the waterwheel can be estimated from the position of the surviving shaft, the depth of the wheel pit and the original height of the sagging penstock. About 3.0m or just under 10 feet appears to be a reasonable value. This is consistent with a reported diameter (Stidder 1990, 56) but this is not authenticated and could have been confused with the width quoted in 1941 and discussed above. It should be noted that the rotation of overshot wheels is impeded if they dip into the water in the wheel pit. The tail race at Paddington Mill is probably deep enough for this not to be a problem. There is no way of deducing the number of spokes which the waterwheel had or the number, shape and size of its buckets. However, a typical overshot waterwheel of this size and period would have had six or eight spokes in each set, and about 36 curved buckets about 0.30m deep (Foreman 1983, 4–6; Reynolds 1970, 25).

The fourth set of splines on the wheelshaft was located inside the mill building and corresponds to the vertical bevelled cog-wheel, known as the pit wheel, which linked the waterwheel with the equipment in the mill (Vince 1993, 17). It consists of eight splines, all of which appear to have measured 10 × 50 × 430mm but six, in two groups of three, have been broken, all at their north ends, and are only about 320mm long. There is a deposit, perhaps a mixture of flour and grease, between the splines at their south ends, which suggests that the wedges were hammered home from the north side. This would be consistent with the sense of the axial forces on the pit wheel, which would have tended to push it northwards away from the mill. It would also be consistent with the broken ends of the splines. For the waterwheel it would have been necessary to hammer home wedges from both sides of the hubs and therefore wider gaps between the splines were required. This explains the use of sets of six splines for the waterwheel but eight for the pit wheel.

There is no further information about the exact position of the pit wheel on the shaft and the width of its hub. It is therefore assumed in figure 21 that the hub was the same width as those for the waterwheel and also that it coincided with the broken slats. The diameter of the pit wheel must have been less than 2.30m, in order for it to fit into its pit. This diameter would also allow it to engage satisfactorily with the horizontal bevelled cog-wheel, known as the wallower, on the upright shaft of the mill. It seems likely therefore that the wheel was 7 feet or 2.13m in diameter and this is the value used in its representation in figures 15 and 16. It should be noted that the relative diameters of the waterwheel and pit wheel would then be about the same as in other local mills (Reid 1987, eg 52–3). The pit wheel was said to be *in situ* in May 1941 in a reasonably good state of preservation. One suspects that, together with the waterwheel spokes and buckets, it was taken as scrap iron for the war effort in 1942 but that, fortunately, it was too difficult to remove the penstock and wheelshaft at the same time.

The extension with a square cross-section at the north end of the wheel shaft suggests that water-power was also being used to drive equipment on that side of the wheel pit. If so, this would appear to have been a water pump, as the remains of a pump with the cast inscription J WARNER & SONS LTD / LONDON, together with several large iron tubes, rest on the north bank of the pit. Indeed, water is still pumped by electricity from two covered wells between the wheel pit and the bypass channel. This is used for the watercress beds immediately downstream, which were established in about 1850 (Abinger Hammer 1977, 2) when the Reading, Guildford and Reigate Railway line opened, with a station at Gomshall only 1km down the valley. A more mundane explanation for the extension to the wheel shaft is that it could have been used to raise the end of the shaft with a jack if the bearings needed maintenance

A cross-head iron gudgeon or pivot, attached to the fragmentary remains of a timber shaft, rests on the north bank of the wheel pit. This gudgeon (fig 22) consists of a symmetric cross formed from two orthogonal iron plates, 25mm thick and 0.30m long, which were set into grooves cut into the end of the shaft. A spindle 0.12m long projects from this cross, and a circular iron band 0.51m in diameter and 50mm wide is attached to the plates. This would have encircled the end of the shaft. Three iron wedges are embedded in the small pieces of shaft which survive. Wedges were driven into the wood on either side of the arms of the cross to hold the pivot in place. The gudgeon could have been at the end of a timber waterwheel shaft which was replaced by the surviving iron shaft, presumably in 1867. Alternatively but, as discussed in the next section, less likely, it could have been one of the ends of the upright shaft which was probably removed shortly after the mill closed. In either case it is remarkable that it has remained on the site for so long.

THE UPRIGHT SHAFT

The upright shaft in a watermill enables power to be transferred from the horizontal shaft of the waterwheel to the equipment in the mill (Vince 1993, 17). It may be of timber or iron and is normally supported by a foot bearing at its bottom end, near the inner end of the waterwheel shaft, and by a journal bearing at the top end, fixed to a beam of one of the upper floors of the mill. Usually three horizontal cog-wheels are attached to it. The lowest is the wallower, which is a small bevelled wheel engaging with the larger pit wheel. The upright shaft therefore rotates faster

Fig 22 Photograph of the cross-head gudgeon found on the north bank of the wheel pit at Paddington Mill (May 1996).

than the waterwheel. The middle wheel is the great spur wheel and this meshes with much smaller horizontal cog-wheels, known as stone nuts, which are located immediately below the centres of the millstones. The stone nuts, which are linked by spindles to the upper millstones, therefore rotate much more rapidly than the upright shaft. Finally there is the crown wheel which is at the top of the upright shaft and drives, by means of shafting, the hoist and other ancillary equipment in the mill.

At Paddington Mill the upright shaft and its associated cog-wheels have been removed but, from minor traces that survive, it has been possible to reconstruct the arrangements shown in figures 12, 13, 15 and 16. First, as shown in figure 18, the location of the bearing at the top of the shaft, which was just beneath the floorboards of the bin floor, is clearly revealed by additional heavy beams, a pair of iron bolts and oil stains. This indicates that the shaft was approximately 1.19m and 2.34m from the north and east walls respectively. The corresponding position downstairs on the pit floor is, as expected, on the alignment of the shaft of the waterwheel and some 75mm south of its end. Here, the bearing at the bottom of the upright shaft would probably have been supported on an arch over the end of the wheelshaft. This would have been about 0.5m high and hence the upright shaft was about 3.5m long. The only evidence for the arch is a pair of bolt holes 0.38m apart in a depression in the upper, ogee-ended, timber beam supporting the bearing and a further pair of intersecting double holes 1.12m apart in the larger beam below this (fig 17).

Usually upright shafts are of timber, rather than iron, and it is almost certain that this was the case at Paddington Mill. Indeed, it is possible that the cross-head gudgeon discovered on the north bank of the wheel pit (fig 22) belonged to this shaft. However, if it did, its diameter would have been in excess of 0.51m, as these shafts are usually tapered at their ends. This is exceptionally big, the upright shaft at the much larger Shalford Mill, on the Tillingbourne near its confluence with the Wey (TQ 001 476), having for example a maximum diameter of 0.48m. It seems more likely therefore that the gudgeon came from an earlier waterwheel shaft. Upright shafts, being protected inside the mill, do not decay as rapidly as waterwheel shafts and it therefore seems likely that an earlier timber upright shaft was retained when the iron waterwheel shaft was installed. This has been assumed in figures 15 and 16 where a timber shaft 0.4m in diameter is shown.

As the horizontal wallower meshes with the vertical pit wheel the diameter and position of the former on the upright shaft are defined by the diameter and position of the latter on the waterwheel shaft. Therefore, assuming the estimates for the pit wheel in the previous section to be correct, the wallower was about 1.15m in diameter and was centred about 1.25m above the floor. These values have been used in preparing figures 15 and 16. Next, the position and size of the great spur wheel is revealed by the fact that it was slightly too large to fit into the mill. Therefore, a recess was made in the north wall to accommodate it (fig 17). This is centred 1.66m above the floor and is four courses of bricks or about 0.32m high and 1.00m wide. Hence, knowing the position of the upright shaft, the diameter of the great spur wheel can be deduced to be about 2.60m, as indicated in figure 12. A recess in a wall to accommodate the great spur wheel is a common feature of mills. This is because it was advantageous to have the shaft of the waterwheel as short as possible to maximise its strength and durability. However it was also necessary to have a high gear ratio so that the millstones would turn at the optimum speed, which meant that the great spur wheel had to be as large as possible. These conflicting demands could be alleviated by creating a recess. Sometimes this was done when the mill was built, in which case the recess will probably be well constructed, but sometimes the recess had to be made when a great spur wheel was replaced by a larger one. The recess at Paddington Mill is interesting because the top two courses of bricks are carefully shaped whereas the bottom two are crudely hacked out of the wall. This suggests that at some time either the great spur wheel was lowered some 0.16m, possibly through lowering the whole upright shaft, or a new thicker one was installed, but with the same diameter. This may have happened when the pentrough was introduced in 1867. Finally, some information about the horizontal bevelled crown wheel is provided by the fact that it meshed with vertical bevelled pinions on line-shafting on the stone floor. The traces of these shafts indicate that they were about 2.00m above the floorboards and the space available suggests that the crown wheel was below rather than above them. Unfortunately no information is available on the diameters of these bevelled wheels and the dimensions used in figures 15 and 16 are based on typical arrangements at other mills.

Although, as shown in figure 18, the location of the top bearing of the upright shaft is clearly defined, there are indications that this might not have been exactly its intended position. In particular it is not mid-way between the additional pair of longitudinal heavy beams which help to support it, and the cross member to which the bearing was attached does not appear to be original, being shorter than the gap between the beams and fixed in place rather crudely by wedges at its north end. It appears that the original intention was for the bearing to be 0.13m farther north than the position recorded. Incidentally this position would have placed the upright shaft exactly mid-way between the centres of the two pairs of millstones.

THE HURST FRAME AND MILLSTONES

The hurst frame, hurst or hursting in a mill is the structure which supports the millstones and holds them in place. At Paddington Mill, as shown in figures 12, 13, 15 and 16, the hurst was located in the north-east corner of the pit floor and supported two pairs of mill stones. It was of timber and, because much of it survives, it has been possible to prepare the isometric reconstruction drawing of figure 23. Unfortunately, as shown in figure 17, most of the lower beam on the north side has been removed and this has caused the post at the north-east corner to drop about 0.5m. Hence the frame has twisted, forcing the post at the south-east corner off its supporting beam. The two transverse horizontal timbers linking the posts, which are known as bridge trees, have also disappeared. The locations of these can however be deduced from vertical single mortices in the two south posts and twin mortices in the two north posts. Also, the two down-braces on the north side are missing but the mortices on the inner faces of the posts are for oblique tenon joints (Brunskill 1985, 140, 145) which indicates that they matched those on the south side.

At the west end of the hurst the four longitudinal beams are fixed to transverse beams crossing the mill but at the east end they are not linked directly to the wall of the mill. However, to avoid the possibility of the hurst shearing, the ends of the beams are connected diagonally in pairs by a

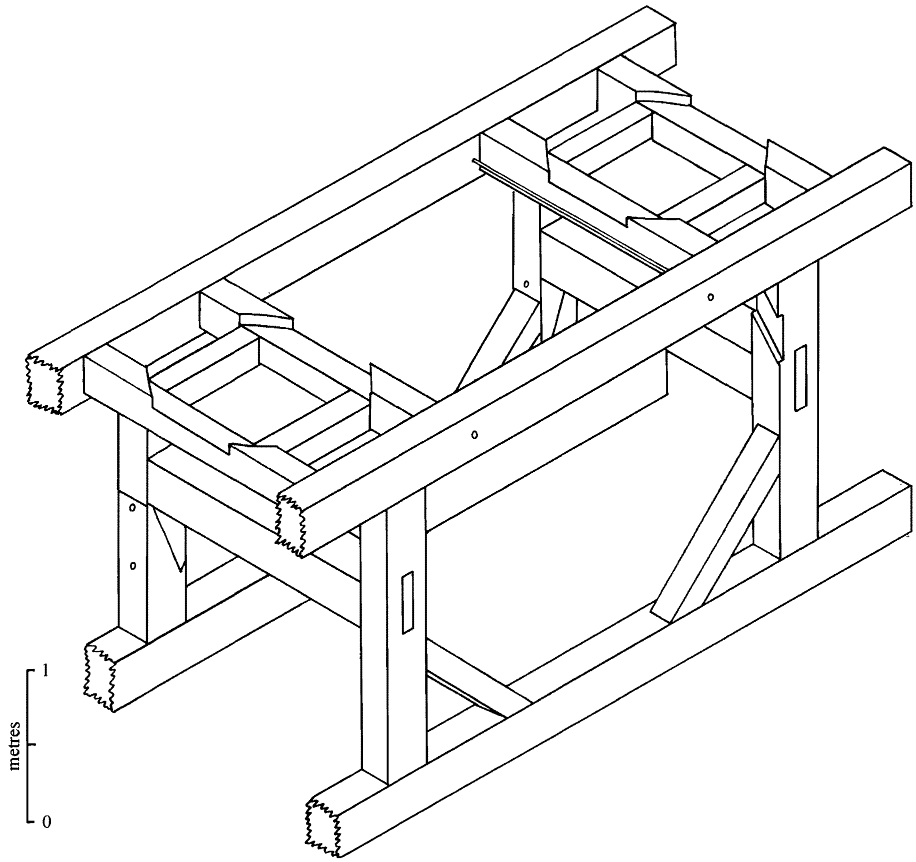


Fig 23 Isometric projection of the hurst frame at Paddington Mill viewed from the south-west. Note in particular the depressions for the bed-stones in the upper timbers, the repairs to the two posts on the north side and the groove for a meal spout on the south-east post.

cross-brace with a double notched joint and an iron bolt at its centre. This can be seen in figure 17 but has not been included in figure 23. The hurst is also strengthened by two transverse iron rods joining the upper longitudinal members and one of these can be seen in figures 17 and 23. Finally the two posts on the north side of the hurst consist of upper and lower parts joined, just below the pivots of the bridge trees, by splayed scarf joints with square under-squinted abutments (Brunskill 1985, 39, 145–6) fixed by pairs of iron bolts (fig 23). It is therefore clear that the lower sections of these posts have been replaced at some time.

At each end of the top of the hurst there are two transverse and two short longitudinal beams forming a square frame (fig 24). These frames, as shown in figure 23, are cut away so that they hold in place the two lower millstones, known as bedstones, which are fixed. The millstones have been removed but their locations and diameter are defined by the cut away frames and more clearly, in the case of the east pair of stones, by some boards which fitted around them and remain in place (fig 24). They were 1.22m or 4 feet in diameter.

Immediately below the frames, the bridge trees crossed the hurst and supported, by means of iron spindles, the weight of the upper rotating stones, known as runners. At their north ends the bridge trees were pivoted and at their south ends they could be raised or lowered in order to adjust the gap between the stones, an operation known as tentering. Most of the mechanism for doing this survives for the east pair of stones and can be seen in figure 17. It consists, as shown in the reconstruction sketch of figure 25, of two rods, with threaded ends, attached by means of pivots to a crudely made heart-shaped plate, the point of which is itself pivoted to a horseshoe-shaped plate.

Fig 24 The section of the hurst frame at Paddington Mill which supported the bedstone of the eastern pair of millstones. The view is from below looking east. Note in particular the curved timber which helped to define the diameter and location of the stone (April 1996).

This is fixed to the north side of the south-east post just above the mortise for the bridge tree. One rod passes horizontally through a hole in the post and would have had a control device such as a small wheel. The other rod would have passed downwards through a hole in the missing bridge tree and had a fixing nut at the bottom, which could be adjusted if necessary. The corresponding mechanism for the west pair of stones is missing but its former presence is indicated by a hole through the post for the horizontal rod and marks where its horseshoe-shaped plate was fixed to the post. In addition the south-facing sides of both posts have traces of what appear to be an earlier type of tentering mechanism, perhaps a simple screw jack.

In most mills, the bridge trees also supported the mechanisms which lifted the stone nuts out of engagement with the great spur wheel when the millstones were not in use. No evidence for this arrangement survives at Paddington Mill. However the radius of the stone nuts can be deduced as it is equal to the difference between the distance between the axis of the upright shaft and the

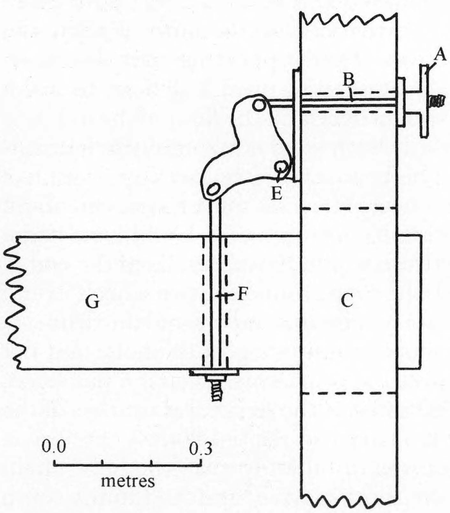


Fig 25 The tentering mechanism on the south-east post of the hurst frame at Paddington Mill. When turned, the control wheel A would cause the horizontal threaded rod B, which passes through the post C of the hurst frame, to move and hence the heart-shaped plate D to tilt about its pivot E. This, in turn, would cause the vertical threaded rod F to move up or down and hence raise or lower the bridge tree G, through which it passes.

axis of a pair of millstones, which was 1.50m, and the radius of the great spur wheel. Hence the outer diameter of the stone nut, allowing for the engagement of the cogs, was about 0.45m. This information has been used in drawing figures 13, 15 and 16, although the thickness used for the stones is arbitrary.

The meal from the stones would have descended down sloping chutes to be collected in sacks on the south side of the hurst. These chutes have gone but their positions are evident as they were attached to the south posts of the hurst. In particular the chute for the east stones fitted into a diagonal depression near the top of the west face of the south-east post. This is shown in figure 23 and is also detectable in figure 17. The corresponding west chute was simply nailed to its post so that its position and angle are less clearly defined.

THE HOIST

In a water-powered corn mill, a hoist is used to lift sacks of grain or flour from lower to upper floors. Pairs of flaps are placed in the floors and these open to allow full sacks, attached to a chain, to pass upwards, after which they close by gravity. The mechanism is powered by the waterwheel and can be engaged or disengaged as necessary. Much ingenuity was used by millers and millwrights in designing convenient arrangements. At Paddington Mill several traces of the hoist structure and mechanisms have survived. Although the flaps have been removed, replacement patches of floorboards, which occupy spaces of about 0.80m square, can be detected. Also at the sides of the patch on the stone floor the positions where the hinges of the flaps were fixed are clearly visible. In addition, as the spacing of the joists is only about 0.35m, less than the size of a full sack, a section of a joist had to be removed in each floor. Hence, as indicated on the plans of figures 12–14 and 16, the hoist can be located accurately along the centre line of the building about one-third of the way from the west end and immediately west of a transverse horizontal beam on each floor. This location is confirmed by the presence, in the ridge beam at the top of the mill, of a heavy iron eye-ring, to which a pulley wheel would have been attached.

The principal clue to the mechanism for powering the hoist is provided by two vertical oil-stained timbers descending from neighbouring joists near the south-west corner of the stone floor (fig 19). These carried a horizontal lay-shaft across the mill, from the crown wheel, at the top of the upright shaft, to near the south wall. Between them would have been a wheel which carried an endless rope into the bin floor above. This wheel is lost but its position and diameter are indicated by two plugged holes in the floorboards, through which the rope must have passed. A second parallel wheel probably of about the same diameter would have been located immediately above in the bin floor, but this and its axle are also missing.

A reconstruction of the mechanism which raised and lowered this second wheel by a small amount, in order to tighten or slacken the rope and hence drive or stop the hoist, is shown in figure 26. It consisted of a long lever, pivoted near the upper wheel and supporting one of the bearings of its axle. This lever has again disappeared but the location of its pivot is defined by a slot with a transverse hole in a vertical timber in the bin loft. Also, in debris on the floor of the loft, was found a beam of triangular cross-section which had previously been fixed horizontally to four rafters on the south side of the building, parallel to the lever. This beam clearly reveals the location of the bearing at the southern end of the axle of the upper wheel. The axle must have been about 0.80m long and in addition to the relatively narrow wheel at its northern end would have had a broad horizontal drum over the rest of its length. To this drum would have been fixed the end of the chain of the sack hoist. Thus, when the lever was raised, the rope around the two wheels would tighten causing the upper wheel and drum to turn and the hoist chain to wind around the drum.

There was however a complication. The drum was remote from the top of the hoist and not perpendicular to the straight line joining it to the pulley over the trap doors. Even if it had been, the path of the taut hoist chain would probably have fouled some of the structural timbers of the roof and interfered with use of the raised walkway along the length of the bin floor. Therefore, a complex arrangement, involving three additional rollers was installed to take the hoist chain around a corner. Two of the rollers and the bearings of the third survive, attached to the south

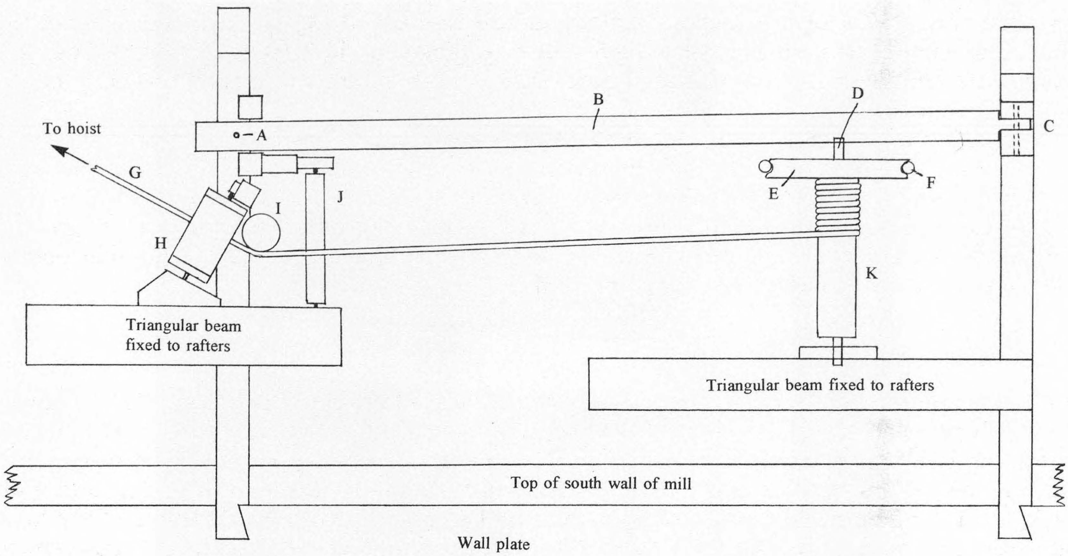


Fig 26 Plan of the control mechanism for the hoist at Paddington Mill. When pulled, the control rope A raised the lever B, which was pivoted at C. This caused the bearing D of the pulley wheel E to be raised and hence the slack rope F to tighten. Wheel E was then linked to the waterwheel and therefore rotated. Hence the hoist chain G, which turns a corner by passing around the rollers H, I and J, was wound around the drum K and raised a sack attached to its other end.

side of the central truss of the roof structure (fig 27). As a sack was hoisted, the chain came down at an angle from its pulley, which was hanging from the ridge beam, around the underside of a surviving metal roller, oriented to be perpendicular to the chain, around the top iron-sheathed part of a surviving vertical timber roller, over a supporting 50mm diameter horizontal transverse roller, which is missing, and then horizontally, approximately parallel to the eaves, to be wound up on its drum. A smooth plank of wood is attached diagonally to the rafters between the pulley and the first horizontal roller and would have prevented the chain from fouling the sloping, plastered ceiling. Also, a small strip of wood is fixed horizontally just below the first roller to prevent the chain from dropping down if it became slack. The fact that this did indeed tend to happen is revealed by a perfectly located worn groove in the upper surface of the strip of wood (fig 27). As the working sections of the two surviving rollers are iron it is thought that a chain rather than a rope was used for the hoist and this has been assumed in the foregoing discussion.

The remaining feature of the hoist is the arrangement for raising and lowering the free end of the lever which supported the upper wheel. This passed between two vertical posts, again attached to the south side of the central truss. The inner surfaces of these posts are polished from the lever rubbing against them. Hanging vertically between the posts, from a heavy staple in the beam above, is a piece of frayed rope about 0.57m long and this provides a clue to the way in which the miller operated the lever (fig 27). Normally this would have been done by pulling on a rope which passed down through small holes in the floors to convenient locations on the stone and pit floors below. Unfortunately these holes have not been discovered, probably because the evidence has been destroyed. However, a threaded bolt hole in a triangular piece of timber above and immediately to the west of the hanging piece of rope probably contained an eye-ring supporting a pulley. It appears therefore that the short piece of rope is all that remains of a much longer piece which passed around a pulley wheel attached to the end of the lever, around the pulley wheel attached to the missing eye-bolt above, along the bin floor to another pulley, probably near the hoist, and then downwards through small holes in the floors.

Fig 27 Photograph, looking south-east, of two of the three rollers on the bin floor at Paddington Mill which took the chain of the sack-hoist around a corner. The chain came down from the hoist pulley, under the horizontal roller, around the right side of the vertical roller, over a third roller which is missing and was then wound on a rotating drum (figure 26). Note the crude horizontal stick, just below the horizontal roller, which supported the chain if it sagged. It has a worn groove in its upper surface which indicates that this happened. Note also the frayed rope end at the top left which is all that remains of the control rope (April 1996).

THE CLEANING AND DRESSING EQUIPMENT

In a corn mill, the grain had to be cleaned before it was fed to the millstones and a wide range of mechanical equipment was available for removing dust, dirt, straw, fungus spores, weed seeds and pieces of stone and metal (Watts 1983, 24–7). Also the meal which was produced by the millstones was sieved, dressed and graded to remove bran and obtain fine flour, using either flat or cylindrical sieves of linen, wire or silk. No evidence of any of this equipment survives at Paddington Mill but its presence, especially on the stone floor, is indicated by bolts or bolt holes in floorboards and overhead boards and beams, by holes which fed grain and meal through shoots from the bin floor, and by traces of shafting, linked to the crown wheel, which powered the machines. However, during the working life of the mill, there were many developments in cleaning and dressing machines and no doubt the equipment was replaced several times, resulting in new arrangements for supplying the grain, meal and power. Consequently it is very difficult to interpret the surviving traces of information but, by considering the sequence of operations in the mill, suggestions can be made.

It seems likely that grain was delivered to the mill through the south door of the stone floor, as this was level with the lane along the top of the dam and near the hoist (fig 13). It would then have been hoisted to the bin floor and stored at the west end of the building (fig 14). The logical place for the cleaning machinery would therefore have been at the west end of the stone floor and there are several conveniently located chutes for the grain to descend. There is also an oil-stained recess at the south-west corner of the building which presumably supported an overhead transverse shaft which powered the machine. This shaft would have been linked by a belt or rope to a parallel shaft across the centre of the building. Having been cleaned, the grain would be returned to the bin floor in sacks, using the hoist. It would then have been taken, probably in a barrow, along the raised walkway and tipped into bins at the east end of the building. From there it would descend down chutes to be ground by the millstones below and the resulting meal would be collected in sacks in front of the hurst on the pit floor. These sacks would then be hoisted to the bin floor and tipped into the bin in the north central bay so that the meal could descend through the large spout, subdivided by a shaped joist, to a dressing machine aligned across the centre of the stone floor. This machine would be powered by an overhead transverse shaft linked by a belt or rope to a short shaft to the north of the crown wheel. There are recesses in the north wall and bolt holes in overhead boards and beams for the bearings of both of these shafts. The sacks of dressed flour could then be collected from either the south or east doors of the stone floor or stored, probably on the pit floor where space was likely to be available.

Discussion

A water resources survey of 1851 records that on average Paddington Mill worked 8 hours per day and produced 40 sacks of flour or grist per week (WRS 1851). A pair of millstones produces about 5 lbs of flour per minute or about one sack, which weighed 280 lbs, per hour. Therefore in a working week of 48 hours the mill could have produced about 96 sacks. It thus appears that in practice, on average, only one of the two pairs of stones was working and then only for about 7 hours per day. It requires about 3.75kW (5hp) to operate a pair of 1.22m (4 feet) diameter millstones. Taking the head of water at Paddington Mill to be 3m and assuming that one pair of stones was working and that the system was 50% efficient, one concludes that the flow of water to the wheel needed to be about 0.25 cubic metres per second. The 1851 survey provides three estimates of the flow of water in the Tillingbourne at Wotton, just 2km upstream from Paddington Mill. In cubic metres per second, these are 0.047, 0.069 and 0.183, giving a mean of 0.100. Hence, on average, milling using one pair of stones could only be carried out for about two-fifths of the time, which corresponds quite well with 7 hours per day. This explains the need for a large millpond which, overnight, would get deeper and extend over at least part of the marshy land upstream. A rough calculation indicates that in the morning the pond would on average contain about 0.3m of usable water above the level of the bed of the penstock; this seems to be a reasonable value.

The surviving iron penstock was installed in 1867 by Thomas Spencer, millwright of Guildford, and he must also have installed, at the same time, the surviving iron wheelshaft and the associated missing waterwheel and pit wheel. According to local directories the millwrighting firm of Bishop and Spencer was at Quarry Street, Guildford, in 1845 and 1859 and their names, with the date 1839, are cast on a pentrough at Gomshall Mill 1.6km downstream from Paddington Mill. However they are not mentioned in directories of 1839 and 1865. It appears therefore that the senior partner, Bishop, left the firm sometime after 1859 and the junior partner, Thomas Spencer, who was born at Bridgeham Farm on the Evelyn estate in 1811, was in charge by 1867 (Corke, in prep). No other work carried out by him is known.

The information deduced about the dimensions of the missing pit wheel, wallower, great spur wheel and stone nuts indicates that the upper millstones rotated at about 10.7 times the speed of the waterwheel. In order to produce good quality flour, millstones which were 1.22m in

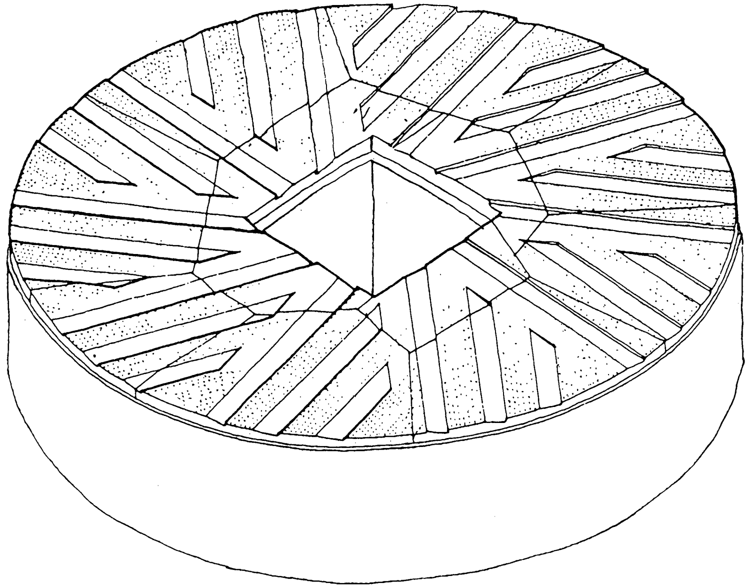


Fig 28 The dressing of a clockwise millstone as used at Paddington Mill. The example shown is a French burr consisting of twelve blocks of stone bound together. There are ten harps, each with a master furrow and two slave furrows. It is a bedstone as it has a square eye. Runner stones have circular eyes with slots for an iron bar known as a rynd. This was attached to the stone nut and hence linked to the waterwheel so that the stone rotated. The sense of the dressing, clockwise or anticlockwise, is the same for matching bedstones and runners.

diameter needed to rotate at about 120rpm so that the waterwheel must have rotated at about 11rpm, which is a typical value. The waterwheel was overshot and with the system of gearing at the mill, both of the upper millstones or runners would have turned clockwise, when viewed from above. The dressing of the two runners and two bedstones would then all have been as indicated in figure 28, with the master furrows tangential to the right of the eye at the centre of a stone, when viewed from the rim, and with the minor or slave furrows parallel to these on their right side. Frequently there were ten master furrows each with a harp of two or three slave furrows, and this pattern has been adopted in the figure.

It is recorded that in 1851 Paddington Mill had two pairs of stones and produced flour and grist (WRS 1851). It is likely therefore that it had one pair of French burr stones for milling flour and one pair of Derbyshire Peak stones for grinding animal feed. It is possible that, when they were removed, the stones were left as decorative features outside the building and remain under accumulated rubble. Alternatively, they may of course have been moved to nearby gardens and it is interesting that Gertrude Jekyll used 13 millstones in her garden at Goddards, a house by Edwin Lutyens at Abinger Common, only 2km to the south-east (Roberts 1995). Ten of these stones, five burr and five Peak, are about 4 feet in diameter. Of these, five are clockwise stones, including a pair of burrs and a pair of Peak stones with matching harps and furrows. It is tempting to think that these came from Paddington Mill but the Goddards garden is said to have been designed in 1900 and the mill might have worked until 1915. However in 1891 Mark King, the farmer at Paddington Mill, was described as a 'steam miller'. There is no indication of an engine or boiler having been located at the mill, the concrete plinth and stone block on the pit floor being too small for this purpose. Another possibility therefore is that the millstones had been removed to the farm where they were powered by a general purpose steam engine.

The brick walls of Paddington Mill are partly English bond and partly Flemish bond. The traditional English bond, with alternate courses of headers and stretchers, is very strong, as it has no continuous vertical joints. However, in the early 17th century it became fashionable to use Flemish bond, with alternate headers and stretchers in each course. This is less strong than English bond, as it has some joints in the vertical plane at the centre of the wall which run uninterruptedly from top to bottom. Then, in the 19th century, English bond was re-introduced, partly because of the Gothic Revival but also because of its structural qualities. Walls with each of these bonds can be built either one brick thick (0.23m) or one-and-a-half bricks thick. However, in the case of Flemish bond, some bricks have to be cut in half to construct the thicker wall and this results in even more uninterrupted joints and, compared with the thicker English bond wall, an even weaker structure. At Paddington Mill the walls which are one brick thick are Flemish bond and those which are one-and-a-half bricks thick are English bond. It would therefore appear that the builders were conscious of the need to have strong thick walls around the milling equipment but preferred Flemish bond, which presumably was still more fashionable, for the thinner walls well away from the waterwheel and millstones. Perhaps if the thinner walls were also of English bond the west wall of the mill would not have cracked (Brunskill 1990, 49–52, 88, 91; Jaggard & Drury 1926, 2–11).

The bricks used in the walls of the mill do not have the depressions, known as frogs, in their largest faces. At the end of the 18th century the frog was introduced into hand-moulded bricks for several reasons including lightening the brick, economizing on material, providing a recess for the mortar, which when set helped to prevent displacements of the bricks, and making it easier to bed courses closer together. Then, from the middle of the 19th century, extruded wire-cut bricks were made and these had no frogs. However, shortly afterwards machine-made pressed bricks, often with two frogs and incorporating the makers name and trade mark, were introduced. Wire-cut bricks can be recognized from traces produced when they were being cut and these are not present on the Paddington Mill bricks. Therefore, because these bricks have no frogs and are not wire-cut, they could date from the end of the 18th century or earlier. However local brick works no doubt continued to make bricks without frogs well into the 19th century (Brunskill 1990, 24–25; Jaggard & Drury 1926, 4–5).

Unfortunately no documentary information on the construction date of the present brick mill has been discovered. However it is clear that this preceded the installation of the iron pentrough in 1867. For example, this trough is considerably narrower than the existing wheel pit and, unusually, is not adjacent to the wall of the mill. Also the opening in this wall for the wheel shaft is large and more suitable for an earlier thick timber shaft, represented by the surviving gudgeon, than for a slender iron one. Again, inside the mill, the bearings for both the wheel shaft and the upright shaft and the recess in the wall to accommodate the great spur wheel all had to be adjusted when the new waterwheel was installed. Also the posts on the north side of the hurst frame had to be repaired and the tentering mechanisms attached to the south posts were replaced. It is unlikely that all of these changes would have been made in the first few decades of the life of the mill. However the fact that the representation of the plan of the mill building on the tithe map is different from the present building may suggest that it was built shortly after 1840. This is perhaps a rather late date for the type of bricks used and also for the single dovetail halved joints in the wall plates on the bin floor. Then the window furniture seems more likely to be Victorian than earlier, but could have been inserted in 1867 when the refurbishment took place. On balance however a tentative early Victorian date for the building is suggested.

Few clues survive about the structure of earlier mills on the site, which were probably mainly of timber construction. However, the fact that the foundations of the north wall of the mill are of stone near the dam and brick at the west end may suggest that the previous building was restricted to the stone footings and was therefore smaller. The only other information is provided by the stone-faced section of the dam which forms the east wall of both the pit floor and part of the wheel pit. The dressing of these stones indicates that they are likely to have been put in place before 1750, which is consistent with the construction of a new pond somewhere on the Evelyn estate in 1720–1, when John Byde became the tenant. The stones indicate that the earlier wheel pit was narrower than the existing one, which presumably dates from the construction of the brick mill. No specific information is available about the mill site before the 18th century but it would be surprising if the Evelyn family, who were active in introducing several water-powered industries to the Tillingbourne valley, including iron forging, wire drawing and gunpowder making, did not make use of the site.

Again, considerable uncertainty exists about the date when milling ceased on the site. As indicated above, this might have happened by 1891 when steam milling could have started at Paddington Farm. Alternatively it might have happened as late as 1915 when the Coe family, the local watercress growers, were also said to be millers. However, in July of that year it is known that the building was being used as a stable. Also at some stage the western ends of the stone and bin floors were partitioned off to provide what seems to have been living accommodation including a stove. Indeed in 1916 a letter was addressed to a Mrs Russell at Paddington Mill but this could have been an abbreviation for Paddington Mill Cottages (Corke, in prep). By 1941 the mill was being used as a store for watercress containers, after which it became derelict until the start of conversion to residential use in 1996 prompted the survey described here.

In conclusion, it is interesting to compare the fate of Paddington Mill with that of the other corn mills which were active in the Tillingbourne valley in the second half of the 19th century. First, Abinger Mill, which is 1km upstream, closed in the early 1890s. It was similar in size to Paddington Mill as in 1851 it also had produced 40 sacks of flour and grist per week using two pairs of stones (WRS 1851). Only the wheel pit now survives. Gomshall Mill (TQ 085 478), 1.6km downstream, fared much better and worked until 1953, after which it became a restaurant. During the 19th century it was operated with Netley Mill (TQ 079 479), an estate mill 0.6km further downstream, which was constructed to look like a folly. This closed in 1907 and became a pumping station. Shalford Mill is much larger and had three pairs of stones powered by a low breast-shot waterwheel. It closed in 1914, was restored in 1932 and is maintained by the National Trust. The mill in the modern village of Albury (TQ 052 479) also had three pairs of stones powered in this case by an overshot wheel. However, before it closed in 1910 a water turbine and roller mills had been installed. This was a significant development as turbines are more efficient than waterwheels and roller mills are more suitable for milling imported North American grain. The mill building is now used as an engineering testing laboratory. It was replaced as a corn mill by a much larger turbine-powered roller mill 1.3km downstream at Postford Pond, on the boundary between Albury and Chilworth (TQ 039 479). This was also known as Albury Mill and worked until 1990. The site was redeveloped in 1997 for offices and housing. Hence the closure of corn mills in the Tillingbourne valley has taken place over a period of about 100 years, Paddington Mill being one of the earliest to cease work. The reason for this decline was the importation of vast amounts of grain and hence the construction of large steam and electrically powered roller mills near the ports and large cities.

Postscript, March 1999

As explained in the Introduction, the survey upon which this paper is based was carried out mainly in the spring of 1996. Since then Paddington Mill has been converted into residential accommodation and although the work has been carried out sympathetically many of the features which were recorded have been lost. For example, the pentrough has been dismantled and only the W J EVELYN 1867 plate shown in figure 4 has been retained. It is now placed below the window on the east façade. Also the waterwheel shaft has been removed from the building and now lies at the side of the lane across the dam. Inside the building, the hurst frame has gone but most of the structural timbers have been retained and can still be interpreted in terms of the operation of the mill. Even the frayed end of the control rope of the hoist, visible in figure 27, is still in place. In 1996 the window at the north-east corner of the stone floor, overlooking the pentrough, was not accessible because the floor below it had collapsed. Now that it can be reached, an inscription, TP 1881, can be seen carved into its lintel, corresponding to Thomas Parkhurst who, as mentioned in the introduction, was the tenant miller by 1891. Finally, it is encouraging to note that the millpond, empty since 1965, is being re-established.

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