THE PHYSICAL HISTORY

OF

THE HOPEWELL FURNACE GROUP

1770-1883

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INTRODUCTION

The following study is an attempt to summarize all available information on the physical history of Hopewell Furnace and its related structures. Much of this data rightfully belongs in the Historical Base Map narrative, which is now undergoing revision, but is collected here in an effort to satisfy an immediate need. Some elements of the Furnace Group, namely the Bridge House and Wheel House, are in process of restoration, and the restoration of the Cast House is planned for the near future. But problems have arisen, especially concerning the Bridge House, which must be solved before final and authentic reconstruction drawings can be made, for the recent archeological exploration of the area has failed to give conclusive answers to a number of questions. Archeological excavations in the Cast House area will be undertaken, it is hoped, during the next few years, but here again historical research must supplement archeological findings before restoration can be contemplated. The present study, therefore, is seen to be vitally necessary to accomplish these ends, and greatest emphasis will be placed on the Bridge House, the most pressing problem.

It has long been hoped that detailed drawings or blueprints of the Furnace Group, made during its active period, would be found, but that hope has unfortunately not been realized, nor does it now seem likely that such drawings ever existed. These structures were built,

not by architects or engineers, but by practical ironmasters who merely followed the pattern laid down by other ironmasters, found to be efficient through trial and error. Both labor and building materials were generally cheap, and with the exception of the furnace stack itself these structures were not built to be permanent; repairs or complete reconstruction could be made easily and economically at any time. This fact is attested by the many entries to be found in the Hopewell business records listing work done by carpenters and masons. On the other hand, extensive research in these records by Hopewell historians, principally Mr. Kurjack, has failed to discover either drawings or detailed descriptions of these buildings.

Without such detailed information, the physical history of the Furnace Group must be gathered from a multitude of other sources, not all equally complete or equally trustworthy. Part of our knowledge of the appearance of these structures through the years is based on fragmentary data on construction activity taken from the Hopewell Furnace account books and records. This has been supplemented by information gained during the past fifteen or twenty years from interviews with Hopewell "old timers"; most of this information, of course, relates only to the last period of Hopewell history, and much of it is either contradictory or vague. A third source of information, in many ways the most valuable despite a certain lack of precision, is photographic evidence. A number of informative views of the Furnace Group, the earliest dating from 1896, have been found, but many construction details must be inferred or estimated because of photographic distortion or lack of clarity; unfortunately, most pictures

were taken from only one vantage point, east of the furnace, and distortion has made an accurate scaling of the photographs extremely difficult if not impossible. These three sources of information have also been collated with archeological data and the present physical evidence on the site.

No effort has been spared to widen our field of knowledge. All known logical repositories of documentary information which might have a bearing on our problem have been checked. Contacts have been made with many persons who might have information or reminiscences of value. Photographic collections, such as the Keller Collection in the American Iron and Steel Institute, have been investigated. Moreover, a study has been made of a number of early 19th century ironworks comparable to Hopewell Furnace which might shed light on construction details not available from other sources. It is disappointing that the results of this endeavor have been largely negative, so that we are forced to rely for the most part on sources exhausted by previous research. As a result, our conclusions do not differ radically from the tentative findings of former Hopewell technicians, but it is hoped that the systematic arrangement of facts and suppositions in the following synthesis will give those conclusions coherence and consistency.

HOPEWELL FURNACE

Discussion of the physical history of the furnace stack is somewhat academic, since it was restored and stabilized about fifteen years ago and needs no further rehabilitation work. Nevertheless, the known facts in its history are hereby presented for the record.

Although there has been some dispute regarding the original construction date of the furnace, most evidence seems to support the contention that it was built in 1770 and first put into operation the following year. Some older historians have given it an earlier date, but the crudely cut date stone near the base of the furnace combined with testimony given in the case of Penn's Lessees v. Kahler (1810), that Hopewell Furnace was built about 40 years before, are virtually conclusive proof of the later date.[1] Moreover, it has been established that Mark Bird, the first ironmaster, purchased the land on which the Hopewell Mine was located in 1769, and it can be logically assumed that the blast furnace was built shortly thereafter.[2]

Early furnace records are extremely fragmentary, so no evidence has been found of any building activity at the furnace while Bird was ironmaster. After his bankruptcy and loss of the property in 1786, it passed through several hands, none of whom was financially successful, so one would assume that little money was available for rebuilding during this period. When the Brooke and Buckley interests took over the furnace property in 1800, there is some evidence of renovation and rebuilding, although it was more likely repair than reconstruction.[3] Between 1828 and 1833 the furnace records show a

great deal of building activity at the furnace stack, indicating that it was completely overhauled, if not rebuilt from the ground up; according to the blast data, its annual capacity was increased at this time from about 700 to 1,000 tons, evidence that the new furnace was probably a few feet higher than the old one, but differed little in other details.[4]

In 1849 an anthracite-burning, hot-blast furnace was built a few hundred yards north of the old furnace, but it was not successful and was closed down in 1854. During this period it is likely that the charcoal-burning, cold-blast furnace was not in operation. In 1877 the furnace was blown out, it was thought, for the last time, but a sharp rise in the price of iron led to the decision to resume operations. As a result, the furnace was rebuilt in part in 1879 and remained in production until 1883, when it went out of blast permanently.[5] Much of the repair and rebuilding detailed above was not extensive or radical, but consisted mainly of renovating the hearth and in-walls, a job which had to be done in part annually after each blast. For this reason, it seems likely that the only major changes in the physical history of the furnace stack took place in the period 1828 to 1833, so it can be assumed that the furnace of today is essentially the restoration of the structure in operation at that time. The only missing feature is the relatively minor one of a masonry fire wall which, according to old photographs, extended above the tunnel head on the north side of the furnace (for further discussion, see under BRIDGE HOUSE below).

CUPOLA

The existence of a cupola, or reheating furnace, at Hopewell during the early 19th century is known, but its location, size, and description remain a mystery. These small furnaces were used extensively during that period, principally in the manufacture of small finished castings, a major part of Hopewell's production. Although all castings in the earlier period were made directly from furnace pig iron, this often was too impure for satisfactory work, so it was learned that better results would be obtained if the pig iron was reheated in a cupola, ridding it of most of its impurities.[6]

A number of references in the furnace records for 1817 indicate that a cupola was built in that year, but there is no detail regarding the size and appearance of this structure.[7] Moreover, no further references to the cupola have been found for succeeding years, although it would seem logical that it would have continued in operation until the 1840's, when the manufacture of finished castings ceased. Such furnaces were usually made of sheet iron and varied in size from a few feet to eighteen or more feet in height; the smaller ones were equipped with only a hand-operated bellows, but the larger ones required water-powered blast machinery. From the number of men employed as molders at the cupola in 1817, and the tonnage of castings produced, it may be inferred that Hopewell's cupola was a fairly large structure with blast furnished by a water wheel. This would imply that the structure was located near the blast furnace and water wheel

(since no evidence of a second water wheel has been found), possibly west of the furnace,[8] but there is no confirmation of this guess.

Archeological investigation of the furnace area in 1942 uncovered two walls west of the Tailrace and just south of the Wheel House walls which could possibly have been the foundation of such a structure; it is interesting, moreover, that castings were found buried to the west of these walls.[9] Two informants mentioned a cupola, but disagreed as to its location and description; neither saw it in operation, so they may be confused in their memories of Hopewell legends. One placed it behind the Blacksmith Shop, while the other placed it across the road from the Blacksmith Shop, between French Creek and the Barn.[10] Until and unless further evidence is uncovered, there seems little or no justification for planning the reconstruction of this feature.

STAMPING MILL

Another missing feature of the Furnace Group about which little is known is a stamping mill. This was a contrivance used to crush the furnace slag to recover iron lost through inefficient smelting; the "stamped" or crushed slag was then re-charged into the furnace. According to furnace records, a stamping mill was in operation at Hopewell from 1805 to 1822, but no description of it has been found.[11] It probably was some sort of hammer arrangement operated by water power, possibly by the same wheel which provided the furnace blast. Many other furnaces of the late 18th and early 19th centuries installed stamping mills of this type.[12]

The stamping mill was in use for a comparatively short period, and was necessary primarily, it appears, because the early blast equipment was inefficient. As improvements were made in the blast machinery in the early 1820's, the need for it disappeared, since the amount of recoverable iron lost in the smelting process was infinitesimal.[13] Representing only a passing phase in the industrial history of Hopewell Furnace, the stamping mill should not be considered for eventual restoration.

WATER WHEEL AND BLAST MACHINERY

Traditionally, the earliest water-powered blast equipment was a 30-foot overshot wheel running north and south, or at a right angle to the furnace stack, which operated a large double bellows of wood and leather by a cam or counterbalance arrangement.[14] Machinery of this type was generally typical of 17th and 18th century American ironworks.[15] This tradition was substantiated in part during the summer of 1951 when archeological investigation uncovered a wheel pit and forebay pier in approximately the traditional location.[16] This wheel was turned by water carried in two headraces, the old West Race and the East Race, each over one mile in length.[17] The course of the former has long been eradicated, but the latter is still in evidence and has been partially restored.

Sometime between 1790 and 1810 (tradition leans towards the earlier date), a new water wheel was constructed; this was a 22-foot breast wheel running east and west, located just south of the old wheel. Apparently, this change was primarily the result of a dispute with a neighbor regarding water rights, which denied the ironmaster access to the headwaters of the old West Race. The forced abandonment of that raceway led to the damming of French Creek about one-quarter mile west of the furnace, and the new West Race was constructed from that point to the new wheel. It was designed as a breast rather than an overshot wheel because the change in raceways had reduced the head of water to sixteen feet. The East Race was continued in operation as

a supplementary supply, the water being piped under the Furnace Bank to a wooden trough which carried it to the wheel.[18] A tailrace, carrying the water from the wheel, behind the furnace to French Creek, also had to be built. It was first mentioned in the records in 1802, although no description was given, and it was extensively repaired or rebuilt in 1830.[19]

There was apparently a change made in the blast machinery around the turn of the century, for the old furnace records indicate that "tubs" were used at Hopewell at least as early as 1798, which may be the date the new east-west wheel was built.[20] These "tubs" probably consisted of two cylindrical casks, one fitting inside the other, moving up and down between four wooden posts; the air, blown into a leather bag, was then fed to the furnace through an iron pipe. Such blowing cylinders or "tubs" supplanted the more primitive bellows in many Pennsylvania ironworks shortly before the end of the 18th century.[21]

During the remaining years of furnace operation, until 1883, it appears that no further important structural changes were made in the basic wheel pattern, although the mechanism had to be continually repaired and was several times partially or completely rebuilt (roughly every fifteen years). Improvements were made, however, in the blast equipment in an effort to increase its efficiency, the major changes being adopted at Hopewell between 1817 and 1822. The furnace records of those years contain numerous entries regarding work on the "blowing tubs", and pistons are mentioned for the first time with the purchase

of "patent elastic piston springs."[22] All this is evidence that a system of double cylinders, developed in the early 19th century and adopted generally by the American iron industry, was installed at Hopewell at that time. These were two wooden tubs with wooden pistons connected to the shaft of the water wheel below them; the air produced in these cylinders by the action of the pistons was piped into a wooden air chamber or receiver which provided a comparatively uniform air pressure for the blast, carried by tuyere or blast pipe into the furnace.[23]

The Hopewell ironmasters continued to make minor improvements in the mechanism throughout the remaining sixty years of the furnace's operating history. The wheel bearings were babbitted (1869), metal piston rods were substituted for wooden ones (1869), and a tin blast pipe replaced the cast iron one (1850), to mention only those changes which can be documented.[24] Moreover, constant repairs of the blast machinery had to be made. Nevertheless, the water wheel and blowing tubs restored and put into operation by the National Park Service, patterned upon the last operating equipment which had been dismantled and stored on the area, appears to be a faithful reproduction of the primitive machinery of the early 19th century. Only one important exception may be noted: the present receiver is a larger one which was installed in 1881 to maintain a more constant pressure, but differs little except in size from the previous receiver. A more basic change made at about the same time (1880) was not included in the restoration.

This was a steam boiler and engine used to propel the wheel in times of water scarcity or freezing conditions; hot gasses piped from the top of the furnace to the boiler provided the motive power.[25] The elimination of this feature was justified by its recency in relation to what is essentially an early 19th century ironworks.

One part of the blast mechanism has been unknown until recently, when it was mentioned in an interview with a Hopewell informant. This was a blast regulator, a wooden box mounted on the ground in front of the tuyere arch of the furnace, through which ran the blast pipe from the receiver. A handle, like that of a tire pump, was set vertically into the box from the top, and movement of this handle regulated the blast of air into the furnace. The box must also have contained an escape valve so that air could be released when the pipe was closed; otherwise, the backed up air pressure would damage the blast equipment.[26] Since this information has come to light, a diligent search of old photographs in our files has revealed something which generally fits this description, although the details are not clear.[27] It seems strange that no other informant has mentioned it, since such a device would be vitally necessary to control the blast; without it, the air could be regulated only by stopping or changing the speed of the wheel, a much less efficient and less exact method. This blast regulator was undoubtedly disposed of or disappeared some time ago, long before the old wheel was dismantled in 1950, and this explains why it was not

WHEEL HOUSE

and protecting the water wheel and blast machi

se, built of wood and stone. Such a structure

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of the furnace, the only change on record beir

the Wheel House roof in 1879 to connect with th

, a distance of only a few feet.[29]

use consisted of masonry walls on three sides o

e east side was completely open); wooden posts

were mounted on these walls. The roof was a sa

sloping down from the Bridge House to the west,

e or slate (possibly both at different times).

e roof was supported on posts approximately thre

high, mounted on the west Wheel House wall (now

Wooden steps led from the wheelpit, along the

E), to the blowing tub platform. These consiste

a handrail, the first flight apparently running

ding at the top of Wall E and the second flight

point to the platform; there was a door leading

he landing, located at the northeast corner of the

Apparently this structure was sided between the

supporting posts, at least on the north and south sides.[30]

The three Wheel House walls have rather a complex history. The north wall, or Wall E, was apparently once the same height as the other walls, but was raised a few feet in 1879, probably to help in retaining the increasing charcoal fill on the Furnace Bank.[31] Archeological investigation has shown that Wall N, the west wall, was also built in two periods, having been raised about three feet above its original elevation. The same is true of Wall Mg the south wall, although it was apparently raised only eighteen inches from its original elevation. Moreover, a doorway has been made in Wall M, about four feet west of the tailrace; later, the original opening was partially filled in and the sill raised about two feet, probably due to increased slag fill south of that wall.[32]

After considerable discussion it was decided to restore these walls essentially to their height during the last period, rather than building them all to the same height at a lower elevation. This was justified primarily by the presence of large amounts of operational debris (charcoal siftings and slag) in the area, the most likely cause of the raising of the walls in the first place, and the belief that such a restoration, supported by considerable evidence, would be more authentic.[33] The Wheel House walls have been completely reconstructed according to this decision, including the construction of a stone pier on Wall N to support the flume, but the Wheel House proper has not as yet been rebuilt.

OFF ROASTER

The physical history of this structure was brief, for it was not erected until 1882, a year before the furnace went out of blast for the last time.[34] Its only purpose was to remove harmful sulphur from the ore before it was charged into the furnace, a necessary expedient at that time in order to make use of a newly found ore deposit.[35] Because it was of such late construction, it probably should not be included in the restoration program, but the following description is included here for the record.

The roaster was built against the south side of the wall which extended from the Furnace Bank to the Office and Store (Wall H), and was located approximately where the modern road was cut through that wall. The ore was charged into the roaster from the top and, after being heated to a cherry red by anthracite coal, was removed from an opening in the funnel-shaped base. Mounted on a masonry pedestal, it was made of sheet iron plates riveted together and painted red; it was cylindrical at the top and conical at the bottom, and has been described as being 12 to 16 feet high and 10 to 12 feet in diameter.[36] According to the furnace records, 31 plates of rolled iron weighing over 7,000 pounds went into its construction; 20 days mason work was also involved, so much of Wall H may have been built at the same time.[37] Further evidence on the roaster can be found in one of the Bull Collection photographs, discovered by Historian Kurjack.[38] Nothing remains of the roaster now, for it was sold for scrap during the first World War.[39]

CHARCOAL HOUSE

The Charcoal House, a large stone structure with a frame extension and a capacity of 90,000 bushels, is the only historical element of the Furnace Group, other than the furnace stack itself, still standing, but its actual age is questionable. Some such structure would have been extremely necessary throughout the operating history of the furnace, in order to protect the fragile charcoal from the elements, and a "Colehous" is mentioned in the furnace records as early as 1801, but with no location or description given.[40]

According to Harker Long, Hopewell's last furnace manager, the Charcoal House was rebuilt in 1880 and made two feet higher, but there is some question whether this was the rebuilding of an older structure or the building of a new one.[41] A distinct line in the masonry is visible all around the outside of the building, giving the appearance that an addition had been made to the height of the walls, but closer study reveals that this line varies from about two to four feet from the top, and it cannot be seen on the unpointed interior. For these reasons, Archeologist Hotz concluded in 1941 that the line was probably caused by a different mix of mortar used in pointing the upper portion of the exterior walls, and added that "the writer is inclined to believe that the coal house was originally built to its present height."[42] On the basis of numerous entries in the Hopewell Furnace Day Book for 1880, it appears that the work done at that time was a major construction job, the mason work amounting to 364 perches

and the carpentry work costing seventy-five dollars. Moreover, the structure was continually referred to as the "New Coal House," thus tending to support Motz's contention.[43]

It does seem odd, nevertheless, that Harker Long, employed at Hopewell from 1867 to 1885 and with a well-deserved reputation as a credible informant, failed to mention an earlier Charcoal House, nor has any other Hopewell informant. One answer to this riddle may be that the pre-1880 Charcoal House was a wooden structure, standing at the same location as the present structure, and either too small or too dilapidated to keep in use; there would appear to be little or no justification for demolishing a stone structure and then rebuilding it. Evidence that a previous structure had been razed previous to the rebuilding of the present Coal House is found in the contract drawn up with the carpenter who was to work on the "new Coal House"; he was instructed to use "all the old plate" and "what ties that are good" in his work.[44]

Another possible explanation lies in the existence of an "upper charcoal house," reported by Appleman on the basis of his conversations with Harker Long, and confirmed by other informants. This building was located four feet north of the present structure, and was described as a frame shed of the same length (102 feet) and about twenty feet wide. It was not enclosed, but had a roof supported by wooden poles about twenty feet high and spaced about twenty feet apart. The charcoal wagons drove into this shed to unload, after which the

charcoal was wheeled in barrows up planks to the three doors (actually, large dormer windows) in the north side of the present Charcoal House. When this structure was full, the upper house was also used for storage by boarding up the sides between the poles.[45] Although one informant maintained that the frame building was erected in 1880 at the same time that the stone structure was built (or rebuilt),[46] evidence found in the furnace records implies that the former was in existence before the rebuilding operations took place. Part of the construction activity of that year entailed roofing over the easternmost 42 feet of the four-foot gap between "the new and the old" buildings; this was done in order to prevent water from running off the roofs and collecting in the space between the two structures.[47]

This "upper" Charcoal House, then, may have been the only such structure in existence prior to 1880, and the Bridge House may have extended northward to the frame building. This conjecture can be supported or demolished only by archeological investigation of the area inside the present Charcoal House, for such investigation might reveal either the post bases of the Bridge House extension or the foundation of an earlier Charcoal House on the site of the present building. Even if such evidence was found, however, it would be mainly of academic interest, for there would seem to be little justification for demolishing the present building and attempting to reconstruct an earlier, and largely conjectural, building which served the same purpose. On the other hand, the reconstruction of the frame "upper"

Charcoal House, and its connection to the stone building, should be seriously considered in order to present an authentic picture.

One minor modification should be made, however, in the existing Charcoal House. At present, the south end of the frame extension of this building is completely closed off with boards and large double doors, but an early photograph reveals that this end was originally open from the ground level up to the knee braces and cross tie, a height of about 17 feet at the center.[48] This situation should be remedied when the Bridge House is restored, since it is logical that the entrance to the Charcoal House was open at all times when the furnace was in operation.

CAST HOUSE

This building, although oftentimes in the past discussed separately as the Cast House and the Moulding House or Moulding Rooms,[49] will be discussed as one structure in this report, since it was all under one roof as an integral unit in the operation of the furnace.[50] The Cast House has been completely gone since before the area was acquired by the Federal Government, although Appleman wrote in 1936 that the outlines of its foundation were still visible at that time.[51]

The date of erection of this building cannot be found in the furnace records, although some type of shelter must have existed from the time the furnace began operations. The earliest it can be dated accurately is 1773, and the evidence appears to indicate that this structure was substantially the same as that in use more than a century later.[52] Numerous references were made in the 1780's to both pig iron and finished castings produced at Hopewell Furnace, so it can be assumed that the Cast House contained both pig beds and one or more Moulding Rooms.[53] After the Brooke and Buckley interests took over the property in 1800, minor repairs were made to the "Pothouse" (another name commonly given to the Moulding Room), which had probably become dilapidated through disuse during the preceding decade.[54] A quarter-century later, at the same time that other elements of the Furnace Group were refurbished or rebuilt, there is a record of three and one-half man-days of unspecified mason work at the "molding room." The next, and the last, entry relating to this structure was in 1880,

when the Charcoal House was being rebuilt, listing work done by masons and carpenters, apparently extensive repairs.[55]

Since no description or dimensions can be found in the manuscript records, other sources must be used for this information. Some evidence on construction details has been obtained from interviews with Hopewell informants, but the information is incomplete in many respects and often contradictory. One reason for this, aside from expected flaws in memory, is that the making of finished castings in the Moulding Rooms was discontinued in the 1840's, after which Hopewell Furnace produced nothing but pig iron, so it is possible that part of the Cast House was demolished as unnecessary at that time. Since our informants' memories seldom go back earlier than the 1860's (Harker Long, our best authority, came to Hopewell in 1867), much of their description is often confused with accounts remembered from remarks made by their elders about things in the early years.

Harker Long, in his conversations with Appleman, described the Cast House as a frame building erected against the east side of the furnace stack. The center section, or casting shed containing the pig beds, was approximately 24 feet wide, extending from a point about four feet south of the northeast corner of the furnace to the southeast corner; in floor plan it was roughly a square, extending eastward to a point about four feet east of the modern road embankment. The peak of the roof was centered on the furnace at the second lift from the top, a height of about 26 feet from the ground. A two-foot high ridge

ventilator was built above this, and a belfry, about four feet high, was erected at the eastern end and slightly to the north of the ridge. Two Moulding Rooms, one on each side of the casting shed, were also described. The south room, no longer standing when Long first came to Hopewell, extended south of the furnace about twenty feet and west to the tailrace which runs behind the furnace; there was a low stone wall on the south edge of this building. The north room was not demolished, but continued in use as a bunkhouse and tool storage room. It extended from the central casting shed to Wall G, and presumably as far eastward as the casting shed; it had a salt-box roof, running from the wall upward to the eaves of the casting shed. Long believed the roof of the south room was roughly similar.[56]

Evidence from other informants supplements or corrects the preceding picture. Architect Paul Koch, on the basis of his discussions with Harker Long, stated that the Cast House extended "some thirty-five feet" eastward from the furnace, its roof ridge reaching the center of the top lift of the stack. No mention was made of the south Moulding Room, for Koch described the building as extending from Wall G southward only to the southeastern corner of the furnace. He added that the roof over the north Moulding Room was so low at the northern end that a man could jump easily onto it from the bank north of Wall G.[57] Charles S. Care, born in the Village in 1866, declared that the Cast House measured about fifty feet (east to west) by seventy-five feet (north to south), large enough to have included a south Moulding Room, but gave

no more detailed description. He further maintained that the terrace between Walls G and H was the site of a cleaning shed where castings were prepared for shipment; only one other informant referred to this space, stating that on the testimony of his elders the section was once roofed over and probably was used as a pattern shop or cleaning shed.[58] Another informant, David Boone, drew a sketch of the Cast House, but was not sure of its dimensions. It extended, however, from Wall G southward to the southeastern corner of the furnace, and appeared to be longer on its east-west axis than on the north-south axis. He added that there were four small square windows on the north side, above the top of Wall G, for he recalled standing north of the wall and looking into the building at the bunks inside; there were also windows on the south and east sides, and an entrance door on the east side. No mention was made of a ridge ventilator, but the belfry was described as being located at the east end of the building on the peak of the roof; a rope attached to the bell descended through a hole in the roof to the inside. He remembered the roof as of slate; another informant agreed on this point, but Nathan Care maintained it was shingled.[59]

Some evidence on the physical appearance of the Cast House in its last period of operation can be gleaned from the Bull photographs, for the shell of this structure was still standing in 1896 when they were taken.[60] Although many details are missing, the north Moulding Room is generally as described, with a salt-box roof extending apparently to Wall G. This roof extended upward over the central part

of the Cast House, its peak apparently extending slightly above the second lift from the top of the furnace. According to these pictures, the Cast House also extended considerably south of the southeastern corner of the furnace stack, and westward towards the tailrace against the south side of the furnace. Because of the angle from which the photographs were taken, it cannot be determined how far eastward the building extended. It is difficult to tell whether there was a doorway in the east side, but one window is visible there and the method of framing the structure is apparent. On the basis of this and other evidence, it seems that the south roof was more steeply pitched than the north roof which extended farther from the ridge to cover the north Moulding Room. From a study of other iron furnaces, contemporary with Hopewell, it has been found that this may have been characteristic, pictures of two other Cast Houses displaying the same phenomenon; moreover, other construction details, such as the ridge ventilator, were probably similar.[61]

Much of the disagreement on the size and dimensions of the Cast House can only be resolved by archeological investigation of the area, which should discover at least part of the foundation of the building, but this project is awaiting the acquisition from the Township of the modern road which passes over the eastern section of the Cast House site. As a result, no attempt has been made to include this structure in the rough drawings of the Furnace Group which accompany this report. It is also hoped that such an investigation will uncover remnants of

the casting beds and other features of the building interior. According to available evidence, the iron was run off into pig beds on the south side of the Cast House, while the slag was run off to the north; this was done primarily because the natural slope of the Cast House floor to the south made it more practical. The slag, after cooling, was hauled by horse-drawn cart to slag piles south and west of the furnace, so it would seem logical to assume that an entrance door, large enough to admit such a vehicle, was in the east side of the building; further evidence of this is that the pig iron awaiting shipment was piled east of the Cast House, between it and the scales.[62]

Another feature on which more light may be shed by further archeological excavation is the cooling trough. An informant, Thomas Hoffman, described a wooden trough, about six feet long by two feet wide and three feet deep, which was located near the west end of the Cast House and was used for cooling tools. In 1951 archeological investigation immediately north of the furnace discovered a stone culvert, or water duct, running about eighteen feet westward from Wall K towards the wheelpit, with a slight downgrade from east to west. It was built up of a series of long narrow stones set on edge, with long broad stones placed on top; no mortar was used, and the stones rested on sterile clay. The theory was advanced that this may have had some relationship to the trough mentioned by the informant. A further element in this picture which needs clarification is a small drain running into the tailrace tunnel south of the furnace and about

sixty feet from the west entrance of the tunnel.[63] Further investigation of this area may reveal whether this drain ran from the Cast House, and should furnish other valuable data necessary to an authentic restoration of the entire structure.

BRIDGE HOUSE

The Bridge House is the one element of the Furnace Group on which accurate and concrete data on construction details is most elusive. It is, at the same time, possibly the most important missing feature, for until it is restored visitor understanding of furnace operation will continue to labor under an almost insuperable handicap. Since the Bridge House was the only means of getting the raw materials into the furnace to begin the smelting process, its presence is almost as necessary as the furnace itself. Work has already begun on the supporting masonry, but this cannot be completed until data on the superstructure has been collated and reconstruction plans have been drafted. The following is a summary of all known information on this feature, and along with the drawings which accompany this report it embodies the conclusions reached on the basis of available data. Unfortunately, a considerable amount of supposition and guesswork has had to be used to reach these conclusions, but we believe that the recommended plan of restoration is not only the most practicable but the most authentic that can be found.

Since the establishment of the site, a continual search has been made by Hopewell technicians for a sketch or blueprint of the Furnace Group which would give accurate and complete physical details of the Bridge House, but none has been found, nor does it seem likely that such a drawing ever existed. Failing that, we have had recourse to the furnace records, interviews, and photographs. The first of these

sources has yielded very little information. The original date of construction could not be found, for example, but it can safely be assumed that such a building was in existence since the beginning of furnace operations in 1770-1771. Several references to the Bridge House have been found in the records for the early years of the 19th century,[64] but no construction details are given. In 1816-1817 a great amount of unspecified masonry and carpentry work was done, which may have included rebuilding the Bridge House. A mason built 262 perches of wall, several thousand feet of pine boards were purchased, and carpentry work amounting to more than two hundred dollars was done; at the same time, the Wheel House, just west of the Bridge House, was built.[65] Our conclusion that this data pertains to the Bridge House is based primarily on the amount of masonry work, for (as will be indicated below) the Bridge House supporting masonry has a complex history and entailed a great deal of construction and repair. The next entries concerning this structure are found in 1847, when a carpenter spent about fifty days working at the Bridge House, probably rebuilding or enlarging it; at the same time, a pair of scales was purchased for the Bridge House at a cost of thirty-five dollars.[66] No mention has been found of any extensive mason work for this period, so possibly only the wooden superstructure was rebuilt.[67] No further entries can be found until 1882, when a minor repair was made to the Bridge House floor.[68]

When archeological findings are correlated with this data from

the furnace records, a clearer picture of the Bridge House history emerges. The original grade of the Furnace Bank sloped down rather sharply in front of the Charcoal House, so that a series of walls had to be built to support the charging bridge. The first of these was probably Wall A, built about 25 feet north of the furnace; in conjunction with it were erected a buttress, at the southeast corner of Wall A, and Wall C, extending about 15 feet north of Wall A at right angles with it. Wall C was also part of the old north-south wheelpit which was built at the same time. To support the northern end of the Bridge House, Wall I was built parallel to Wall A and about 40 feet south of the Charcoal House; Wall J, its buttress, was possibly built at this time, but more probably was added later. An earthen ramp, consisting of rock fill, was constructed immediately behind (north) Wall I in order to make the approach from the Charcoal House to the Bridge House fairly level. It seems likely that the 40-foot gap between Walls A and I was not bridged by a single span, supporting timbers probably being placed at intervals under the Bridge House.

It should be mentioned here in passing, although it has nothing to do with the Bridge House proper, that Walls G and H were probably the next to be constructed. The masonry work referred to in 1816-1817 may have been the building of these walls, or it may have been the construction of Walls D and O. These walls had become necessary, it is believed, because of the accumulation of charcoal siftings north of Wall A, a natural consequence of furnace operations; possibly the

wooden supporting timbers were rotting away in the charcoal fill and it was decided that masonry would be more permanent. These walls, extending northward from Wall A about 25 feet and about 22 feet apart, were apparently the new east and west supports of the Bridge House. It appears also that Walls I and J were covered up at this time, as the earthen ramp was extended southward to the new walls. An open-sided shed, supported by four sets of posts about 16 feet apart (the northernmost set built against the Charcoal House), was constructed over the earthen ramp and built southward to join the Bridge House proper at Walls D and O. Charcoal siftings continued to accumulate, and possibly the tremendous volume of production during the 1830's and 1840's weakened the Bridge House. At any rate, Wall B was built, possibly around 1847, about 15 feet north of and parallel to Wall A, as an additional support wall. Two windows had originally been built in Wall A, probably to furnish light or ventilation under the Bridge House during the early period, but as the charcoal screenings piled up behind the wall, they lost whatever usefulness they once had and were blocked up, either when Walls D and O were built or later during the construction of Wall B. Wall K, a stone pier between Wall A and the furnace, had been built in the early period to support the east side of the Bridge House; now, a new wall, Wall F, was built to connect Wall K to Wall A, not primarily for additional support, apparently, but in connection with the Cast House. The Bridge House of the period ca. 1840 to 1883, therefore, was probably supported by Walls A, D, O,

and K, so these are the walls which have been selected for reconstruction.[69]

Archeology, unfortunately, is of no help in determining the original height of these walls, nor in depicting the structural details of the wooden Bridge House above them. Moreover, interviews with Hopewell informants have furnished little more than a general description of this structure. The most valuable information, as usual, has come from Harker Long. The Bridge House, according to him, was composed of two sections: an open shed about 60 feet long supported by posts about 20 feet apart, and the Bridge House proper (resembling an old covered bridge) which ran from a point about 4 feet north of Wall A to the furnace. This Bridge House, he said, was about 10 to 15 feet high from the floor frame, and was built to the level of the second lift from the top of the furnace. The ore and charcoal, however, were charged into the tunnel head, an opening on the first lift from the top of the stack, so the floor must have been higher than the base of the Bridge House. The three driveways formed by the shed posts were used as a charcoal dumping space, each one of them large enough for a large charcoal wagon to enter.[70] Many other informants recall the Bridge House before it disappeared from the scene some thirty years ago, but can add few more details. There has been much discussion regarding the roof of the Bridge House, two informants insisting that it was slate, one maintaining that it was shingled, and one that it was made of boards battened by laths.[71] Several informants, including

Harker Long, have referred to scales inside the Bridge House for weighing the ore before it was charged into the furnace; they were located on the east side of the building near the tunnel head of the furnace, not as platform scales but built into the floor. A piece of slate hung near the scales on which the furnace charge was recorded. At night, light was furnished by the glow from the tunnel head, but coal-oil torches were used in addition; each of these contained a wick and about one pint of oil.[72] References have also been made to bins inside the Bridge House, several ore bins on the east side and one limestone bin on the west side near the furnace stack. These bins were simply constructed by boarding up the knee braces which were placed against the inside walls.[73]

During all this discussion, however, little has been said about one of the most crucial points in the Bridge House construction. It is obvious from the elevations of the ground line at the Charcoal House and the tunnel head of the furnace that the Bridge House ramp had to have an upward slope, for the tunnel head is approximately four and one-half feet higher than the starting point of the Bridge House in front of the Charcoal House.[74] But no unimpeachable or completely trustworthy information has been found concerning the point at which the slope began, the length of the sloping portion, or the percent of grade of the slope. One informant recalls that the floor of the Bridge House proper was inclined to the tunnel head, the slope beginning from "the natural bank"; this point could not be located

more exactly, nor was the approximate percent of grade remembered. Another informant estimated the rise of the Bridge House floor as 24 to 30 inches between Wall A and the tunnel head; this distance is about 28 feet, so this would represent a seven to nine percent grade. One difficulty in obtaining accurate data regarding the starting point of the inclined ramp is that the charcoal fill had accumulated to such an extent by the time the furnace closed down in 1883 that it extended all the way to Wall A. As a result, an earthen ramp, composed mainly of charcoal dust, had gradually been built up to this point, the fill almost covering Walls D and O. [75] Most of our recent informants were born too late to remember the furnace in operation, so they have difficulty in visualizing the Bridge House area when the fill had not advanced to such a point. Since we intend to restore the Bridge House to the mid-nineteenth century or before, when Walls D and O were still in use as supporting members of the Bridge House structure, a hazy description of the appearance of the ramp in the late nineteenth century is of little practical value to us.

Some information regarding the framing of the Bridge House has been given by informants, although most of it was offered tentatively. The structure was said to be as wide as the furnace at the second lift (about 23 feet). On the east side, large timbers ran from the furnace at this point to Wall K and then to Wall A, but since there was no supporting wall on the west side, a truss was constructed to bridge the gap between the furnace and Wall A. Joists were placed across

these timbers to support the flooring which ran lengthwise, or north and south, to make for better traction for the ore carts. Nothing was said about the type of construction necessary to support the sloping floor above the main framing timbers. The pitch of the Bridge House roof was estimated to be 8 to 9 inches per foot. It was further maintained that the siding of the Bridge House (and the Wheel House as well) was made of 1" x 12" white pine boards, with $\frac{1}{2}$" x 3" batten nailed over the joints.[76]

Much of the above information is inconclusive, but many details can be clarified by a close study of the old photographs in our collection. The most important of these are the Ball photographs, taken in 1896, several of which show the Bridge House still in a good state of repair; they are limited, however, in all being taken from the same angle, east of the furnace, and in the summer when many details were obscured by foliage. Part of the open-sided shed, which led from the Charcoal House to the Bridge House proper, is visible, showing that it had a plank roof and was attached to the Bridge House a foot or more below the eave line of the latter; it also appears that the roof had a shallower pitch than the roof of either the Bridge House or Charcoal House. A large tree, unfortunately, hides the supporting posts. The Bridge House itself had three small windows on the east side just below the eaves. The siding was of planks, but the batten either had fallen off or was never there. The base timber running from Wall K to the furnace was attached to the latter at a

point about halfway between the second and third lifts. A vestibule-like structure, based on the third lift, was built to bridge the gap of about 6 feet between this point and the tunnel head; the peak of its roof was at or slightly above the eave line of the Bridge House and only a foot or so above the top of the furnace. A triangular masonry wall, roughly the same size and shape as the gable end of the Bridge House, was built above the top of the furnace stack on the north side, apparently as a protection against fire; another later view shows an arched opening in this wall to permit charging of the furnace.[77]

Other pictures, taken in the 1920's and 1930's when the Bridge House had become more dilapidated, show more construction details. According to these views, the northern end of the Bridge House proper rested on Wall A, contrary to Harker Long's assertion that it extended 4 feet farther north. The open shed has disappeared, but the charcoal bank can be seen extending up to Wall A, the top of the fill rising a foot or so above the top of the wall. The sloping floor inside the Bridge House can also be seen in part, raised above the base timbers of the structure, its north end at about the same level as the charcoal fill. At the south end what appears to be a floor beam can be seen at or slightly below the level of the tunnel head; the vestibule is gone, but a short ramp is shown bridging the gap where it once stood. The point at which the basebeam of the Bridge House is attached to the furnace is fairly clear; it seems to be about two courses above the

offset row of stones, or row-lock, on the second lift.[78] A few pictures taken from west of the furnace add somewhat to our knowledge. No truss is visible, but one or two long poles can be seen supporting the west side of the Bridge House; these, however, may have been a late addition. The floor at the south end appears to be considerably higher than the base of the structure, and at a point slightly below the height of the tunnel head. The roof would appear to be either slate or shingle, and the way in which the Wheel House roof is framed into it is apparent. No further information on the northern end of the structure can be learned from these pictures, due to the angle from which they were taken.[79]

In further search of data on the Bridge House, a study was made of a number of other furnaces roughly contemporary with Hopewell in the hope that many construction details would be similar. No Bridge Houses of the proper period could be found in existence, however, so old photographs were used as source material instead. The results were inconclusive, particularly regarding the slope of the ramp, for it was learned from a study of thousands of photographs, only a few of which pertained to our problem, that construction details did not follow a set pattern but were largely determined by local conditions, especially the terrain. In some cases no slope was necessary to reach the furnace tunnel head, while in others a long and sometimes rather steep incline had to be built. Moreover, some Bridge Houses were supported by masonry walls, as at Hopewell, but others were built on wooden pilings.

One interior view was found, however, which should be of help in drafting the framing plan; although the floor in the picture is level, the knee braces and roof ties appear to be similar to the construction used at Hopewell.[80]

All the preceding data was taken into consideration in making the drawings which accompany this report. Despite photographic distortion, an attempt was made to scale some of the pictures in order to arrive at the roof pitch and the height of the eave lines of the Bridge House and open shed. Measurements and elevations were taken of the existing structures and oriented with the photographs in order to establish the relationship among the various elements of the Furnace Group. The slope of the Bridge House floor was sketched in from available information, plus the practical consideration that it could not be too steep for the wheeling of heavy ore barrows by hand; the result was a grade of approximately eight percent. It was concluded that the sloping ramp must have started at the northern extremity of Walls D and O, or possibly a few feet farther north. This conclusion was based on the fact that the ramp had to be supported at that end, and the most likely means was by timbers resting on these walls; moreover, the southernmost set of posts which supported the open shed were only about 3 feet north of these walls. On the basis of photographic data, it was relatively easy to establish the elevation of the south end of the Bridge House. The top of the supporting beam was found by measurement to have been at elevation 495.49, so Wall A was probably

built at least to this height. But the ground line at the Charcoal House, presumably about the same as the elevation at the beginning of the inclined ramp, is 497.68. It appears, therefore, that Walls D, C, and A were either built approximately to elevation 497 or had about 2 feet of wooden framework to support the Bridge House built on top of them. Wall A could even have been built higher than this, since the computed height of the ramp immediately above Wall A would be at about elevation 500. The exact height to which these walls should be reconstructed is, of course, primarily an engineering problem, but the solution will have to be limited by the above considerations.[81]

Although it appears logical in the light of available data, our conception of the interior framing is partly conjectural, and may need further technical study from the architectural and engineering viewpoint.[82] Nevertheless, we feel certain that the sketches embodying our conclusions represent a reconstruction which is reasonably authentic, in the light of available data, and practicable, in view of the problems to be solved. It is our hope that this report and these drawings will comprise a satisfactory basis for the early restoration of this important missing feature of the Hopewell Furnace Group.

CONCLUSION

On the basis of the foregoing historical survey, a tentative but generally well-established chronology can be drawn up, listing the most important events in the physical history of the Furnace Group. Much known construction activity, of course, is not included, since it cannot be dated even approximately.

1770-1771	Furnace constructed, probably with Bridge House, Cast House, and Charcoal House. North-south water wheel powering large double bellows; water from Old West Race and East Race.
ca. 1800	East-west water wheel powering primitive blowing tubs; water from New West Race and East Race.
1800-1805	Furnace repaired or rebuilt. Cast House repaired.
1805	Stamping Mill built.
1810-1822	Masonry and carpentry work (Bridge House rebuilt?). Cupola built. Blast machinery improved or remodeled. Wheel House built or rebuilt.
1822	Stamping Mill discontinued.
1825	Cast House repaired.
1828-1833	Furnace rebuilt and enlarged. Tailrace repaired or rebuilt.
1836-1837	Longest blast and highest tonnage of mixed castings in furnace history.
ca. 1845	Manufacture of finished castings discontinued. South Moulding Room demolished (?).
1847	Bridge House repaired or rebuilt. Bridge House scales installed.
1849-1854	Anthracite Furnace in operation. Charcoal Furnace possibly out of blast.

1877 Furnace blown out, it was thought for the last time.

1879-1882 Furnace rebuilt and put back in blast.
Wheel House roof extended to Bridge House.
Wall E raised a few feet.
Steam boiler and engine installed to turn wheel.
Larger receiver added to blast machinery.
Cast House repaired.
Charcoal House rebuilt, or new one constructed.
Bridge House floor repaired.
Ore Roaster installed.

1883 Furnace went out of blast permanently.

Four periods of major construction activity are apparent in this chronology: 1) the original construction of the furnace and its outbuildings in 1770-1771, 2) repair and modification around 1800 when the Brooke and Buckley interests acquired the property, 3) the period from about 1816 to 1833 when essentially the entire plant was rebuilt for greater efficiency and productivity, and 4) the period from 1879 to 1882 when the furnace was put back in blast for the last time in a largely futile effort to compete successfully with more modern ironworks. Our knowledge of the earliest period is, naturally, the most sketchy since so many changes followed it and the records are fragmentary, while the largest amount of data is available, through photographs and records as well as reminiscences, on the last period of Hopewell history. It would seem to be most desirable to base our restoration plans on the third period, the most prosperous and in many ways the most interesting and significant, but here again many details have been irrevocably buried under the layers of later modifications. On the other hand, it appears that the ironworks of 1883 differed little from the one in operation

fifty years before. If the Cast House could be restored to the period when finished castings were made in both Moulding Rooms, and if the Ore Roaster and steam boiler and engine were left out of the picture, the physical appearance of the Furnace Group would be virtually the same. Other than minor structural details, the principal difference would be in a greater accumulation of operational debris, such as slag and charcoal screenings.

This being the case, we feel on historically safe ground in adhering to a restoration policy based on our knowledge of the physical appearance of the Furnace Group in 1883, but with the incorporation of earlier known details when they do not conflict with the total picture. Following this procedure, we believe, will result in the restoration and reconstruction of an essentially early 19th century ironworks. At the same time, the Colonial period need not be forgotten or ignored, for although the appearance of the Furnace Group differed in several ways from the later plant it was more a difference in degree than in kind: essentially the same procedure was followed in smelting iron in Colonial days, but the equipment was more primitive. The Hopewell Furnace Group when completely restored will, therefore, represent and typify not merely one brief period in the chronicle of American iron-making, but a complete span of industrial history from its crude beginnings in Colonial America to its fruition in the great iron and steel industry of today.

NOTES

1. Roy E. Appleman, "Historical Report, French Creek Area," August 19, 1935, p. 6, fn 1; for Penn's Lessees v. Kahler, see Pleadings filed in the Office of the Prothonotary, Berks County Court House, Reading, Pa. See also Arthur C. Bining, Pennsylvania Iron Manufacture in the Eighteenth Century (Harrisburg, 1938), pp. 51, 189.

2. Charles B. Montgomery, "Report on Hopewell Furnace," December 7, 1941, p. 4; citing Patent Book AA, No. 11, p. 410, Land Office, Harrisburg, Pa.

3. Hopewell Furnace Day Book, 1800-1802, pp. 74, 191, Historical Society of Pennsylvania mss.; Hopewell Furnace Journal B, 1802-1804, pp. 21, 80, 102, Historical Society of Berks County mss.; Hopewell Furnace Day Book, 1804-1806, entry for June 15, 1805, Historical Society of Pennsylvania mss.

4. Hopewell Furnace Account Book, 1828-1830, pp. 36, 37a, 40a, 62b, 92b; Hopewell Furnace Day Book and Journal, 1830-1831, p. 59; Hopewell Furnace Account Book, 1831-1837, pp. 169a, 169b; all in Hopewell Village mss. collection.

5. Appleman, op. cit., p. 12; Harker A. Long, A Short History of the Hopewell Furnace Estate (Reading, 1930), pp. 12-13.

6. Bining, op. cit., pp. 86-87, 99.

7. Hopewell Furnace Day Book A, 1816-1817, entries for February 3, April 25, 28, May 14, 20, 31, 1817; Hopewell Furnace Journal A, 1816-1818, p. 87a, Hopewell Village mss.

8. See discussion by Dennis C. Kurjack in Historian's Monthly Narrative Report for June 1949, dated July 2, 1949, pp. 2-3.

9. Paul Gebhard, "Report of Wheelpit Excavation from December 3, 1941, to March 27, 1942," pp. 8, 10; Gebhard labeled these walls C and D.

10. Interview with Reginald and Emlen Smith, August 4, 1940; interview with Thomas Hoffman, November 22, 1940.

11. Hopewell Furnace Day Book, 1804-1806, entry for November 9, 1805, Historical Society of Pennsylvania mss.; Hopewell Furnace Journal D & E, 1805-1809, p. 205a (entries for 1822 on back pages), Hopewell Village mss.

27. See photos #30-2
collection.

28. Hopewell Furnace
Village mss.

29. Conversations wit
Appleman.

30. Ibid. See also i
interview with Thomas
Charles S. Painter, Ap
appearance of the Whee
and #70-11, in Hopewel
No. 4-45, accompanying

31. Appleman, "Propos

32. Gebhard, op. cit.
pp. 26-31; see also Di

33. See the recommend
from Historian Weig to
Regional Director Alle
June 18, 1951; and fro
Superintendent, April

34. Hopewell Furnace
Hopewell Village mss.

35. Conversations wi
Appleman.

36. Descriptions of
Thomas Hoffman, Novem
Albert Painter, Decem
Charles S. Painter, Ap

37. Hopewell Furnace
Village mss.

38. This is photo #10
the roaster is barely

39. Interview with N

40. Hopewell Furnace Day Book, 1800-1802, p. 134, Historical Society of Pennsylvania mss.

41. Conversations with Harker Long, December 1935, notes by Roy E. Appleman. Appleman, "Historical Report," p. 27, interpreted this statement to mean that "its original structure was left unchanged except that it was made two feet higher," although his notes say merely: "Big charcoal house rebuilt 1880; made 2 feet higher." Paul Koch, interviewed August 17, 1940, regarding his conversations with Harker Long since 1936, declared that he had "gathered the impression that the building was completely constructed then, not merely rebuilt."

42. J. C. F. Motz, "Hopewell Village National Historic Site" (narrative for Historical Base Map), January 1941, p. 4.

43. Hopewell Furnace Day Book, 1851-1883, pp. 200, 202, 212, 265b, 265b, 266a, 268a, Hopewell Village mss. For extensive quotations from these records, see Motz, op. cit., pp. 4-5.

44. Hopewell Furnace Day Book, 1851-1883, p. 263b, Hopewell Village mss. Motz advanced the theory that these timbers may have come from the northern extension of the Bridge House which led to the upper Charcoal House, and which was dismantled when the new structure was built; see Motz, op. cit., p. 5.

45. Appleman, "Proposed Restoration Plan," pp. 28-29. Cf. Appleman's notes on Conversations with Harker Long, December 1935, and interviews with Nathan Care and Charles S. Care, February 13 and 24, 1941. Paul Koch's description of this building, based on conversations with Harker Long and Nathan Care (the Hopewell farm manager), gives different dimensions: about 50 feet long, 30 feet wide, and 20 feet high; interview, August 17, 1940.

46. Interview with Charles S. Care, February 24, 1941.

47. Hopewell Furnace Day Book, 1851-1883, pp. 201, 206, Hopewell Village mss. Appleman, "Proposed Restoration Plan," p. 29, states the distance as 25 feet; this was based on his notes on Conversations with Harker Long, December 1935.

48. This is photo #122-1 in the Hopewell Village photograph collection. See also Drawing No. 4-43, accompanying this report, for the exact dimensions.

49. See, e.g., Appleman, "Proposed Restoration Plan," pp. 37-40.

50. Here, we are following the sensible practice in Schumacher, op. cit., p. 43.

51. Appleman, "Proposed Restoration Plan," p. 37.

52. Testimony of John Kring (or Gring), Penn's Lessees v. Lock (1810), Historical Society of Pennsylvania mss. See also the conclusions stated in Dennis C. Kurjack, Historian's Monthly Narrative Report for November 1950, dated November 30, 1950, p. 2.

53. Hopewell Furnace Journal, 1784-1785, pp. 4b, 11a, 12b, 16b, 19b, 25b, 29a, 80a, 85b, 87b, Historical Society of Pennsylvania mss.

54. Hopewell Furnace Day Book, 1800-1802, p. 311, Historical Society of Pennsylvania mss. The molders or founders were sometimes called potters; hence, the name. See Dining, op. cit., pp. 119-121.

55. Hopewell Furnace Account Book, 1824-1826, entry for January 29, 1825; Hopewell Furnace Day Book, 1851-1888, pp. 204, 206, Hopewell Village mss.

56. Conversations with Harker Long, December 1935, notes by Roy E. Appleman. Cf. Appleman, "Proposed Restoration Plan," pp. 37, 40; Metz, op. cit., p. 11.

57. Interview with Paul Koch, August 17, 1940. On the dimensions of the Cast House, see also interview with Hunter Care, March 14, 1948.

58. Interview with Charles S. Care, February 24, 1941; interview with Charles S. Painter, April 15, 1955. No archeological investigation has been made of the area between Wells G and H.

59. Interviews with David Boone, February 25 and March 22, 1941. Regarding the roof, see also interviews with Morris Care, February 6, 1941, and Nathan Care, February 13, 1941. The Cast House bell was donated to us in 1949; according to the furnace records, it was purchased originally in 1849. See Dennis C. Kurjack, Historian's Monthly Narrative Report for October 1949, dated November 4, 1949, p. 2; Hopewell Furnace Account Book, 1846-1851, entry for July 11, 1849, Hopewell Village mss.

60. See especially photos #101-5, #101-6, and #101-7 in Hopewell Village photograph collection.

61. See photos 3 and 4 in Walter E. Hugins, "Early Nineteenth Century Iron Furnaces: A Comparative Study," January 7, 1954.

62. Conversations with Harker Long, December 1935, notes by Roy E. Appleman; interview with Nathan Care, February 13, 1941.

63. Interview with Thomas Hoffman, November 22, 1940; Schumacher, op. cit., pp. 44-45.

75. Interviews with Hunter Care, March 14, 1948, and Charles S. Painter, April 15, 1953; in addition, several informal discussions on this point have been held during the past year with the above informants and with Mr. Albert Painter. Further evidence regarding the pitch of the Bridge House floor was given by these informants. As a child, one of them used to play with the old charcoal and ore barrows left in the Bridge House after 1883; they were released at the tunnel head and allowed to roll down the length of the Bridge House to the north end. Another one, who in the 1920's did carpentry work in the Village for the Brookes, once set up his work bench in the Bridge House; he recalls that one end of it had to be jacked up to make it level, due to the pitch of the floor.

76. See especially interview with Charles S. Painter, April 15, 1953.

77. Photographs #101-5, #101-6, and #101-7 in the Hopewell Village photograph collection. For the masonry fire wall, see also photograph #55-25. For the archway, see cross-section A-A, Drawing No. 4-45, accompanying this report.

78. Photographs #22-6, #47-10, and #102-5. See also photographs #20-1 and #57-28 for the original height of Wall A.

79. Photographs #25-8, #55-26, #70-11, #99-19, and #102-5.

80. Hugins, "Early 19th Century Iron Furnaces," pp. 1-5, photos 1-8.

81. See especially Drawings No. 4-42, 4-43, and 4-44, accompanying this report.

82. See Drawing No. 4-45. Photograph #101-6, in the Hopewell Village photograph collection, has a view of the Cast House framing which should be of help on this problem, since all these buildings were doubtless constructed in a similar manner.