6.1 The corner of the refinery forge. (Photograph 131 by Richard Merrill, December 1949.)

The Forge and Slitting Mill

Donald W. Linebaugh

Following Robbins' identification of the blast furnace foundation and its various elements, including the bellows, charging bridge, and casting beds, he continued his excavations to the south and east in search of other ironworks features, particularly the refinery forge and slitting mill. From 1950 to 1953, Robbins excavated features east of the furnace that he confidently interpreted as the refinery forge. From 1952 to 1953, he worked in an area east of the refinery forge that he came to interpret as the slitting mill. These two buildings, clearly documented in the ironworks' business records (see Chapter 2), were central elements in the integrated ironworking operation at Saugus.

In the inventory of Newbridge, Sussex, of 1509 the three essential parts of an English forge are indicated: finery, chafery, and hammer. They were all in one building and equipped with water wheels. The building of the early forge consisted of a wooden framework the interstices of which were boarded with planks of wood; the roof was tiled.

H. R. Schubert, *History of the British Iron and Steel Industry from c. 450 B.C. to A.D. 1775*, p. 273.

A forge, consisting of a finery and chafery, was not always associated with a blast furnace operation; it could be a separate business that simply purchased pig iron from a furnace for refining and processing into wrought iron. The inclusion of a forge in the Saugus operation allowed for the production of a broad range of products sought after by blacksmiths and ironworkers. In the finery, a metal sow (or cast-iron bar) was remelted to burn off additional carbon and then collected into a ball called a loop. The loop was then hammered by hand and by trip hammer into a bloom. The bloom was then reheated in the chafery hearth and trip hammered into the shape of a dumbbell, a process that removed more impurities in the metal. The dumbbell was then heated again and trip hammered into a long bar that could be sold to blacksmiths. Thus, the brittle pig iron of the furnace casting was converted into a refined bar of more flexible and durable wrought iron.

The rolling and slitting mill allowed the wrought iron to be further processed in terms of size and shape to make it more usable by metal crafters. In this building, the long wrought-iron bars could be rolled into thinner sheets and then cut into bars and rods of various sizes and diameters. For example, one of the products of the ironworks was rod iron or nail rod, which is bar iron cut into sizes suitable for blacksmiths to produce nails. The financial records of the ironworks contain numerous references to the sale of various sizes of bar iron and nail rod.

The Refinery Forge

Although Robbins had reported that he identified a "forge or foundry" foundation early in the excavations along the tailrace south of the furnace, he later came to the conclusion that this series of features was likely related to the works of Joseph Jenks. Robbins records in his daily log on July 19, 1949, that "Jenks bought of Undertakers a corn mill, a forge and a slitting mill at the tail of the furnace."[1] Later in the year, Robbins identified a foundation (#6) east of the furnace along Bridge Street; he reports that "slag fill southerly of foundation No. 6, is refuse from forge activity (possibly hammer activity)."[2] While there was clearly no consensus as to the exact location of the refinery forge, Robbins suspected that it was located in the Bridge Street area of the site, east of the furnace.

Robbins got a better sense of what he was actually looking for in terms of the refinery forge equipment when, in April 1950, he met with ironworks expert Earle Smith. Smith helped him understand many aspects of this type of ironworks facility and also provided interpretive ideas about the features that Robbins had identified to date. Robbins notes that Smith told him that "the site of the hammer should produce a wooden block in its center on which the anvil rested. Said the trip hammer's wooden shaft or arm might be about 4-6' in length."[3]

Thus, when Robbins identified a "large circular affair" along Bridge Street in August 1950, he was able to quickly connect it to the refinery operation based on Smith's description. Robbins explains in his daily log that he excavated

> within the large circular affair found handy to the large retaining wall on the northerly side of Bridge St. About 34" down from the top of the circular affair I found the base, stump or block of a tree which was 41" in diameter. It appears that this may be the base of a hammer—the block on which the hammer fell. The circular affair about it, while it appeared to be metal, actually is a metal waste. The theory at the moment is that the circular wood base is the anvil base on which the hammer fell and the metal waste about it was the accumulation of the impurities extracted from the iron by hammer action.[4]

After identifying the anvil base along Bridge Street, Robbins dug several test trenches "to determine the natural soil line" and guide future excavations.[5] Later in August, Robbins and his crew discovered another feature about 11 feet east-northeast of the "circular affair" or anvil base. This feature also appeared to be a section of tree trunk, although in this case squared off and somewhat smaller than the first, measuring 21 by 23 inches.[6] Robbins and Hartley were excited about this discovery, believing that it and the other anvil base were likely part of the ironworks refinery building.[7] This interpretation was strengthened when, on August 31, Robbins found the head of a trip hammer in the immediate vicinity of the anvil base and hammer features along Bridge Street. He notes that the 500-pound iron hammerhead was recovered north of Bridge Street Trench #1; covered with approximately eight to ten inches of soil, it "appeared to be resting on natural clay."[8] "The soil above and handy to the hammerhead," he notes,

To ditto [Francis Perry] cuttinte ye Anuil blocke.

Lynn Iron Works Collection. Baker Library Historical Collections, Harvard Business School, p. 115.

6.2 The first anvil base block at the refinery forge site. (Photograph 189 by Richard Merrill, August 1950.)

"was somewhat loamy etc. for a 5" depth. Then mostly sandy-clay. Some metal waste pieces were evident here, extending to a level corresponding with the under surface of the hammerhead. The surface below the hammer head appears to be natural clay." [9] A chemical analysis of metal samples from the hammerhead indicated a total carbon content of 2.98 percent. This finding, along with spectrographic and microscopic analysis, according to the materials scientists who examined the samples, "clearly indicates the specimens were of cast iron."[10] Robbins also records that "at the broad, southerly end of the hammerhead a 4 ¾" length of pig bar was found."[11]

With the approval of the Central Street detour in September 1950, Robbins and his crew moved from the Bridge Street area to excavate along Central Street in search of the furnace waterwheel. During November and December, they briefly moved back to the excavations along Bridge Street, where they located several new features, including an upright that might have supported the hammer beam, a stone foundation north of the retaining wall (that proved to be a later, post-ironworks structure), and possible evidence of the waterwheel pit and watercourse that powered the refinery.[12] Writing about the stratigraphic profile of the possible watercourse, Robbins comments that

> in this watercourse there was about 42" of metal waste, etc. material, the top several inches being of soil fill. Below the base of the metal waste was encountered 28" of sand and slay. This soil appeared to be natural when first examined. At the bottom of this fill the stone floor was located. This evidence would indicate that after the cessation of iron works operations this area was exposed to the washings from storms etc. This accounting for the 28" of sand and clay found upon the stone floor. Being washed in from the natural soils which abutted the area, particularly from the knoll which abutted the northerly end of the stone evidence, this soil would build up in time, and convey a false impression of natural soil. This would also account for the fact that but little iron works evidence was noted in this sand and clay fill. As for the deep deposit of metal waste material etc. found above the sand and clay, this appears to have been a concerted effort by some later generation to clean up the area and fill in the low spots with refuse left by the iron works activity. Possibly this was done at a period when a new manufacturing development was being set up.[13]

The following day, Robbins reports that while the description of the disturbed soil likely indicated a watercourse, additional digging suggested that it was not a wheel pit as he had hoped.[14]

Shortly after finding these new and tantalizing features, Robbins was informed by the American Iron and Steel Institute's lawyer that the area would have to be backfilled immediately because it was within the forty-foot Bridge Street right-of-way and permission had not been obtained to work in the right-of-way.

The hammer generally used in Britain from the sixteenth to the early eighteenth century was a helve- or tilt-hammer. The helve or shaft was about 8 or 9 feet long and 30 or 40 inches in circumference. It was made of stout wood and clamped at intervals with iron hoops. The hammer head through which the shaft passed was made of cast iron. At the opposite extremity the shaft passed through, and was fastened with wedges into a cast-iron collar called the hurst. The pivots of the hurst constituted an axis for the hammer, and worked horizontally between the limbs of the support.

H. R. Schubert, *History of the British Iron and Steel Industry from c. 450 B.C. to A.D. 1775*, pp. 280-281.

6.3 The discovery of the refinery hammer. (Photograph 58B from the Roland W. Robbins slide collection, 1950, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

Robbins lamented, "[A]ll this work for naught! Another day at the site . . . and we would have plotted [the] details [that had been uncovered]."[15] Before the area was backfilled and fenced, however, Robbins and his crew managed to sketch the evidence and have Richard Merrill take photographs. He notes that architect Harrison "Schock plotted the anvil base, hammer beam anchorage and upright sites making possible their layout and relation to one another."[16] Robbins also relates that

> before filling in the low excavations at northerly end of possible water course, just east of sites of uprights, I drove a stake and a rod into the westerly side of the possible water course marking the site of a large metal waste clinker found there. Whether or not metal waste clinker speaks for the bed of a forge etc. fire, or a development created by 3 centuries of oxidation, there is no way of knowing at the moment.[17]

Robbins labeled this possible eastern watercourse the second waterway crossing Bridge Street and assumed it was related to the refinery forge.

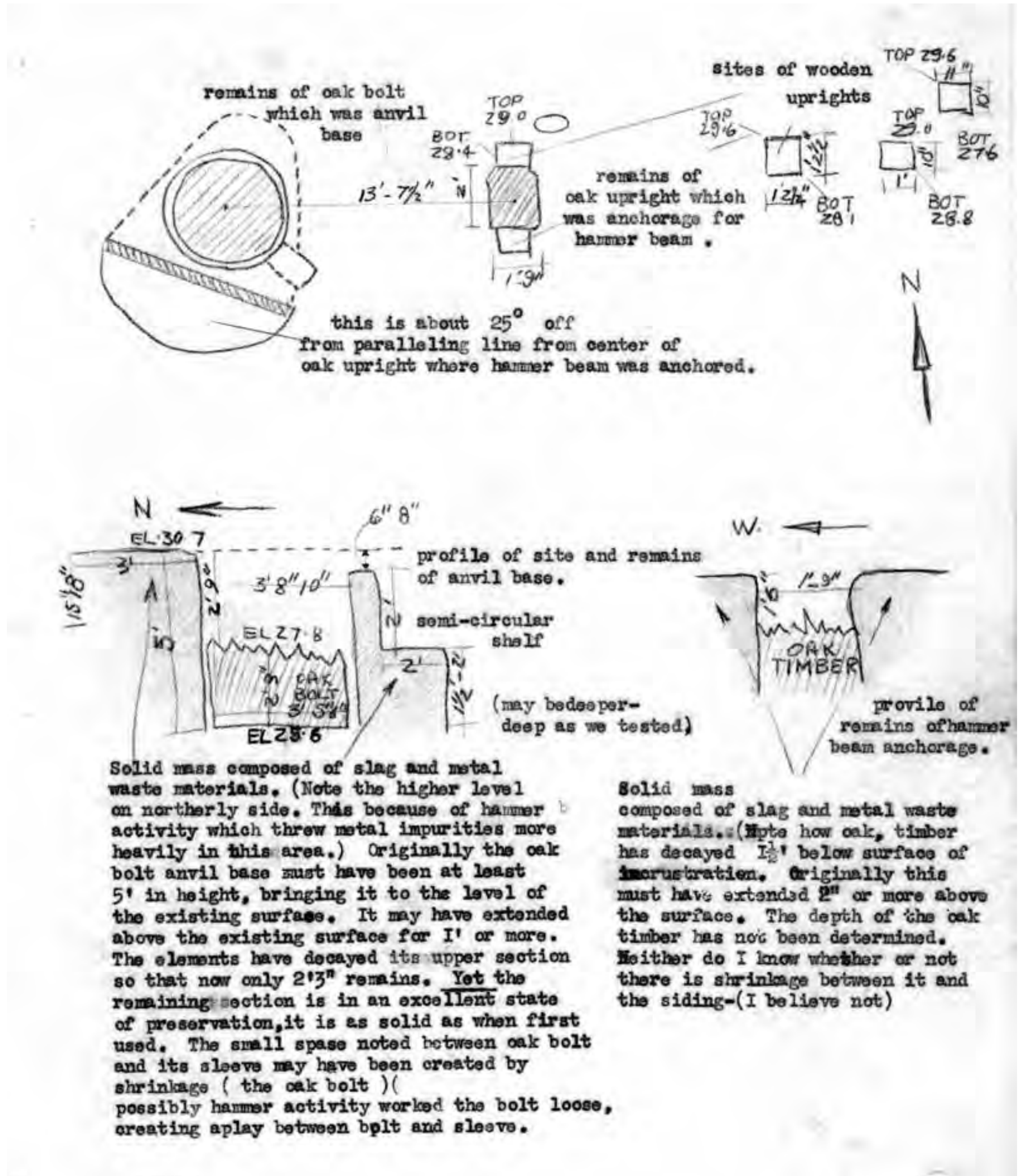
With the refinery forge site temporarily off limits, Robbins and crew moved their excavation work back to the Central Street area. For much of early 1951, they focused on the identification and excavation of the furnace watercourse and waterwheel pit buried beneath Central Street. Subsequently they uncovered evidence of several waterwheels, a power hammer, and a forge, likely part of the Joseph Jenks operation (see Chapter 7), on the furnace tailrace.

In April and May 1951, Robbins was able to again turn his attention to the refinery forge site, focusing on the identification of possible watercourses to the refinery.[18] His excavations on the furnace watercourse and waterwheel pit indicated to him that the refinery watercourse likely was supplied by the same source. Working along the north edge of the ironworks property, the crew dug several test trenches in search of the refinery watercourse. A test trench "to the north side of Chesley's driveway" provided the evidence that Robbins sought: "we found the course. Much iron waste material was found in the disturbed area."[19] His profile sketch of the watercourse includes the notation that the fill contained "large chunks of metal waste from refinery activity, also some stones and charcoal."[20]

In July, Robbins resumed testing near the refinery site and positively identified a second watercourse that crossed Bridge Street approximately fifty feet east of the first watercourse.[21] Subsequent work along this watercourse and below the refinery site identified several large timbers that were interpreted as the wharf or dock area for the ironworks. Robbins and his crew focused their work on the wharf area for the next several months.

The operation in the English finery proceeded in several stages; melting down the pig, refining proper, and lastly working the refined iron into a lump or ball generally termed a "bloom." The whole process of melting, refining and balling took one hour. Success was judged by sounding the metallic mass with a finger.

H. R. Schubert, *History of the British Iron and Steel Industry from c. 450 B.C. to A.D. 1775*, p. 285.



Solid mass composed of slag and metal waste materials. (Note the higher level on northerly side. This because of hammer activity which threw metal impurities more heavily in this area.) Originally the oak bolt anvil base must have been at least 5' in height, bringing it to the level of the existing surface. It may have extended above the existing surface for I' or more. The elements have decayed its upper section so that now only 2'3" remains. Yet the remaining section is in an excellent state of preservation, it is as solid as when first used. The small spase noted between oak bolt and its sleeve may have been created by shrinkage (the oak bolt)(possibly hammer activity worked the bolt loose, creating aplay between bolt and sleeve.

Solid mass composed of slag and metal waste materials. (Note how oak, timber has decayed 1½' below surface of incrustration. Originally this must have extended 2" or more above the surface. The depth of the oak timber has not been determined. Neither do I know whether or not there is shrinkage between it and the siding-(I believe not)

6.4 Sketch of the first anvil base and associated upright posts from Robbins' daily log, December 15, 1950.

In early December, Robbins returned to the Bridge Street area to work on the refinery forge setup. He had the crew excavate test trenches to the east of the hammer wheel pit and begin excavation of the site of the anvil base. Robbins notes that they were “removing fill from the refinery hammer wheel pit in Bridge Street.” He drew a cross-section sketch of the “most southerly evidence of waterway to hammer waterwheel,” showing

> its width [7’ 3”] and elevation [37’]. Originally it was sheathed in this section. This is based on the vertical line between natural, stratified sands and disturbed soils. This sheathing which probably extended to [the] flume . . . [supplying the] hammer waterwheel may have started in this area.[22]

Robbins records in his daily log that he shot 16-millimeter film of the excavation of the hammer waterwheel pit and the anvil base in mid-December.[23] Snow and ice necessitated that Robbins have his men erect a “structure over [the] hammer wheel pit . . . so that the area can be heated, its frost thawed and excavations there continued.”[24]

In early January, his crew was excavating “what may be a second wheel pit just southern of above mentioned pit.”[25] This would have been a second wheel pit on the first or western watercourse across Bridge Street. Robbins reports that they

> found a great deal of Iron works activity below the timbers found at second wheel pit. Many nails, broken casting pieces, wedges, metal pieces, etc., found amid metal waste, stones, etc. About 3 ½’ below the top of the timber evidence a 26” section of pig found, handy by a 6” point of pig found.[26]

Robbins and his crew also resumed work on the Jenks forge site (see Chapter 7), located on the furnace tailrace.[27] Robbins notes that

> Hartley is amazed with developments here. Believes this may be the site of the *Forge the Iron Works* are known to have had. If so, then Jenks concessions must be south of this. While digging about the end of the wheel, Neal found a piece of leather. It had no stitching marks but it is similar to the abundance of leather found southerly of this site. Most of the evidence has been located in this area.[28]

While the discoveries in the Jenks area were indeed amazing and absorbed much of Robbins’ energy and attention, he also had his men continue to work on the second waterway crossing Bridge Street in the vicinity of the refinery forge.[29]

The remainder of the process (following the finery operation) was conducted in the chafery with intermittent hammering. As the hardest and most carbonaceous particles were still in the iron after it had left the finery, a higher temperature was required for sweating them out. The temperature was generated by a stronger blast produced by bellows larger than those at the finery. The heated iron was consolidated by the power hammer, and forged into the final shape of the bar. . . .

H. R. Schubert, *History of the British Iron and Steel Industry from c. 450 B.C. to A.D. 1775,* p. 287.

Due to copyright restrictions, this image is not available in the on-line version of this publication.

6.5 Soil profile of the first refinery waterway. (Photograph 746 from the Roland W. Robbins slide collection, August 1951, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

In April 1952, after several months of focusing primarily on the Jenk's forge area, Robbins received "a copy of Bent's letter to Attwill where he shows concern for 'forge-finery, slitting mill and wharf' restoration, not Jenk's area."[30] Although Robbins began to slowly refocus his work on the Bridge Street site, it wasn't until June that he seriously began to reexamine the refinery forge site along Bridge Street. His log records that he "had men run trenches between 2 waterways crossing Bridge Street, near possible forge site, to determine if these soils are all natural."[31] Robbins' work in this area was pushed along by the architects who were engaged in designing the reconstructed refinery forge building.[32] Work in the refinery area focused on obtaining details of the features discovered to date, as well as more systematically examining the area between the two refinery waterways. For example, Robbins' investigation of the first wheel pit on the first waterway crossing Bridge Street showed "that its overall dimensions [were] . . . about 12' side by 30' in length."[33] Likewise, he notes that additional work around the anvil base "uncovered another beam running beneath base for refinery hammer. This was at a right angle to beam already located."[34] The following day, the crew "removed [a] wooden mallet from beneath forge anvil base."[35]

In early July, the Reconstruction Committee held a series of meetings to "work out [an] acceptable plan for forge, chaffery and two refineries."[36] Although Robbins notes that all were in agreement about the plans, he comments that he hoped "future excavations westerly and south-easterly of second waterway, as well as final work on upper Bridge St. west of first wheel pit, will not prove to have found us having made a premature decision concerning the two refineries and chaffery layout."[37]

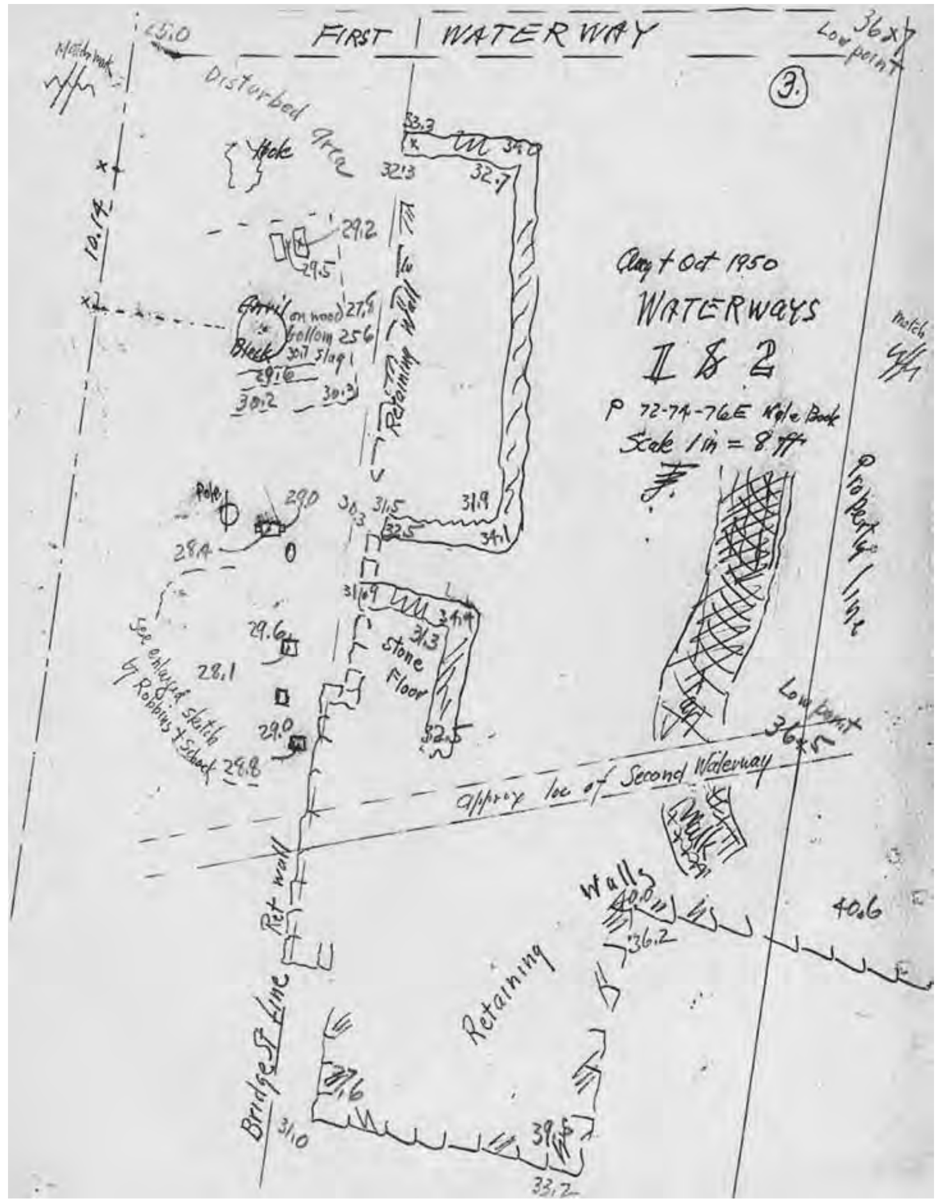
As if in answer to his concerns regarding the refinery forge layout, Robbins and his crew discovered a second anvil base at the site of the forge operation in late July 1952.[38] "It appears," Robbins writes, "to have a 42" diameter, similar in width with the other finery anvil base. This was found handy to the southwest corner of the hutch of the wheel pit of the second waterway crossing Bridge Street."[39] Robbins reported the find to Bent, who replied, "that's right where it should be."[40] Robbins records the details of this new find in his daily log, commenting that the second anvil base was

> 30' 7" from center of the first forge anvil base . . . . Along the northwest side of the second anvil base was found 8" of Iron Works activity above the natural stratified sands. This Iron Works activity appears to be an accumulation from activity here. This area originally had been cut to the sub-soils when being developed. This anvil base compares favorably with the other forge anvil base in diameter. Its northerly-southerly diameter is 43"; its easterly-westerly diameter is 46." We have evidence suggesting this base to be resting upon cross timbers similar to the members on which the first anvil base was placed. However, these timbers do not seem to be as substantial in size as the others. This anvil base did not have packed about it the thick band of slag and iron impurities found about and beneath the first anvil base. At first, it appeared that a hole

Work is to proceed as rapidly as possible on the single-hammer layout based on Scheme "H", SK 324. . . . Robbins is to clarify all evidence in the forge area and attempt to find new pertinent evidence. It was agreed that in putting in the concrete retaining and foundation work the south end of the Forge would be left open as long as possible for further exploration.

Mr. Bent emphasized that we must proceed with construction now even though it may later be proved that we have made mistakes and have not interpreted the evidence properly.

Minutes, Meeting at Saugus, August 28, 1952.



6.6 Field sketch of refinery waterways 1 & 2 by John Bradford, August and October 1950.

> had been dug in the clay, the base sills set in place, with the second anvil base placed upon them. Then the clays that had been removed during this work were used for back fill. However, a closer inspection of these clays notes slag evidence and possibly other Iron Works impurities. This evidence is nowhere nearly as extensive as the evidence found about the first anvil base. It does prove at least furnace production had been conducted to make possible slag in the back fill used here.[41]

Although most of the team members were initially elated by the discovery of the second anvil base, its presence became problematic when the architects sought to integrate it into the plans for the reconstructed refinery forge building. At a meeting on August 6, according to Robbins, "we spent the morning going over forge layout and trying to determine some manner whereby we could incorporate 2 hammers, 2 fineries, and a chaffery within the limited space we have to work with. Didn't arrive at any definite conclusion."[42] In a follow-up discussion with historian Hartley, Robbins notes Hartley had "not been able to figure out any way whereby two hammers, two fineries and a chaffery could be set up in the limitations of the forge area we now have."[43] Hartley, Robbins continues, is "in accord with its north, east and west bounds and does not believe that the actual working area would have extended southerly to any appreciable distance beyond the southerly end of the hutch area on the second waterway crossing Bridge St."[44] Robbins notes further that "I still believe this anvil base was one of a two hammer setup at the forge. My reasons for this belief are based on the fact that it is located *just where it should be located for a two hammer setup!*"[45] At an August 14 meeting, Robbins reports "the group, *excepting myself*, decided that the forge layout had but *one* hammer. They talked themselves into believing that the original hammer site was the second anvil base found recently. They thought that this was discarded, for some unknown reason and was replaced with the first anvil site, found in 1950."[46]

Work on the refinery forge site in late August provided further detail on the construction of the second anvil base. Robbins records that the work

> revealed the outline of the original base sills, which were very large being 18" in width. This work also showed where the bottom of the anvil base itself had a tenon which fitted a mortised area where the two base sills were interlocked. This method prevented a slipping or skidding of the base from position where placed. About an inch above the bottom of the anvil base a metal band encircled it. Apparently seepage carried oxidation from the surface about the anvil base down and about the sides of the anvil block itself as well as about the base sills on which the block was seated. This oxidation impregnated the soils around the base sills and anvil base creating a form which gave us the true outline and original size of the evidence.[47]

I am, of course, disturbed about the discovery of a second anvil foundation but on account of the room within the building, I doubt very much if both hammers were operated at the same time. It rather appeals to me to think of one of the hammers having been abandoned and that the large hammer was, at least in the later years, the one operable unit within the plant. Certainly there is ample precedent for assuming that this was the case particularly as I believe there is some documentary evidence to think that later on a new hammer was installed within the operation.

Quincy Bent to J. Sanger Attwill, August 26, 1952.

Due to copyright restrictions, this image is not available in the on-line version of this publication.

6.7 The second anvil base block at the refinery forge site. (Photograph 1430 from the Roland W. Robbins slide collection, April 1952, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

Although the new discovery clearly added to the interpretive difficulties of the refinery forge site, Quincy Bent instructed the architects to "go ahead with the building work on the refinery and on chaffery starting with the one hammer layout .... It is true that Robbins' discoveries subsequently made, may make some changes but I think we are fairly safe as far as the building is concerned and the one hammer installation with the chaffery division."[48]

At an August 28th meeting, the decision was approved to "proceed as rapidly as possible on the single-hammer layout . . . ."[49] This decision was bolstered by a mid-September letter from English ironworks expert H. R. Schubert. The second anvil, he argued, was typically used for making and repairing by hand the various tools and implements needed for finery and chaffery operations.[50]

Architect Andrew Hepburn replied to Schubert in late September regarding the second anvil feature, noting that Robbins had subsequently "found the imprint of a very large upright post about 14 feet west of the new anvil base. This upright bears the same relation to this base as does a similar upright to the anvil base found earlier, and they both would appear to have been end supports for large overhead 'dromes' for power hammers."[51]

Hepburn admitted that everyone agreed that they "were faced with the fact that there had been two power hammers in the forge area at Saugus."[52] After further discussion, the group decided that the southwest hammer must have been built first and then abandoned ca. 1652 when a new hammer was built in the northwest corner of the structure.[53] "The best single reason for deciding that one of them must have been abandoned in favor of the other," wrote Hepburn, "is the fact that the physical limitations in the size of the forge area and the arrangement of the water courses and wheel pits prevent us from working out a two-hammer layout in which two fineries and a chaffery are also included and arranged in a manner satisfactory to us all."[54] Schubert was quick to adopt this new interpretation, writing that "I heard from the architects & I am completely agreeing to the view that one power hammer was abandoned in favour of a new one placed at a different spot . . . ."[55]

In September, Robbins notes that he and his crew "continued excavations at forge layout, taking the existing surface down to determine whether or not sites of any uprights, fulcrum, etc., still exist." He hoped to discover evidence that might support the architect's and historian's theory that the two anvils never operated at the same time.[56] Excavation around the first anvil base revealed that

> the base did not have a tenon on it, similar to what was found on bottom of 2nd anvil block at forge. Nor did it have any metal bands about it . . . . Beneath the block itself was . . . about 2-1/2" of metal materials, as well as pieces of metal. This evidence

I was pleased about the discovery of the second anvil base because it fits in very well with the plan of the forges we all approved on July 7th, & the plan I received from Mr. Fitch last week confirms it. Just near the fineries—where it should be! It is quite in keeping with many 17th-century inventories in which 2 anvils are referred to. Such a second anvil however most certainly does not require a second power hammer.

H. R. Schubert to E. Neal Hartley, September 10, 1952.

Due to copyright restrictions, this image is not available in the on-line version of this publication.

6.8 The second anvil base sills and metal band after block's removal. (Photograph 1888 from the Roland W. Robbins slide collection, December 1952, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

> could not have been accumulation of seepage action because of the metal pieces being found here. The 2-1/2" thick incrustation was noted below the outer diameter of the block . . . . At the junction of the base sills . . . [the incrustation] was about 11-1/2" thick, making its way to the bottom of the base sills. . . . I noted that blue clay was used for fill between the base sills, coming to their surface. The slag and other I.W. impurities being seated upon the clay and beams, as well as the metal materials below the anvil block.[57]

In mid-September, Robbins and architect Conover Fitch further examined the clay soils removed from below the base sills of the first anvil base. Robbins reasoned that

> . . . they may have dug out several inches of the natural yellow clays where the large base sills were to be seated. Then they used blue clay (which was foreign to this area) with considerable slag and other I.W. impurities for a fill on which to place the base sills. Inasmuch as they used blue clay for packing between the base sills and for footing below the base sills, it suggests that they found the blue clays more suitable for the job than the natural yellow clays in this area. Actually the area is made up mostly of yellow clay. They may have found from experience that the blue clay had greater binding qualities than yellow clay. In any event Fitch and I were particularly concerned about the I.W. materials found in the soils on which the base sills rested. To find slag there proves that furnace activity took place before this work was done. But had forge activity taken place before these sills were set in place? We broke into a piece of the soils on which the junction of the two beams rested. The surface of these soils had considerable slag. About 3" below the surface, Fitch found a piece embedded in clay which was quite heavy and appeared to be iron. I had it buffed down and it proved to be iron. We do not know whether or not it is cast iron or wrought iron. If an analysis shows it to be wrought iron conforming with the wrought iron pieces we know to have been made there, then we will have evidence that suggests that forge activity had taken place before this anvil base was erected. He found other evidence that seemed to have the qualities of impurities from forge activity. This evidence also was found about 3" below the surface on which the base sill of the anvil rested, and had considerable blue clay about them. Buffing these pieces revealed particles of iron amid them. If this proves to be impurities from forge activity, and later examinations of the soils found below the base sills of the 1st anvil base supplement it, then we could assume that *forge activity took place before this anvil was set up.*[58]

By cutting one Anuell block. By Sawing one tree for hamer beame.

Lynn Iron Works Collection. Baker Library Historical Collections, Harvard Business School, p. 151.

Due to copyright restrictions, this image is not available in the on-line version of this publication.

6.9 The "fulcrum" posthole related to the second anvil base. (Photograph 1712 from the Roland W. Robbins slide collection, September 1952, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

Throughout late October and November, Robbins and his crew worked on clarifying the course of the third waterway crossing Bridge Street, in what was suspected to be the area of the slitting mill.[59] In early December, with work on the refinery forge area nearing completion, Robbins began to explore the area east of the refinery forge site and west of the third watercourse. He notes that he wanted to examine that area by trenching along Bridge Street from the third waterway to the bridge before conducting more intensive work.[60] Robbins and Fitch had speculated that the third watercourse might have powered the as yet unidentified slitting mill.[61]

In mid-December, Robbins followed up on his findings regarding the soils below the first anvil base by examining "the soils on which the base sills below the 2nd anvil base rested."[62] He details this work in his daily log for December 12:

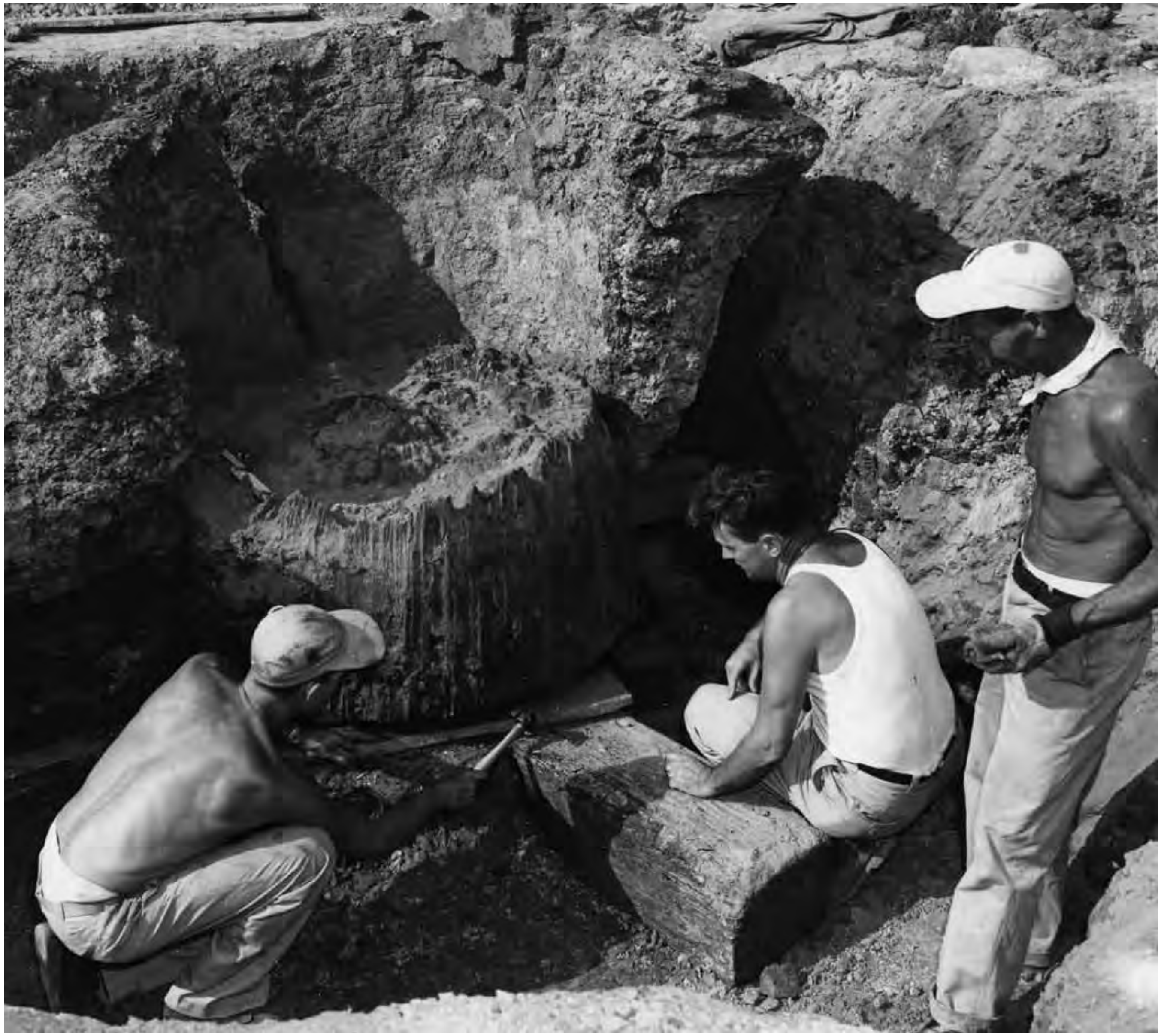
> The soils were of a yellow clay. Yet, the surface on which the base sills of the 1st anvil at the forge rested was a blue clay fill. This blue clay replacing the natural yellow clays that predominated in that area. (See notes for September 11th and 16th.) Why were blue clays not used beneath the base sills of the 2nd anvil block? It would be difficult to determine whether the clays below the base sills of the 2nd anvil block were not disturbed, or were a back fill. I have just examined these clays, they suggest that they are of a natural nature, only their surface having been disturbed slightly. Is it possible that the 2nd anvil site found at the forge was the original forge anvil? When it was set up they utilized the natural yellow clays below and from this experience they found that the yellow were not as beneficial as the blue clays for stabilizing their anvil block. As such, assuming this to be the case, when they got around to building a 2nd anvil at the forge, they remedied this situation by replacing the natural yellow clays with a blue clay fill.[63]

Robbins goes on to note that these findings provide some "interesting speculation" and wonders what the different clays beneath the anvil bases might indicate.

> *I do find* that directly below the junction of the base sills of the 2nd anvil base, *slag!* It appears as though the slag was sprinkled about on the surface where the base sills were to be seated. Then the sills were set in place. This slag evidence does not penetrate to a depth exceeding an inch to an inch and one half, most of it being not more than an inch. (See relics for this day, for this slag evidence.) An examination of the surface below the base sills of this 2nd anvil base, while producing slag evidence, produces no evidence of impurities from forge activity or possible wrought iron specimens, such as was found in the soils below the junction to the base sills at the 1st

The water tapped from a river some distance away was first led in a leat to a pond where it was stored. From the pond it ran to the wheel through a channel called the head-race. The channel, either in its whole length or only at the end approaching the wheel, was a wooden trough with a sluice at one end which was operated by a cog on a shaft turned by a handle. If the sluice is down, the overflow of water runs through a shoot at the side of the trough above the sluice. If the sluice is raised the overflow stops and the water, discharged from the bottom of the sluice to the top of the wheel, keeps it turning. By the quantity of water allowed to flow from the sluice the speed of the wheel can be regulated. The water falls into the wheel pit whence it is carried away by a channel called the tail-race that joins the river at a lower level.

H. R. Schubert, *History of the British Iron and Steel Industry from c. 450 B.C. to A.D. 1775*, pp. 134-135.



6.10 Removal of the first anvil base block at the refinery forge site. Note shim between block and sills. (Photograph 725 by Richard Merrill, September 1952.)

anvil site. This could be quite revealing, first, if an analysis of the slags found beneath the base sills of both of the anvils excavated at the forge site proves this slag to be the impurities from smelting activity at the Saugus furnace, it would show that this forge activity didn't get set up until sometime after the furnace had begun production. It would also suggest that the 2nd anvil base probably was the 1st to be erected at the forge. I base this on the fact that no evidence of impurities from forge activity or wrought iron specimens were found in the fill below the base sills of the 2nd anvil block. Inasmuch as both slag and what appears to be impurities from forge activity, as well as pieces of wrought iron, were found below the base sills of 1st anvil block at the forge, it suggests that this anvil block was set up not only after the Saugus furnace began operations but also after some forge activity had taken place. If analysis on the impurities and wrought iron pieces found below the base sills of the forge 1st anvil block compared favorably with the impurities and wrought iron pieces we know to be from the forge area, and forge activity, we could assume that the 1st anvil was set up after both furnace and some forge activity had gotten underway here at Saugus. In checking the back fill soils which went about the base sills of the forge 2nd anvil block after they had been set in place, I noted that this back fill appeared to be some of the clay that had been dug from this area during this work. These back fill clays, beneath and on the north-westerly section of the anvil block, were about 13" in depth. Slag evidence here penetrated to a depth of about 3". I also noticed that this 13" of back fill appeared to have been thrown onto stratified natural clay. This evidence again suggests that this area was dug only to the depth desired for the seating of the base sills. Here again no evidence of forge impurities or wrought iron particles was found in any of this fill. I have no accurate measurement of the back fill that surrounded the anvil block itself. However, the clay back fill contained a bit of slag evidence. This evidence was quite remote compared to the slag and other impurities used in the clay for the back fill around the 1st anvil base. I don't know whether or not this back fill may have contained impurities from forge production, I rather doubt it. The back fill about the sides of the anvil block at its bottom didn't contain slag extending from it more than 4½". This slag was quite scattered. I also noticed that back fill about the base sills of the 2nd anvil block, while made up of clays, presumably the clays removed during these excavations, contained evidence of slag not throughout them but only in the clay that packed the sills themselves. In other words, particles of slag were found in the fill that packed the sides of the sills to a depth of only 3". Beyond that, I noted only clay soils. It appears as though a sprinkling of slag took place where the base sills were seated. Then a mixture of clay with some slag was daubed to the sides of the base sills to a thickness of about 3". The fill between the base sills beyond this 3" packing was com-

The clay fill found here, as well as the deep clay fill found directly to the south of the forge, where it is three or more feet in depth, is the type of natural sub-soils found at the site of the forge building. I believe that when the slope was being leveled for the forge building the clay sub-soils were used to elevate the low natural slope to the south of the forge, as well as the area southeasterly of the forge where we find the abundant evidence of iron works activity. None of this clay fill, nor the natural loam line below it contains any evidence of iron works activity.

Roland W. Robbins to E. Neal Hartley, May 4, 1953.

Due to copyright restrictions, this image is not available in the on-line version of this publication.

6.11 Aerial view of the refinery forge excavation; the water wheel pits are at the far right and left of the photo. (Photograph 1762 from the Roland W. Robbins slide collection, September 1952, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

> prised of what appears to be the natural yellow clays which were disturbed at a time this area was being prepared for the anvil block and its base sills.[64]

Although Robbins and crew continued to finalize the excavation of the refinery forge as December progressed, most of their effort was redirected toward the search for the slitting mill in the area east of the refinery forge and the wharf or dock site to the south. In mid-December, Robbins noted that he and Fitch "agreed that extensive digging should be done now at 3rd water way crossing Bridge St, to determine the possibilities of wheel pits having been in that area."[65] Robbins and Fitch examined a test trench in this area in late December; Robbins reports that Fitch "thinks the chances are good that the slitting mill was just east of the forge."[66]

Summary of Refinery Forge Features

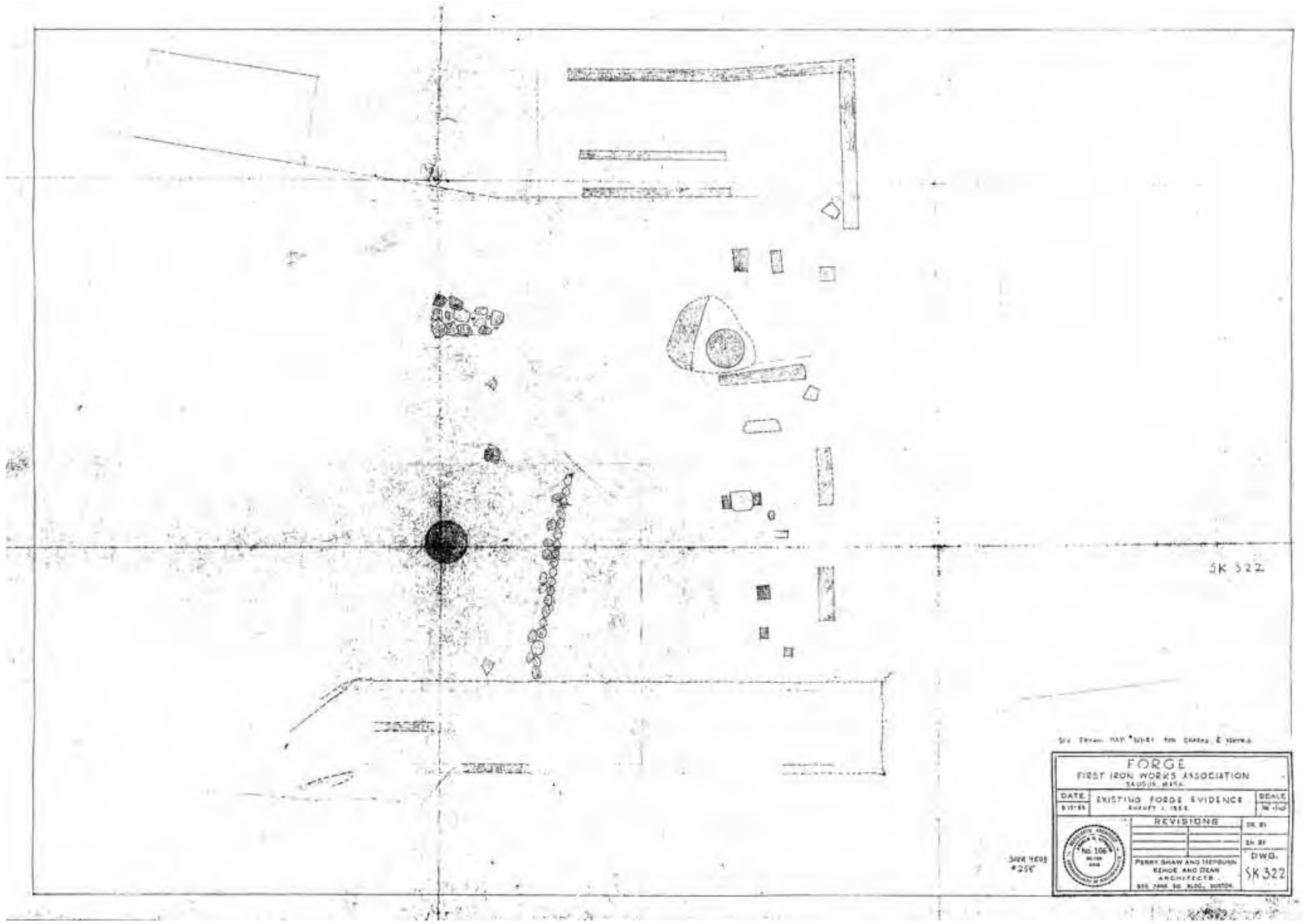
The final list of features associated with the refinery forge building is impressive and includes the two watercourses and associated wheel pits, the two large anvil bases, a series of posts or "uprights," and two stone features, one west of the second anvil base at the southeast corner of the building and the other a linear feature running east-west and located just north of the second anvil base.

Robbins identified two watercourses or waterways that powered the refinery forge operation. Trenching uncovered clear stratigraphic evidence for linear features that were approximately seven feet wide and shaped like a canal for carrying water. He found evidence of waterwheel pits on both the first and second waterway crossing Bridge Street; the second waterway was approximately fifty feet east of the first waterway, so that the two waterways essentially framed the west and east sides of the refinery forge building. The first or western waterway had two wheel pits, while the second or eastern waterway had only one. Evidence for the upper wheel pit on the first waterway included sections of wooden sills and impressions of sills that outlined the pit; the lower pit was identified primarily based on soils evidence from a large wheel pit-like feature.[67] Like the upper wheel pit on the first waterway, the wheel pit on the second waterway was identified through soils evidence, as well as the remains of several wooden sill fragments for the wheel pit.[68] Although both wheel pits contained fill that held ironworks artifacts and later materials, neither contained remnants of the waterwheels themselves.

The first anvil base was identified in the northwestern corner of the forge building, about twenty feet east of the first wheel pit on the "1st waterway" crossing Bridge Street. This base was a large section of an oak tree, measuring approximately three feet, six inches in diameter, that sat upon two large oak beams. These beams were joined with a lap joint and crossed at a ninety-degree angle. A hard shell of metal impurities, waste from the hammer process, encased the anvil base.

In the forge 2 pair of smyths fondry bellows, 30 li; 1 pair chafery belloes, 20 li; 7 Anville, 38 hamers, 10 hursts, all waying about 275 C. at 10s. per C, 137 li.; plates at all the 3 hearths fitted, way about 60C. at 6 li.; 8 workeing furgins & ringers, 1C. waight, 1 li. 8s.; 1 Turne sow Ringer, 13s.; 2 Iron shovels, 16d.; 2 Cole wheele barroes, -; the beame and scales, 2 li. . . .

"An Inventory of the stock and tools at the forge at Hammersmith taken Dec. 20, 1650," ***Records and Files of the Quarterly Court of Essex County, Massachusetts***, Vol. 1, p. 294.



6.12 Plan of existing forge evidence by Perry, Shaw, and Hepburn, Kehoe and Dean, August 1, 1952.

Archeological assistant Stephen Whittlesey counted the tree rings of this first anvil base to determine its approximately age. He found 324 actual growth rings and estimated that there were another 10 to 12 rings in center. Thus, he speculated, when the tree was cut in 1647, it was approximately 336 years old.[69] Forester Jack Lambert of the Massachusetts Division of Forestry subsequently examined the base and counted 285 discernible rings and an estimated 10 additional rings between last identifiable ring and pith of the tree, "giving it an overall age of about 295 years."[70]

Approximately 13 feet, 7.5 inches east of the anvil base lay the remains of an intact wooden upright measuring approximately one foot, nine inches by two feet and identified on plans drawn in December 1950 as the "hammer beam anchorage." Another eight feet, four inches east of this feature were a series of postholes, or "sites of upright foundations" as noted in the 1950 plan, that were spaced several feet apart. These postholes ranged in size from one foot square to one foot, two and a half inches square.[71] A 1952 drawing of the same area included several additional postholes that had subsequently been identified just north of the larger posts; these measured approximately six inches square.[72] Only two of these posts appear on a slightly earlier drawing of the forge evidence dated August 13, 1952.[73] The function of these smaller posts was never firmly established.

A second anvil was indispensable for making and repairing the various implements required for fineries and chafery. It is frequently termed "an anvil to mend the tools upon." The implements were made by the finers and hammermen themselves, not to forget the iron bars such as morris bars which required frequent restitution and all the smaller pieces of iron laid into the chimneys to strengthen the structure. Implements used at the furnace such as the various kinds of ringers, also were made at the forge.

H. R. Schubert to Neal Hartley, September 15, 1952.

The second anvil base feature was identified in the southeastern corner of the forge building, just west of the wheel pit on the second waterway and about thirty feet southeast of the first anvil base feature.[74] Robbins notes that along the northwest side of the feature was an eight-inch deposit of "Iron Works activity above the natural stratified sands."[75] The base was a section of oak tree trunk measuring between 43 and 46 inches in diameter. Like the first anvil base, this one rested on large base sills, approximately 18 inches in width, which were crossed at a ninety degree angle. Robbins notes that the second anvil base had a tenon in the bottom that locked it into the point at which the sills lapped over each other.[76] This anvil base was not encased in the same thick shell of metallic impurities from the hammer operation found at the first anvil base; however, subsequent investigations did identify some metallic waste and impurities surrounding the second anvil base. Unlike the first anvil base, the second had a metal band, approximately two inches wide, running around the base near its bottom.

Several other small post or posthole features were found in the vicinity of the second anvil base. In particular, a large posthole was identified about 12 feet west of the base that was thought to be the post for the "fulcrum" for the hammer; this post would have been similar in size and location to the intact wooden post identified as the "hammer beam anchorage" east of the first anvil base.[77] Just west of the posthole was a "pile of stone" measuring about five by two feet; this feature was not identified as to possible function. To the north of the second anvil base, a narrow, linear feature of stones ran from the edge of the wheel pit on the second waterway to the west for approximately 20 feet.[78] This possible wall fea-

Due to copyright restrictions, this image is not available in the on-line version of this publication.

6.13 The first wheel pit at the refinery forge excavation. (Photograph 1697 from the Roland W. Robbins slide collection, Saugus Iron Works. August 1952. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

ture, two stones wide in some places, appeared to divide the area between the second anvil base and the post features in the northeastern corner of the building.

Finally, the excavation of the forge area revealed the impressions of several possible wooden sill elements along the northern edge of the building. These elements, along with the waterwheel pits framing the east and west sides, helped to determine the approximate footprint of the refinery forge building.

The Slitting Mill

As noted above, excavation of the area thought to contain the slitting mill was begun in October 1952, as Robbins and crew worked east from the refinery forge site and along the Bridge Street right-of-way.[79] Throughout November and December, Robbins focused on identifying the slitting mill site and on excavating the wharf or dock area to the south.[80] In early December 1952, he noted that he "did a bit of work in the slitting mill area. [I] outlined the remains of the charcoal bed in the northerly area of possible slitting mill site."[81] He also excavated a test trench "through to the side of the middle stone well in the slitting mill area to determine the possible period of this well."[82] In mid-December, Robbins and Fitch spent several days going "over details of slitting mill and forge layouts." Robbins notes that they "agreed that extensive digging should be done now at 3rd water way crossing Bridge St, to determine the possibilities of wheel pits having been in that area."[83] A little later in the month, excavations along the third waterway caused Robbins to speculate on the size of the waterwheel and pit, noting the

> possibility of an 18' overshot wheel at the slitting mill area. I told him [Fitch] that if we are to accept what appears to be wheel pits in the 3rd waterway on lower Bridge Street for possible slitting mill activity, then I believe its wheel or wheels may have had a diameter of nearly 18'. This is based on the known elevations of the bottom of the waterway, the bottom of the water basin in Chesley's backyard and the minimum elevation for a working surface to the west of the 3rd waterway.[84]

As December ended, Robbins reports he and Fitch examined the "3rd waterway area, test trench easterly from its possible slitting mill site to west of 3rd waterway, etc." Fitch, he writes, "thinks the chances are good that the slitting mill was just east of the forge."[85]

In January 1953, Robbins met with Hartley, Fitch, and Attwill to discuss the third waterway crossing Bridge Street.[86] The group worked with the evidence of the waterway and wheel pits and the negative results of testing east of the waterway and "all agreed that undoubtedly the wheel pits found there were for slitting mill activity. It was also agreed that the working units were to the west of the wheel pits, just east of the forge."[87] The discussion also helped to confirm Robbins' speculation that a slitting mill in this

Whereof those [bars of iron] they intend to be cut into rodds, are carried to the slitting Mills, where they first break or cut them cold with the force of one of the Wheels into short lengths; then they are put into a furnace to be heated red hot to a good height, and then brought singly to the Rollers, by which they are drawn even, and to a greater length; after this another Workman takes them whilst hot and puts them through the Cutters, which are of divers sizes, and may be put on and off, according to pleasure; then another lays them straight also whilst hot, and when cold binds them into faggots, and then they are fitting for sale.

Robert Plott, *The Natural History of Staffordshire,* 1686, p. 163.

Due to copyright restrictions, this image is not available in the on-line version of this publication.

6.14 The first anvil base and sills after removal from the refinery forge site. (Photograph 1521 from the Roland W. Robbins slide collection, September 1952, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

location would have "had but one waterway."[88] H. R. Schubert comments on the single waterway in a February letter to Hartley:

> I am extremely interested in the discovery of one single watercourse for the slitting mill. This would coincide with an idea of mine that the early slitting mill which is mostly termed here a cutting mill, was a much simpler device than the publ. by Swedenborg & Emerson.[89]

In March, Robbins began excavations in the area east of the forge and west of the third waterway. He notes that "this work will be done manually, removing all fill soils to the natural sub-surface which can be carefully studied for evidence of gear pits or other slitting mill activity."[90] This work turned up a stone feature running roughly east–west across the suspected site of the slitting mill.[91] In early April, he spent much of a day examining the south side of the slitting mill site, concentrating on the "charcoal bed and stone work located there."[92] The "large" charcoal bed feature was located at the south edge of the slitting mill site and described by Robbins as "a bowled-out area here, having no evidence of hearth stones about it."[93] The bottom of this feature contained a layer of "clinker material [remains from burning coal] . . . about six inches thick in some places."[94] Robbins also reported examining a "semi-circular stone formation just southerly of the charcoal bed."[95] The charcoal bed, or firebed, as he came to call it, was 20 ½ inches deep. Robbins notes that

> at the very bottom was the 5" of clinkers from earlier activity; on top of this was the 1"-1 ½" bed of charcoal, on top of which was the ½" – 1 ½" strata of lime, which had the 13 ½" of burned materials, including slag, metal waste impurities and clinkers with considerable metal in them.[96]

Robbins interpreted this feature as "some form of open-pit fire activity," but its actual purpose remained a mystery.[97]

Robbins and his colleagues puzzled over the charcoal bed feature as they believed that charcoal was not typically used for the heating processes necessary in a slitting mill. Moreover, this activity did not typically produce clinker or waste impurities of the type found beneath the charcoal. Because of this they initially considered the feature to be related to forge activities.[98] Subsequent research indicated that charcoal was definitely used for heating metals for slitting and rolling activities and a reference in Diderot's encyclopedia indicated that "heating activity at slitting mill ***did*** create an impurity."[99] Thus, while it appeared that this feature could be related to the slitting mill operation, its purpose remained unclear.

Despite the obvious advantages of the water hammer, there were limits to what it could do. It could not draw bars to less than ¾ inches square, because they were too flexible when hot and cooled quickly. For this reason, if small bars were required, it was necessary to have recourse to a slitting mill.

H. R. Schubert, *History of the British Iron and Steel Industry from c. 450 B.C. to A.D. 1775,* p. 304.

Due to copyright restrictions, this image is not available in the on-line version of this publication.

6.15 The clay mound and stone hearth features at the slitting mill site. (Photograph 2147 from the Roland W. Robbins slide collection, May 1953, Saugus Iron Works. Courtesy The Thoreau Society® Collections at the Thoreau Institute at Walden Woods.)

By late May, Robbins was identifying the "semi-circular stone formation," located south of the charcoal bed, as a "stone hearth."[100] In a meeting with Robbins, Fitch "said the stone hearth suggested to him the blacksmith activity which was associated with the slitting mill, this work repaired the cutters, etc., and other slitting mill machinery."[101] Robbins discussed a new feature that he identified as a "clay mound, about 7 ½ feet northwest of the stone hearth. . . ."[102] In June, Robbins reports that he had identified several "Indian ash pits" to the south side of the slitting mill; they were found below the "working surface" of the area.[103] He continued to examine the slitting mill site over the next month with particular focus on the group of features to the south of the site area. Project engineer Steve Whittlesey took over this work upon Robbins' abrupt resignation on July 31, 1953, and assisted the architects with finalizing a plan for the reconstructed slitting mill building. Although Whittlesey clearly continued to work in this area after Robbins' departure, few records of his excavation activities survive.[104]

Summary of Slitting Mill Features

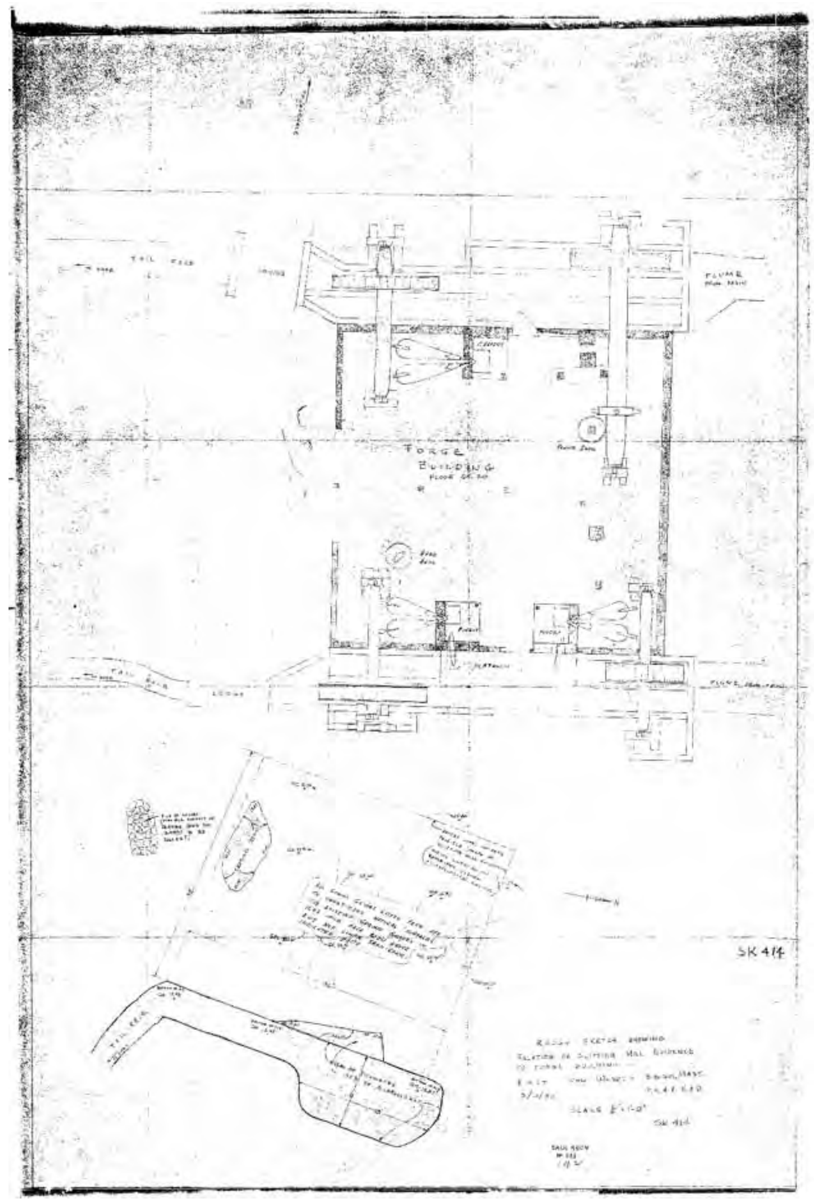
In marked contrast to the refinery forge excavations, the examination of the suspected slitting mill site revealed few features that could be definitively linked with a slitting and rolling mill operation. In addition to the third waterway crossing Bridge Street and its wheel pit, the excavations revealed a linear stone feature, a large charcoal bed, a possible stone hearth, and an unidentified clay mound feature. Several artifacts in the collection also speak clearly to the operation of a slitting mill, although no specific provenience information is available for these objects.

The principal evidence guiding the exploration of the slitting mill site was the location of the third waterway. It crossed Bridge Street approximately fifty feet east of the second refinery forge waterway, suggesting that the third watercourse must have powered the slitting mill. This interpretation was reinforced by the identification of a sizable waterwheel pit in early 1953. However, the watercourse and wheel pit presented some interpretive questions because they were not parallel with the refinery forge watercourses, but at an angle of approximately thirty degrees with these features. The wheel pit itself measured approximately 18 feet north-south by ten feet east-west; no intact wooden elements were found in association with this wheel pit.[105] Subsequent work east of the wheel pit failed to identify any other features. Work to the west and south provided additional clues that supported the speculation that the building stood west of the wheel pit, between it and the 2nd forge watercourse. However, the location and angle of the wheel pit would have required squeezing the building into an awkward space immediately adjacent to the forge.

The only substantial feature in what eventually was interpreted as the footprint of the reconstructed slitting mill building was a linear stone feature. This feature ran east-west across the site, starting from the southern end of the wheel pit feature. Although its function was never determined, this feature might

In the slitting mill: 1 pair of Rowles, 1 pair of Cutters wth Collers and geers Compleat at work, 2 pair of spare Rowles, 12s.; 1 pair of great Cutters four corner Collers[,] 1 li 6s. 8d.; 3 greate brasses, a li; 2 lesser brasses, 13s . . . .

"An Inventory of the stock and tools at the forge at Hammersmith taken Dec. 20, 1650," ***Records and Files of the Quarterly Court of Essex County, Massachusetts***, Vol. 1, p. 294.



6.16 Rough sketch showing relation of slitting mill evidence to forge building by Perry, Shaw, and Hepburn, Kehoe and Dean, March 10, 1953.

have been some type of support wall for the building or a support for an internal wooden frame that carried the slitting machinery (like a hurst frame in a grist mill).

A "charcoal bed" feature was identified south of the linear stone feature, approximately halfway between the second and third watercourses. This feature measured 12 feet east-west by five feet north-south, and had a bowl-shaped profile. Although Robbins labeled the feature "charcoal bed," the stratigraphic profile revealed several layers of differing material including a five-inch layer of clinkers at the bottom, a one and-a-half-inch layer of charcoal, a thin stratum of lime, and some 13 inches of various types of burned matter, including metal waste and slag.[106] Robbins interpreted this feature as "some form of open-pit fire activity" and came to see it as related to the nearby "stone hearth" feature.[107]

Approximately ten feet south of the "charcoal bed" was a feature consisting of stones and measuring about eight feet east-west by three feet north-south. Robbins thought that the feature might be some type of heating oven or furnace used to heat bars for the slitting mill or for some type of "blacksmith activity which was associated with the slitting mill, this work repaired the cutters, etc., and other slitting mill machinery."[108] The close association of the stone feature with the charcoal bed and its evidence of heating activity lend themselves to this sort of interpretation, although a specific function was never agreed upon by Robbins and the other researchers.

Robbins identified another feature of uncertain purpose as a "clay mound, about seven and a half feet northwest of the stone hearth . . . ."[109] Measuring approximately three feet in diameter and about 20–24 inches high, this feature was located about halfway between and at the western edge of the "stone hearth" and the "charcoal bed" and may have been related to this feature grouping.

In addition to these features, two artifacts in the collection, a spacer (SAIR # 2916) and a "squid" (SAIR #2463), relate specifically to the slitting mill operation. The "squid" provides absolute proof that a slitting mill operated at Saugus. The "squid" is actually a flat bar of metal that has been partially slit in a slitting mill; it has a solid flat body and nine thin "tentacles" or partially cut metal rods. Researcher Cyril Stanley Smith examined the Saugus squid and reported that it was the result of being jammed in the mill while it was being cut. "Since it was only partially slit," Smith notes, "it has preserved impressions of the cutters and gives other evidence as to the design of the mill."[110] No exact provenience information exists for this artifact, although Smith's report includes a photograph of the squid with the caption "found on the site of the slitting mill at Saugus."[111]

Smith's careful analysis concludes that the piece demonstrates that the slitting mill at Saugus "produced nail rod by slitting a forged and perhaps rolled flat bar (about 2.55 inches wide and 0.29 inches thick) into nine nail rods averaging about 0.26 inches wide."[112] He further notes that "there were five cutting

At Professor Hartley's request, we are sending you a very rough diagrammatic plan showing the relation of our "Slitting Mill" evidence to the forge and giving a few dimensions and elevations. It is very hard to explain the peculiar angle taken by what appears to be quite definitely a wheel pit and the only wheel pit which has turned up in the evidence anywhere on the site (slitting mill). We also enclose a print of Drawing SK 15 which shows at smaller scale the location of the possible Slitting Mill. On this latter drawing, the Slitting Mill is indicated as having two wheels on one side and mechanism similar to that shown by Swedenborg. Professor Hartley is quite reluctant to adopt such a plan as yet.

Conover Fitch, Jr., to H. R. Schubert, March 10, 1953.

6.17 The partially slit bar (known as the squid) from the slitting mill operation. (Photograph 1180 by Richard Merrill, 1954.)

discs mounted into one of the intermeshing slitting rolls and six in the other. The discs were perhaps 12 inches diameter and were fitted with considerable slack, which resulted in a 40 percent variation in the width of the slit rod."[113] The distance between the cutting discs, which regulated the thickness of the rod being produced, was controlled by spacers that were inserted between the discs. One of these spacers was discovered in the Saugus collection and fits both the description offered by Smith and an illustrated example in Diderot's mid-eighteenth-century ***L'Éncyclopédi***é. Smith describes the cutting discs as ten inches in diameter, with "6 ½-inch diameter spacing discs between them, the assembly being held together by four round pins."[114] Although it is not provenienced in the Saugus collection, this object exactly matches the description, down to the holes for the four pins used to hold the cutters and spacers in place.[115]

Summary

From 1950 to 1953, Robbins and his crew excavated a series of features east of the furnace that were interpreted as the remains of the refinery forge. This evidence, including two watercourses and associated wheel pits, two large anvil bases, a series of posts or "uprights," and two stone features, provided conclusive evidence of the refinery forge operation. From 1952 to 1953, Robbins, and later Whittlesey, worked in an area east of the refinery forge that came to be interpreted as the slitting mill. The evidence for the slitting mill, although much less conclusive than the forge features, included the third waterway crossing Bridge Street and its wheel pit, a linear stone feature, a large charcoal bed, a possible stone hearth, and an unidentified clay mound feature. In addition, two artifacts, the squid and a spacer, in the collection point to the operation of a slitting mill.

These two buildings were central elements in the integrated ironworking operation at Saugus and the First Iron Works Association and American Iron and Steel Institute strongly desired to include them in the reconstructed ironworks. Although both reconstructed buildings are based on archeological and historical evidence, the refinery forge is clearly the more accurate because of the level of information available to the architects. Nevertheless, in both cases, the architects ignored some archeological features that could have informed their designs. Other aspects of the design were very speculative due to a lack of archeological evidence.