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SEVENTEENTH CENTURY BRICKMAKING AND TILEMAKING AT JAMESTOWN, VIRGINIA¹

by J. C. HARRINGTON*

*"Here's my furnace; let none say it ill,
For nobly it serves its turn,
And here, the maker, with easy skill
And prudence my bricks I burn.*

*Away with the stones you have bought, rash wight,
For the house you have builded high
Stands naked now to the tempest's might.
Then come to my kiln and buy."*

From THE BRICKMAKER'S SONG²

DOCUMENTARY evidence to the contrary, the legend persists that bricks were brought over to the Virginia Colony as ship ballast. But students of Jamestown history have long recognized that most of the bricks used in the Colony, even in the earliest days, were made literally on the spot.³ This refers, of course, to the regular sized bricks and not to the small Dutch bricks, presumably imported from Holland and used to some extent at Jamestown, particularly for cellar floors and fireplace hearths.

It was clearly the intent of those directing the various English colonizing ventures that the settlements would be of a permanent nature, with living conditions as nearly as possible like those back in England. Brickmakers,

¹All of Jamestown Island, with the exception of approximately 21 acres, is now a part of Colonial National Historical Park, administered by the National Park Service, United States Department of the Interior. The 21-acre tract, which was designated a National Historic Site in 1940, belongs to the Association for the Preservation of Virginia Antiquities, which has administered the tract since 1893.

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²Nathaniel Lloyd, *A History of English Brickwork* (London and New York, 1928), 29-30.

³Bruce, after reviewing the documentary evidence concerning brickmaking and the use of bricks in Virginia during the seventeenth century, makes the following statement: "It would appear that all bricks used in Virginia in this century were manufactured there." Philip A. Bruce, *Economic History of Virginia in the Seventeenth Century* (New York and London, 1896), II, 134. A very good discussion of the manufacture and use of bricks, as well as other building materials, is furnished by Henry C. Forman, *Jamestown and St. Mary's: Buried Cities of Romance* (Baltimore, 1938). Forman concludes: "It appears that hand-made bricks were manufactured at Jamestown from the first." *Ibid.*, 83.

limemakers, bricklayers, and other building tradesmen were among the first settlers, both at Jamestown and at Sir Walter Raleigh's earlier settlements on Roanoke Island.

The first bricks were undoubtedly used as nogging, or filler between structural timbers, and for chimneys, and it is probable that bricks were not made in any large quantities during the first few years at Jamestown.⁴ Even so, bricks were made in sufficient quantities to be exported to the Bermudas in 1621, where they were traded for fruits, fowl, and other commodities.⁵

As the Colony became better established, brick was used more extensively, although Secretary Kemp's house, erected in 1638, was possibly the first house at Jamestown constructed entirely of brick. It was about this same time that instructions were issued to Governor Wyatt that everyone having 500 acres of land was to build a house of brick.⁶ A legislative order, issued in 1662, called for the building of 32 brick houses and required that no more wooden houses were to be built at Jamestown.⁷ As might be expected, this order was not popular, and in 1671 permission was granted to repair wooden houses so long as no new ones were built. The 32 new brick houses were certainly not built, for at the time of Bacon's Rebellion in 1676, Jamestown was said by a contemporary writer to have "some 16 or 18 houses, most as is the Church built of brick."⁸

There are many other documentary references to the use of bricks, both in houses and other structures, such as the brick fort and various public buildings. Probably the most notable brick structure is the church, the ruined tower of which is the only structure of old Jamestown remaining above ground.

In addition to the scattered references to the use of brick during Virginia's first century, there is the more concrete evidence of the many brick foundations excavated at Jamestown. The reasons for the extensive use of brick in the Virginia Colony, as well as the ways in which they were

⁴Probably the first extensive use of bricks in the Virginia Colony was at the settlement of Henricopolis on Farrar's Island in the James River near the present city of Richmond. There, in 1611, Dale laid out a town of three streets with several houses, the first stories of which were of brick made on the spot by brickmakers brought by Sir Thomas Gates from England.

⁵Bruce, *Economic History*, II, 137.

⁶"Virginia in 1638-39," *Virginia Magazine of History and Biography*, XI, 55. Gov. John Harvey's double house, probably built about 1632 and purchased by the Colony in 1641 for use as its first state house, may well lay claim to being the first brick house at Jamestown.

⁷William W. Hening, *The Statutes at Large; Being a Collection of All the Laws of Virginia . . .* (New York, 1823), II, 172.

⁸Peter Force, comp., *Tracts and Other Papers Relating to the Origin, Settlement, and Progress of the Colonies in North America, From the Discovery of the Country in the Year 1776* (Washington, 1836-1846), I, Tract XI, "A Narrative of the Indian and Civil Wars in Virginia," 25.

used, is an absorbing subject, but must be left for a future article, since we are concerned here only with the manufacture of clay building materials at Jamestown.

Although the extensive use of bricks is not proof that they were locally made, there are several accounts relating to brickmakers practicing their trade at Jamestown. Brickmaking was a highly respectable trade and many brickmakers were men of means in the Virginia Colony.⁹ This is not surprising, since bricks sold for 15 shillings per thousand in 1668, although the price dropped to as little as 8 shillings a few years later.¹⁰

In view of the clear evidence for the extensive manufacture and use of bricks at Jamestown, it is surprising that no document has been found containing an explicit reference to a brick plant in operation there. In fact, the writer knows of only one specific reference to a brick kiln on Jamestown Island. It is found in the patent issued in 1637 to Alexander Stomer, "brickmaker," for a parcel of land at the western end of the Island "neare the brick kill."¹¹

Unlike bricks, clay roofing tiles were not used extensively at Jamestown, in spite of the Act of 1662 which required that the roofs on 32 new brick houses, ordered to be built at that time, were to be covered with slate or tile.¹² In "A Perfect Description of Virginia," printed in 1649, an anonymous writer states that the settlers have "Lime in abundance made for their houses, store of Bricks made, and House and Chimnies built of Brick, and some Wood high and fair, covered with *Shingell* for *Tyle*, yet they have none that make them, wanting workmen; in that trade the Brickmakers have not the art to do it, it shrinketh."¹³ The obvious conclusion would seem to be that the brickmakers at Jamestown in 1649 did not have the art of making roofing tiles which would not shrink. However, in the same account, the writer lists "tyle-makers" as one of the tradesmen who "gaine much by their labours and arts."¹⁴ Furthermore, it is recorded that the great hail-storm of 1684 destroyed tile roofs at Jamestown.¹⁵ Archeological evidence from the excavating of several house sites at Jamestown would indicate

⁹Bruce, *Economic History*, II, 141.

¹⁰*Ibid.*, 142.

¹¹Virginia Land Patents, Patent Book 1, 466-467. The final *n* in kiln became silent in Middle English, hence the frequent spelling *kill*. Other spellings found are *kylle*, *kyl*, *kil*, *kelle*, *kell*, *keele*, and *kiele*. The older form, *kiln*, derives from Old English *cyline*, thence Middle English *kulne* and *kylne*.

¹²Hening, *Statutes*, II, 172.

¹³Force, *Tracts*, II, Tract VIII, "A Perfect Description of Virginia . . ." 7.

¹⁴*Ibid.*, 7-8.

¹⁵Forman, *Jamestown*, 90.

that a fairly large proportion of the better houses at Jamestown, especially those constructed during the last half of the century, were roofed with either tile or slate. Against this evidence, however, is the statement in Robert Beverley's *History*, published in 1705, to the effect that very little tile was used in Virginia for roofing.¹⁶

Discovery of the remains of two brick kilns in the course of archeological excavating at Jamestown confirms the documentary evidence for the local manufacture of bricks.¹⁷ In addition, these discoveries provide, for the first time, information concerning the technical process employed in brick-making in the Virginia Colony during the seventeenth century. Since roofing tiles were also being burned in one of the kilns, there is now proof that they, too, were made at Jamestown.

Remains of the first kiln discovered at Jamestown are located near the ruins of William Sherwood's house in the "New Towne" section (Brick Kiln "A," Figure 1). The kiln had been built directly on the ground, and consequently only fragmentary sections remain. Portions of several benches, each containing a few bricks, indicate that the fire chambers, or arches, were approximately 20 inches wide. The bricks were stacked in herringbone fashion, two bricks wide, between the fire chambers. This, apparently, was a relatively large kiln, containing at least 12 arches, with a depth of about 18 feet. It is possible, however, that these remains represent two adjoining kilns, rather than one large one. Because of the very fragmentary condition of the remains, little more can be said concerning this kiln.

Remains of the second kiln, designated "Structure 102" are located on a triangular tract of land lying along the "Great Road"¹⁸ about 200 feet northeast of the old church (Brick Kiln "B," Figure 1). Careful study of all available records prior to the excavating gave no hint that a brick kiln might be found in this part of the site. As mentioned earlier, there is one

¹⁶Robert Beverley, *The History and Present State of Virginia* (Chapel Hill, 1947), 290.

¹⁷A broad program of research was carried on by the National Park Service at Jamestown from 1934 through 1941, including both archeological exploration and historical research. Only about one-third of the principal town area has been explored thus far, although several outlying sites have been excavated. Remains of the first kiln were discovered in 1935 in the "Country House" tract. The second kiln, with which this article largely deals, is located on the grounds of the Association for the Preservation of Virginia Antiquities. Excavation of this ruin, made possible through a cooperative agreement with the Association, was carried on in 1941 under the supervision of the author.

¹⁸From the founding of Jamestown in 1607 until some time in the nineteenth century, the island was connected with the mainland, although at times precariously, by a narrow isthmus. During this entire period, the highway from Jamestown to the mainland extended from the town-site northward across this isthmus. It was referred to variously as the "Great Road," "Main Cart road," "Cartway," "Main Road," "great old Road," and "way leading toward the Mayne." Charles E. Hatch, Jr., "The Great Road," *The Virginia Magazine of History and Biography*, Vol. 57 (January, 1949), 14-21.

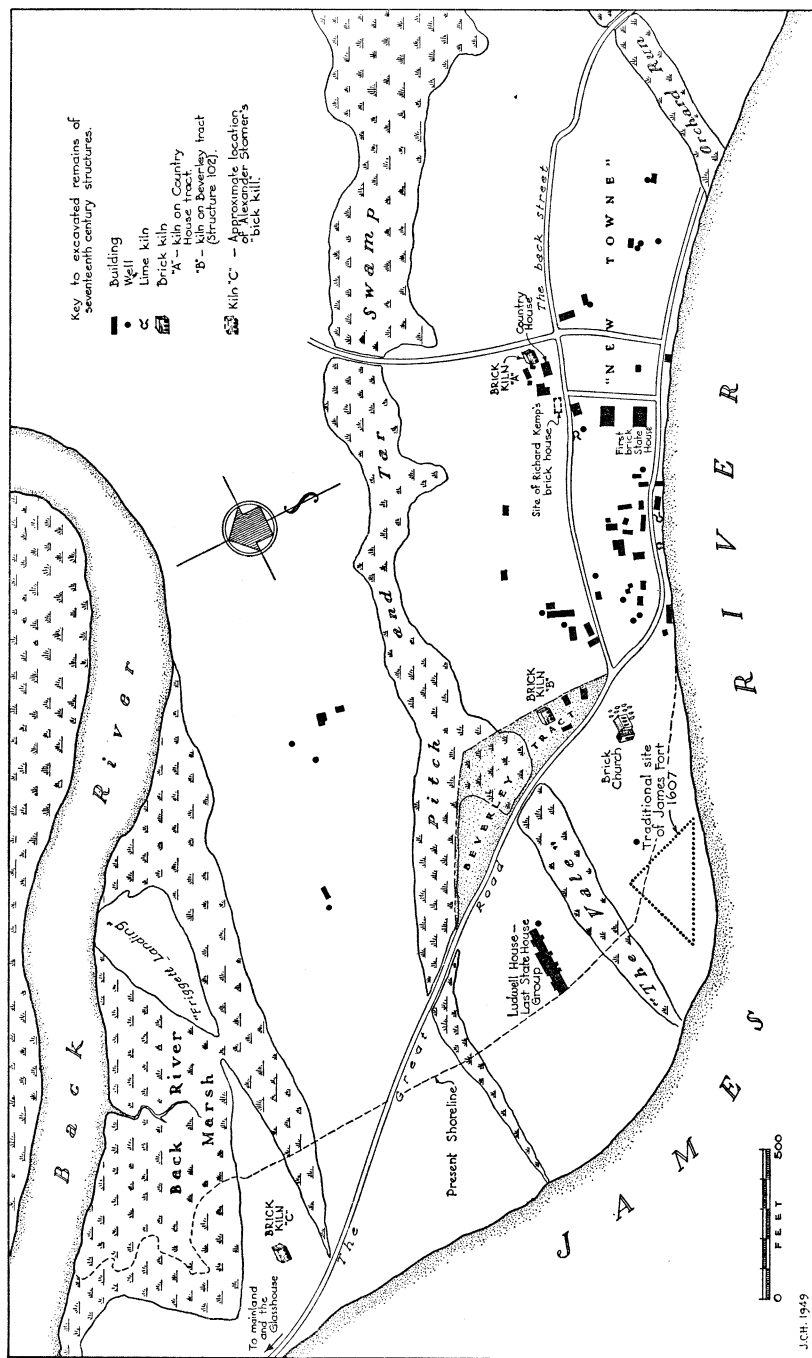


FIGURE I — Map of western end of Jamestown Island, showing location of 3 seventeenth century brick kilns.

specific reference to a brick kiln on Jamestown Island, the one referred to in the Stomer patent. It could not conceivably be the kiln excavated in 1941, as the Stomer tract is nearly half a mile away.

The structure in question is located within the 3-acre tract patented by Robert Beverley in 1694.¹⁹ The records, in addition to locating Beverley's property in relation to the "Main Cart road," "Pitch and tarr Swamp," and adjoining property, reveal that he built a house there sometime around 1694 and sold the property in 1718. No mention is made of a brick kiln in these records, or in those pertaining to adjacent property of the same general period. Nor were there surface indications of any subsurface remains in this area when excavating began in the summer in 1941.²⁰

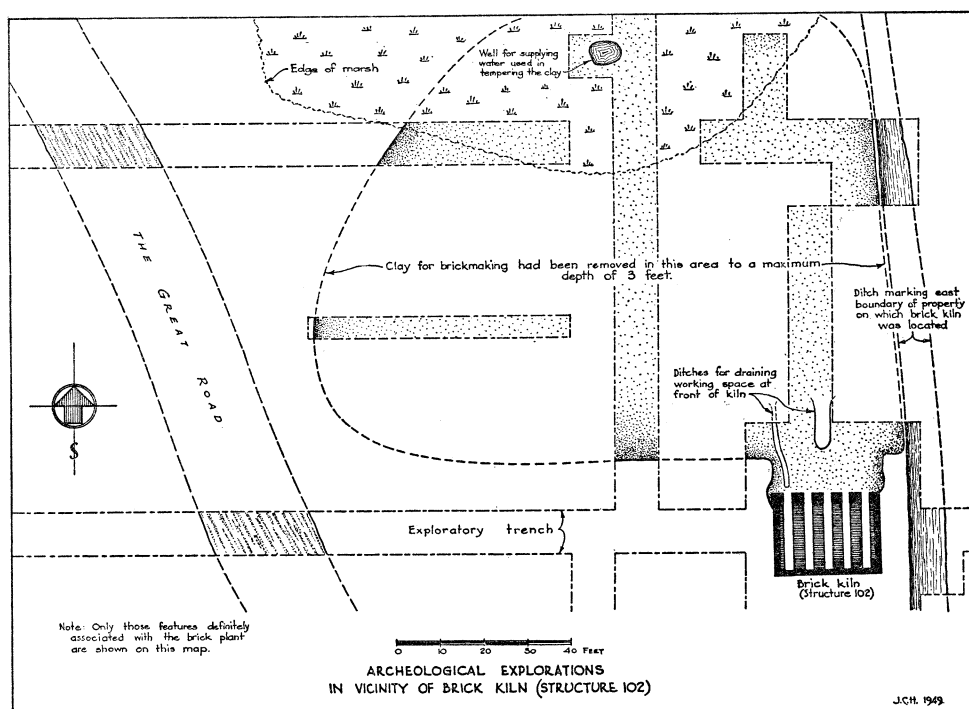


FIGURE 2 — Archeological explorations in vicinity of Brick Kiln "B" (Structure 102).

¹⁹Virginia Land Patents, Patent Book 8, p. 400.

²⁰A French military map, made in 1781, indicates two structures, presumably houses or ruins, at the southern point of the Beverley tract. Colonel Desandrouins, "Plan du Terrain a la Rive Gauche de la Riviere de James vis-a-vis James-Town en Virginie ou s'est livre le Combat du 6 juillet, 1781, entre l'armee Americaine Commandee par le Mes de la Fayette et l'Armee Angloise aux ordres du Lord Cornwallis." Manuscript map in the Map Division, Library of Congress. Lyon G. Tyler (*The Cradle of the Republic*) shows a single ruin as still visible. Grading in connection with the construction of the tercentenary Monument in 1907 probably covered any surface evidence of old building sites.

This particular area was selected for excavation as the first exploration in the grounds of the Association for the Preservation of Virginia Antiquities in order that key landmarks could be located as reference points for determining the exact position of certain land tracts and structures described in old land records.

Excavations began with a test trench running east and west across the assumed location of the triangular Beverley tract. This first trench was extremely fruitful, for, in addition to locating the "great road" on the west side of the tract and a property line ditch bounding the east side, the trench went squarely over the center of the brick kiln (Figure 2). Since the present article is concerned only with the kiln and related features, no detailed description of other remains encountered will be given here. Briefly, the excavations carried on in 1941 consisted mainly of preliminary exploration of the area in the south apex of the triangular Beverley tract, primarily by means of a series of trenches, 10 feet in width, spaced at approximately 50-foot intervals.

As a result of this test trenching, several interesting remains were encountered, none of which were fully explored, with the exception of the kiln. These included, in addition to those previously mentioned, two building foundations and evidences of a third, two wells, three graves, and several unidentified features. By locating certain critical points on the boundary of the Beverley and adjoining tracts, such as ditch corners, the exact location of the entire Beverley tract was determined. This, in turn, established the location of other adjacent property referred to in seventeenth century land records.

Excavation of Kiln and Related Features

First indications of the brick kiln ruins were the side walls of the structure encountered in the initial 10-foot exploratory trench. As usual at Jamestown, the foundation walls were first observed approximately eight to twelve inches below the present ground, or at the level of the deepest disturbance from cultivation. There were two distinct zones of cultivation; the upper one, about six inches thick, representing the depth of modern plowing. The deeper disturbance may have resulted from tobacco cultivation.

The first trench, which crossed the structure almost at right angles, was carried down in order that a full cross-section could be obtained showing the stratigraphic nature of the fill within the structure.

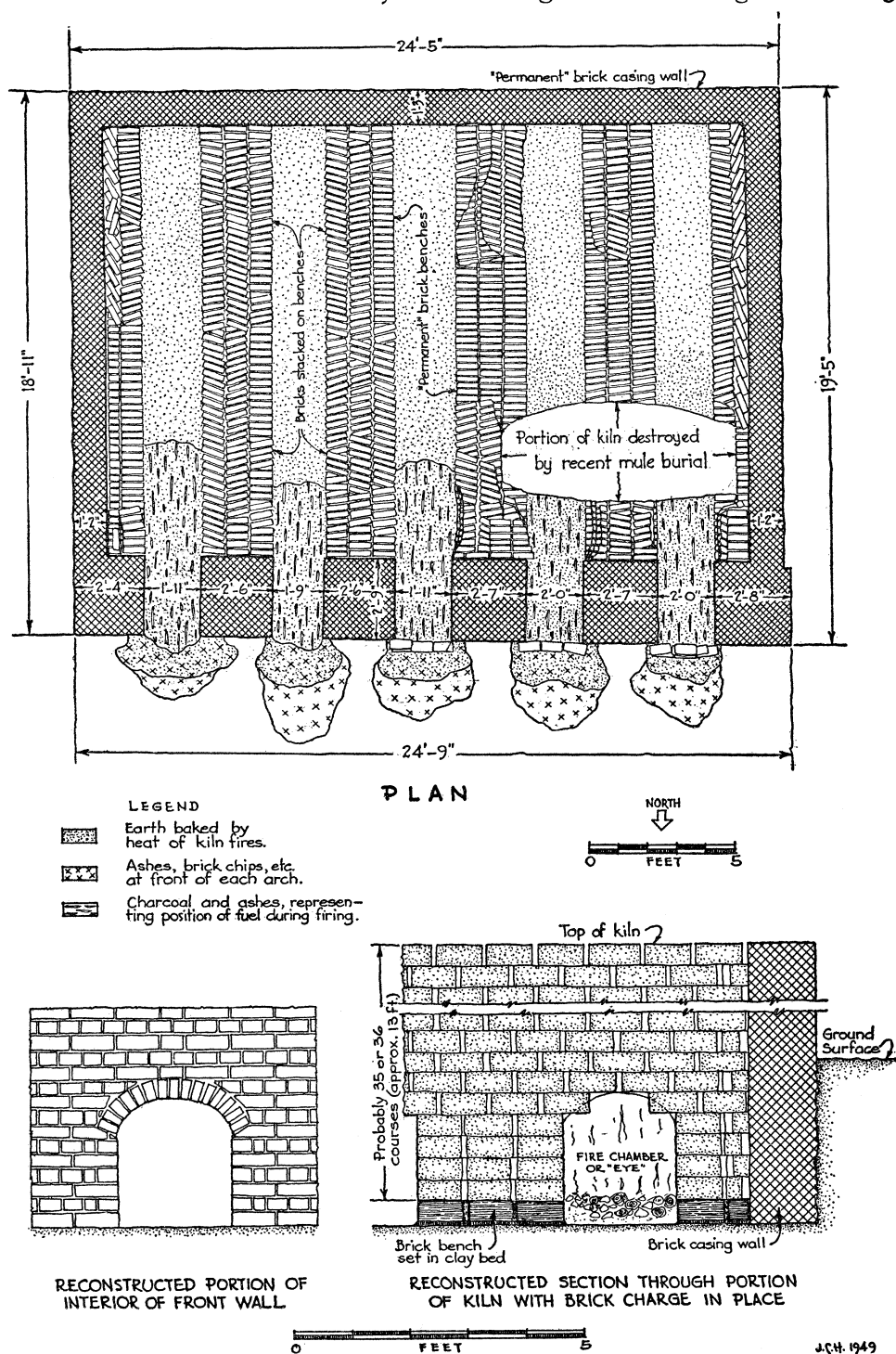


FIGURE 3 — Remains of Brick Kiln "B" (Structure 102).

It was assumed when the two walls were first uncovered that this was a house foundation. The ruin was recognized as a brick kiln, however, upon discovery of layers of bricks between the walls, laid on edge without mortar. In addition to the bricks, flat roofing tiles were found in the kiln, placed there for firing along with the bricks.²¹ Examination of the fill within the structure revealed very little concerning its original appearances, period of use, or date of abandonment. The lower layers were composed almost entirely of decomposed bricks and tiles which had previously been stacked in the kiln preparatory to firing. Most of the tiles and bricks were lightly burned, while some of the tiles were entirely unburned, being soft and pliable when wet.

Above this layer of crumbled, underfired or unfired bricks and tiles, was a deposit of mixed earth, brickbats, and miscellaneous refuse. Some very interesting articles were found in this upper layer, but none of them can be associated with the kiln. They undoubtedly were dumped in the depression at a later date and could have come from any part of the site. There is evidence that the kiln stood as an exposed ruin for some time before the above-ground portion was razed and the depression filled.

The unfired state of some of the tiles and the lightly burned condition of the others, as well as the bricks, would suggest that the kiln had been abandoned shortly after the burning process began. A second, but less plausible, explanation is that the kiln had only been partially readied for the next charge, using underfired bricks from a previous charge in the bottom layers. This explanation would mean that the kiln had been abandoned before the last charge had been placed and the fires started. In any event, the abandoned kiln stood for some time in a ruined condition, most of the bricks eventually being carried away for other uses. Part of the front wall apparently collapsed some time after the kiln was abandoned, leaving a jumbled pile of bricks lying on top of a layer of fill outside the kiln. A half-inch layer of silt, obviously washed in during rains, lay directly on the floors of the fire chambers and over the charcoal and ashes in the arches. This shows that some time elapsed before the abandoned kiln was disturbed.

After completing the first trench across the kiln, the excavation was extended, eventually uncovering the entire structure, as well as a limited space around it (Figure 2). In addition, the area in front of the kiln was explored well beyond the edge of the present marsh, some 100 feet to the north. This area, bounded on the south by the kiln, on the north by the

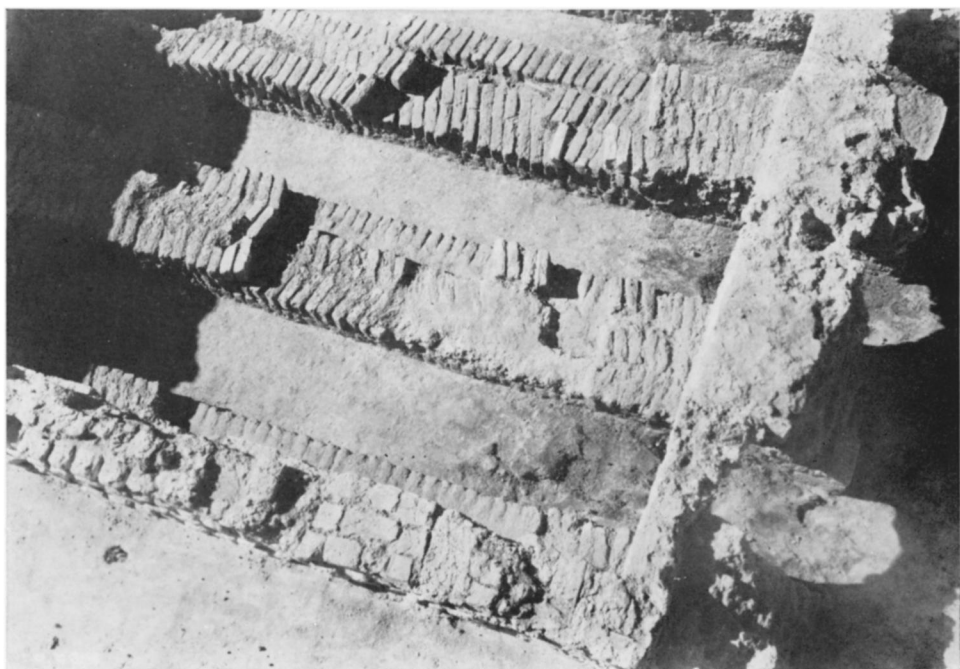
²¹It is known that in England and other European countries bricks and clay roofing tiles were made by the same artisans in the same plant, and fired in the same kiln.



Overall view of Brick Kiln "B" (Structure 102) from the front, or north, side at completion of excavation.



Overall view of Brick Kiln "B" from the rear at completion of excavation.



Looking down on portion of Brick Kiln "B"; front wall of kiln at right.



Close-up of portion of interior of Brick Kiln "B," showing how the bricks were stacked in the kiln.

marsh, on the east by the ditch marking the eastern boundary of the Beverley tract, and on the west by the "great road," had provided the clay used in making the bricks and tiles manufactured at this plant.

The earth in this area of approximately one-third of an acre, had been removed to varying depths, up to three feet in some places (Figure 2). The remaining portion of the tract — the triangle of high ground south of the kiln — was occupied by other structures, probably houses and dependencies, as revealed in a partial excavation of that area.

It appears, therefore, that most, if not all, of the available land within this particular 3-acre tract from which earth could have been secured for brickmaking was exploited to that end. It is estimated that roughly 825 to 850 cubic yards of earth were removed from the pit. Assuming that some of this was topsoil not suitable for brickmaking, the pit would have furnished enough clay for approximately 500,000 bricks.

The pit had been filled in again, apparently in two operations. The lower deposit, averaging six inches to one foot, was mixed clay and topsoil, and contained relatively little cultural material. The upper fill, on the other hand, contained considerable more brick chips, broken glass and ceramics, and other refuse. Most of it was seventeenth century material, but some dated from the following century. Obviously the pit had been filled intentionally after the abandonment of Jamestown, and probably for the purpose of farming the land.

At the north side of the pit near the edge of the marsh was discovered a circular excavation nearly five feet deep. Although this depression does not resemble the typical dug wells found in other parts of Jamestown, it would have contained from one to three feet of water at all times, and undoubtedly served as the source of water for tempering the brick clay.

Description of Kiln Ruins, Structure 102

Overall dimensions of the outside walls of the kiln are roughly 24½ feet in width by 19 feet front to back. Inside dimensions are approximately 22 by 15 feet. The rear and two side walls average 14 inches in thickness, while the front wall, pierced by five segmental arched openings, is 34 inches at the bottom (Figure 3). This additional thickness was required for proper firing, the fuel being concentrated in the front of each fire chamber. A similar kiln, in operation in England in 1683, is described as follows:

This *Kiln* we build two Bricks and a half thick, sixteen *Bricks* long from inside to inside [12 to 13 feet] and 12 bricks over from inside and about fourteen or fifteen foot

high; at the botton we make two *Arches* three foot high, three *Bricks* broad, and seven *Bricks* long, that is five *Bricks* longer than the Wall of the *Kiln*, and so the sides will be a *Brick* and a half each; . . .²²

This English kiln is similar in size to the Jamestown one, except for the width, which is dependent, of course, on the number of arches. The front wall of the Jamestown kiln was thicker (4 bricks as against 2½), but this was made up for in the English kiln by building an extension on the arches to provide an adequate fire chamber at the front of each opening. The front wall of the Jamestown kiln probably was stepped back above the arches to a 14 inch wall.

The arched openings, or fire-holes, vary in width from 20½ to 23½ inches (2½ bricks), and in height from 20 to 26 inches, which is slightly smaller than the English kiln described above. Over the openings are single row-lock, segmental arches (Figure 3). The front five or six feet of each fire chamber contained a layer of charcoal and wood ashes, reaching a maximum thickness of about 4 inches near the back face of the front wall, and extending out a few inches in front of each opening. A portion of the clay floor in front of each arch had been burned a deep red for a distance of a foot or so beyond the opening. Charcoal, ashes, and brick chips were tramped into the clay floor some two to three feet in front of each fire-hole.

Three of the arches were partially closed off with bricks laid without mortar, from one to three courses high. It was assumed that these low walls served to control the air intake, just as cast iron covers were used in later times. It has also been suggested that they are the remnants of the seal that was placed over the fire-holes after firing so that the kiln would cool off without admitting sufficient air to damage the bricks. There is a third explanation, which the following contemporary account describes quite graphically: "[we] make the holes up with Bricks four Course high, to keep the Fire-Feeders shins from burning."²³

The kiln was prepared in the first place by excavating a level space in the side of the sloping ground the exact width of the kiln, leaving a working space at the front, or down-hill side. This space was kept dry by ditches emptying into the clay pit to the north (Figure 2).

Construction of an English kiln of the same period is described as follows:

When we begin a new *Brick Ground*, for want of *burnt bricks* we are fors't to build a Kiln with *raw Bricks*, which the Heat of the fire by degrees *burns*, and this will last

²²Lloyd, *A History*, 35. This and subsequent passages used from Lloyd, *A History* . . . (1928 Edition), were quoted by Lloyd from sources not available to the author of this article.

²³*Ibid.*

three or four year; but afterwards we make it with *burnt bricks*, which we reckon better, and we choose for it a dry ground, or make it so by making *Dreyms* round it.²⁴

The outer walls of the Jamestown kiln were laid directly on the excavated level area, and without any special footings. The back and side walls were laid against the vertical sides of the excavation. Extensive use of brickbats in these walls suggests that the bricks were either salvaged from other structures or were discards from earlier operations at this plant.

The front and rear walls were laid in regular English bond, whereas the side walls are quite irregular, the stretchers varying from half to whole bricks. Horizontal and vertical joints are about half an inch thick, or slightly more, and contain soft earth or clay. As has always been the practice in such kilns where fire-clay is not available, loam was used in place of mortar, since the lime would have destroyed the brickwork under the intense heat.

One or two entrances were usually provided in the side walls of the kiln for placing and removing each charge, but no evidence of such openings was found in the underground remains of this kiln. Nor was there any evidence that this kiln had been "scoved," that is, plastered with clay on the outside. Although contemporary records do not indicate that "scoving" was practiced in England, the scoved kiln has been used in America rather generally during the past two centuries.

The fire chambers extended straight back to the rear wall of the kiln, being the same width as the arches. The sun-dried bricks were stacked on permanent benches, or bases, between the fire chambers. Such bases of well-burned bricks were often used to prevent moisture rising up into the bottom courses of the charge and damaging these bricks before they were burned. The benches in this kiln were three bricks wide, the bricks laid on edge, end to end, and, like the walls, without mortar. The floors of the fire chambers were hard-packed, natural clay, burned deep red to a depth of several inches. These floors were about an inch below the bottoms of the permanent bench bases, or roughly level with the bottom of the exterior walls. Undoubtedly, the bases were laid in a thick bed of loam or clay to make them uniform and level.

On each of these bases were found from one to five layers of incompletely fired bricks. The bottom four layers were stacked on edge at a slight angle. Corbelling over the fire chambers began with the fifth layer, which, unlike the first four, was laid at right angles to the chambers. Each corbelled course overhung just half a brick, which would have formed a complete

²⁴*Ibid.*

arch with the third course. It would appear, therefore, that the fire-chamber was seven bricks high, including the permanent base, or approximately 28 inches, which is roughly the same height as the arched openings in the front wall. This conclusion is substantiated by the blackened and spalled areas on the rear wall, which reveal quite clearly the area directly exposed to the smoke and fire of the kiln.

All of the roofing tiles found had apparently fallen into the fire chambers from a higher level, none being observed in place on the benches. Consequently, it is not possible to say how they were originally stacked in the kiln.

There is no archeological evidence indicating the original height of the kiln. From contemporary English accounts and descriptions of other kilns of this type in later times, it is assumed that the kiln was between 12 and 15 feet high. The description of an English kiln, quoted earlier, gives its height as 14 or 15 feet. This same account mentions that the bricks were stacked in the kiln 35 or 36 courses high. Thirty-six courses in the Jamestown kiln would have made it about 13 feet high. On this basis, the kiln would have held approximately 50,000 bricks.

It is said that kilns of this type, usually referred to as "rectangular up-draft" or "Scotch" kilns, usually were not built to hold more than 40,000 bricks, and some held as few as 15,000. On the basis of the estimate that the clay from the pit was sufficient to make half a million bricks, it is apparent that at least 10 charges might have been burned in this kiln. It is also possible that additional earth was brought to this plant from other pits, particularly in view of its convenient location on the highway leading to the mainland.

Period of Operation and Ownership of the Kiln

There is no conclusive evidence, either historical or archeological, as to the period of the kiln's operation or its ownership. As mentioned before, none of the land records or other contemporary documents thus far discovered make any mention of a brick kiln being located in this part of Jamestown. The earliest known land record pertaining to the tract in which the kiln is located is the patent to Robert Beverley in 1694. Beverley, who was 21 years of age at the time, received the property for the importation of one person to the Colony. A patent to Nathaniel Bacon, Sr., recorded in 1683, for the tract to the east of Beverley's property, makes no mention of a brick kiln on the adjoining land. It would seem, therefore, that we are

safe in assuming that the kiln had been abandoned, and possibly covered over and forgotten, when Beverley acquired the property in 1694. There is archeological evidence that this process must have required several years. For one thing, a rather thick layer of sand accumulated in front of the kiln before a section of the wall collapsed and covered it.

Also, there is no archeological evidence which would give a clue as to the exact period within the seventeenth century when the kiln was operated. Undoubtedly the surest method of dating the kiln, lacking historical records referring to it, would be to identify the bricks in a dated foundation as having been made at this kiln. A detailed study of this sort cannot be made at the present time, since all of the excavated foundations have been covered over again for preservation until a suitable method of exhibiting them has been worked out. However, based upon all the evidence at hand, it is the opinion of the author that this brickyard operated around the middle of the seventeenth century.

How Bricks and Tiles Were Made at Jamestown

From a study of the bricks and tiles made at Jamestown, and from contemporary accounts of brickmaking and tilemaking in England, a fairly authentic description of the operation at Jamestown can be postulated.

The first step was the digging and preparation of the clay.

Before *Christmas* we begin to dig as deep as the *Earth* allows, and lay it as level as can be, and end before *Candlemass*, that it may lie mellow, that is, that the hard-lumps we dig may shake to pieces; which it will do either by help of *Rain* or *Frost*; when 'tis thus dug, we let it lie till *Lady Day* or *Easter*, when we seldom fear [for] fair weather. Then we water the *Earth* well, and temper it with a narrow Spade about five *Inches* broad, that the Workman may hold out, with which we dig it down, and then temper it with our bare feet till it is in good case to make a *Brick* on, that is, like a piece of *Dough* such as will just stick in the *Mould* or *Frame* when lifted up, and not fall off of it self; . . .²⁵

There were no archeological finds which would support or add to this description, and we may well accept it as the process used at Jamestown. The pugmill, now used by brickmakers who simulate colonial methods, was probably not introduced until the nineteenth century.

The next step was the molding and drying of the bricks and tiles. Two distinct processes were used in England during the seventeenth century. In one the mold, an open rectangular frame, was set over a board known as

²⁵*Ibid.*, 34.

a *stock*, which was attached to the table. The mold was lifted off, after being filled with clay, and the molded brick moved from the stock onto a pallet and then taken to the drying place. The second method, in which the mold has an integral bottom, is still the one commonly used today in making handmade bricks. After the mold was filled with clay and scraped off, or “struck,” it was carried to the drying place and flipped over and then lifted off. In England, bricks made by these two processes were sometimes referred to colloquially as *stock bricks* and *place bricks*, respectively.

We made two sorts of Bricks, viz., Stock Bricks and Place Bricks. The Stock Bricks are made solid, strong and so hard, that we have laid them under a Loaden Cart-wheel, and yet they will not break.²⁶

Place bricks were considered a poorer product and cost less than stock bricks.

The term *place bricks* seems to have taken on a different meaning in later times, or, possibly in other localities. Moxon, in 1703 writes that place bricks are “so called because there is a Place just by where they strike (or mold) their Bricks.”²⁷ So-called “London stock bricks” are still made, or were a short time back, in some sections of England.²⁸ A stock was used, exactly as described in the seventeenth century accounts. The bricks were baked in a special type of kiln known as a “clamp,” rather than the more common up-draft type.

Lacking any accounts of brickmaking at Jamestown, examination of the finished product is the only means of determining which of these two processes was used. Both the bricks and tiles are sanded on all but the “struck” (upper) side, and these sanded surfaces are relatively irregular and coarse. In the “stock” process, the stock, after some use, would become worn around its margins and would be repaired by tacking on a strip of leather or some other material. The effect of this was to form a sunken margin around the edge of the brick. No such condition has been observed on any of the Jamestown bricks. There is an indentation along part of one edge and one end of each brick on the struck side, made when the bricks were tipped out of the mold. The opposite edges are slightly raised where the clay was squeezed against the edge of the mold when it was flipped over (Figure 4).

Another clue to the process used is the occurrence of animal footprints on a great many of the bricks and tiles. In every instance these prints are on

²⁶*Ibid.*, 33.

²⁷*Ibid.*, 36.

²⁸Edward Dobson, *A Rudimentary Treatise on the Manufacture of Bricks and Tiles*, 14th Ed., Revised and Rewritten by Alfred B. Searle (London, 1936).

the struck surface. Since all descriptions of the "stock" method state that the molded bricks were carried directly to the drying place on pallets and laid on edge to dry, and lacking other evidences characteristic of stock bricks, it seems almost certain that the second, or "place" brick, method was used at Jamestown. The peculiar markings caused when the mold was flipped over to remove the brick add further evidence to this conclusion.

The following accounts describe clearly the process of molding and drying bricks and tiles as it was undoubtedly carried on at Jamestown.

. . . then we bring to the *Earth* a Table standing on four Legs, about three foot high, five foot and a half long, and three foot and a half over, and load it with as much as 'twill well bear at the Right Hand and about half way; . . . Then we have a *Mould* or *Frame* made of *Beech*, because the *Earth* will slip easiest from it. This *Mould*, *Frame* or *Voyder* is made of the bigness of the *Brick* . . . we also have upon the table before the *Mould* or *Frame* a little *Trough*, that will hold about three or four quarts of *water* which we put in, and in it a strike to run over the *Mould* to make the *Bricks* smooth; this *Strike* is usually made of *Firr*, nine inches long, an inch and a half broad, and half inch thick, . . .²⁹

The table is also provided with a box or "minette," which is filled with sand. The brick mold is tossed into this sandbox by the molder's helper and sand is rubbed around on the inside of the mold before filling with clay.

The moulder plunges his arms into the heap of earth, cuts off a piece weighing from 14 to 15 lb., throws it, in the first place, into the compartment (*la case*) of the mould nearest him, levelling it at the same time with his hand by heaping up the material in it, the excess of which he throws into the second compartment, which was not filled at the first charge, like the other one. He levels this compartment, too, by hand, heaping up the earth and filling any empty spaces. Seizing, at the same time, with his right hand, the strike, the handle of which is conveniently placed at the edge of the wetting trough, in which it has been soaking, he passes it firmly across the mould, to remove all that exceeds the 28 or 29 "lignes" of thickness that the two bricks should be. He gives a tap with the flat of the strike, as with a trowel, on the middle of the mould to separate the two bricks one from the other and places the surplus earth by his side on the table. The Carrier at once draws the mould towards him by the ears and sliding it to the edge of the table, raises it with both hands, turning it over and adroitly placing it on its edge, so that the two bricks, which are soft, can neither fall nor get out of shape. He proceeds to carry the two bricks the length of his walk (*cordeau*), there he holds the mould close to the ground, as if he were going to place it on its edge, but suddenly turning it over he lays it with the two bricks flat on the ground and lifts up the mould. He takes great care to execute this last movement vertically, for if it were done in the least obliquely, the two bricks would certainly be deformed. The Carrier then returns to the "minette" (sand bin) with his mould.³⁰

²⁹Lloyd, *A History*, 34.

³⁰*Ibid.*, 31.

The bricks were left spread out in this drying place until they were slightly dried, probably one day, and then turned over, allowing them to dry more evenly. At this time, if necessary, they were "drest (that is cut off their Inequalities and Rugosities)." It was during this drying period that the animal prints were made in the partly dried bricks and tiles. The bottom, or struck, side would have been just the right firmness to have left a sharp impression of the animal's foot. This accounts for the fact that the tracks are all on the struck surface. If a brick had been stepped on during the first day, before the clay body had acquired sufficient "set," it would probably have been damaged beyond use.

After the bricks had dried sufficiently in the drying place, they were stacked for curing.

. . . and when they are dry, they carry them to the Hacks (or places where they Row them up, like a Wall of two Bricks thick, with some small intervals betwixt them, to admit the wind and air to dry them). When the Hack is filled, they are covered with straw on the top, till they are dry enough to be carried to the Kiln to be burnt.³¹

Sometimes these hacksteads were in the open and sometimes they were located in open sheds, depending, presumably, upon the climate. As in the case of the preparation of the earth and the tempering, no remains were found at the Jamestown brick plant relating to the molding and drying steps described above. If the area had been excavated completely it is possible that remains of bricks in the drying racks, or other evidences of these operations might have been found. No remains of the equipment used would have lasted the 300 years since the plant was in operation, the table, mold, sand bin, and strike all being of wood.

The roofing tiles were made by the same workmen and in much the same manner as the bricks. The paste had to be somewhat stiffer than for bricks, and greater care had to be exercised throughout the molding, drying, and burning. As the many animal footprints show, the tiles were laid out in the open, struck side down, and then turned over as soon as they could be handled. Two nail holes were punched in each tile from the struck side, probably when the tile was turned over the second day (Figure 4). Although more uniformly spaced than in most of the tiles from building foundations excavated at Jamestown, the spacing is not sufficiently uniform to indicate that a template was used.

The size of the crew working in a brickyard of that day, the number of bricks turned out in a day's time, and the wages paid the workers are also

³¹*Ibid.*, 36.

of interest. Here, again, we must resort largely to English records of that period. Lloyd gives the following information on the rate of production:

In 1683, Houghton states that a moulder, working alone, will turn out 1000 bricks in a summer's day of 14 or 15 hours. With the assistance of a man to temper the earth and of a boy to carry to the hacks he will turn out 2000 in a day, or an extraordinary man 3000.³²

Wages paid to brickmakers varied considerably, and Lloyd cites a number of contemporary references, some being by the thousand bricks, others by the day.³³ The following is one of the more interesting accounts: "In 1651, at Quarter Sessions, Chelmsford, the daily wages of 'Makers of Brick and Tile and Burners of Wood Ashes and Lime were fixed' " as follows: Mid-March to mid-September, with meat and drink — 8 d.; without meat and drink — 16 d.; mid-September to mid-March, with meat and drink — 6 d.; without — 12 d.³⁴ According to a Virginia statute of 1662, laborers working for brickmakers were to receive "beside diett two thousand pounds of tobacco by the year."³⁵

The annual production of a brickyard would depend both on the number of men employed and the length of the season. One Jamestown account, dated 1662, in setting the legal wages to be paid a brickmaker, reads as follows:

Brickmakers haveing theire diett and six able labourers to helpe them, provided at his or their charge that employ them, and wood sufficient brought in place for each thousand bricks moulded and burned, fortie pounds of tobacco.³⁶

This, very likely, reflects the typical brickmaking crew — a brickmaker and six laborers. Because of the danger of freezing, the brick molder at Jamestown would probably have begun his work about the first of April, and the last kiln would have had to have been fired by the middle or end of October. With so many unknown variables, it is impossible to estimate the annual output of the kiln described here, but it is doubtful if a small plant would have turned out more than one, or at the most, two kiln charges during a season.

After the bricks or tiles were sufficiently dried, they were stacked in the kiln and fired. A description of the kiln and how the bricks were placed

³²*Ibid.*, 19-20.

³³*Ibid.*

³⁴*Ibid.*, 19.

³⁵Hening, *Statutes*, II, 173.

³⁶*Ibid.*

in it has been given above. According to a contemporary English description, the firing proceeded as follows:

Then we begin with half a Bavin³⁷ Fire at a time in each *Arch*, supplying it continually till the *Water-Smoak* be off; which is done when the Smoak begins to arise black, and usually in twenty-four hours, then we put in a whole Bavin at a time, . . . and thus we continue till they are at the top red fire hot, which is usually also twenty-four hours, and then we cease our Fire, and let them cool, and sell them as soon as we can for as much money as we can get, but usually about thirteen or fourteen shillings the thousand. The Prices for *Making* and *Burning* is seven shillings the thousand, the *Wood* three shillings the thousand.³⁸

This was an unusually short time for the firing, and it is likely that a larger kiln, such as the one at Jamestown, would have required from a week to ten days.

The quality of the bricks in any one kiln varied considerably. They were usually classed in three groups. Those next to the fire (sometimes called "clinkers") were the best burned, some being glazed. Next to these in the kiln were those that were considered best for general use, and they probably constituted the majority. The outermost, or poorest bricks, were not looked on with favor. They were called "samel" or "sandel" bricks, probably from their salmon color, and it was said that they would "molder away like Dirt, with the least moisture."³⁹

The price received for finished bricks varied over the century, but appears to have been less in the Colony than in England. A statute of 1662 set the price as follows:

Bricks being statute bricks and well burned, one hundred and fiftie pounds of tobacco per thousand.⁴⁰

Description of Jamestown Bricks and Tiles

In addition to the process of manufacturing bricks and tiles, their physical characteristics are of interest, although contrary to common belief, the date of a brick building cannot be determined from the size and appearance of the bricks alone. As Lloyd says of English bricks: "At best, dating buildings by brick dimensions can only be vaguely approximate, and afford but slender aid to the more reliable architectural features and to precise historic records in determining dates."⁴¹

³⁷A *bavin* was a bundle of brushwood bound with a withe in the center.

³⁸Lloyd, *A History*, 35.

³⁹*Ibid.*, 32.

⁴⁰Hening, *Statutes*, II, 173.

⁴¹Lloyd, *A History*, 12.

Even so, on the whole the bricks from a given kiln have certain distinct characteristics. This is not always the case in buildings, however, since the bricks may have come from more than one source. At Jamestown, for instance, salvaged bricks were often used, and additions and alterations to the buildings were frequent.

There was also some change in the normal brick size during the Colonial period, and possibly some change during Jamestown's history. Study of the bricks from all structures excavated at Jamestown suggests that the bricks made during the first half of the century were slightly longer and thinner than those made during the latter part of the century. Similarly, there is a marked trend toward shorter, narrower, and thicker bricks during the next century. Because of the dearth of historical records by which foundations can be dated, and the meagerness of other architectural criteria, such as would be available in a standing structure, bricks tend to assume too much importance in dating foundations, such as those at Jamestown.

As the table of Jamestown brick sizes shows (Appendix), the bricks in Jamestown foundations run about $8\frac{3}{4}$ to 9 inches in length, 4 to $4\frac{3}{8}$ inches in width, and $2\frac{1}{4}$ to $2\frac{1}{2}$ inches in thickness.⁴² There are bricks departing markedly from this range in structures, presumably of the Jamestown period, in other parts of Tidewater Virginia. For example, the Thorogood House in Princess Anne County (believed to date from about 1640) has a very uniform brick measuring $8\frac{1}{2}$ by $4\frac{1}{8}$ by $2\frac{1}{4}$ inches. In many seventeenth century structures, however, such as St. Luke's Church in Isle of Wight County, the Warren House (Rolfe House) and Bacon's Castle in Surry County, and Christ's Cross in New Kent County, the bricks run about the same as those at Jamestown.

In appearance, the bricks used at Jamestown have the usual wide range of colors and textures found in handmade bricks. They vary from light yellows and oranges to deep reds, browns, red-purple, olive green, and even chocolate. On the whole, the colors are relatively soft shades of brown, salmon, and medium to dark red. The wide variety of colors, used at random throughout the walls, produced the pleasing brick surfaces common in that period.

On the whole, all surfaces of the bricks, except the struck side, are relatively irregular, with course sanded texture. Glazing is frequent, often extending over only a portion of the surface and more common on the ends than

⁴²Bricks from the kiln (Structure 102) varied in size as follows: Length, $8\frac{1}{2}$ to $9\frac{1}{2}$ inches; width, 4 to $4\frac{3}{8}$ inches; and thickness, $2\frac{1}{8}$ to $2\frac{3}{8}$ inches. The size of approximately half of the bricks, however, was the "average" size of 9 by $4\frac{1}{4}$ by $2\frac{3}{8}$ inches.

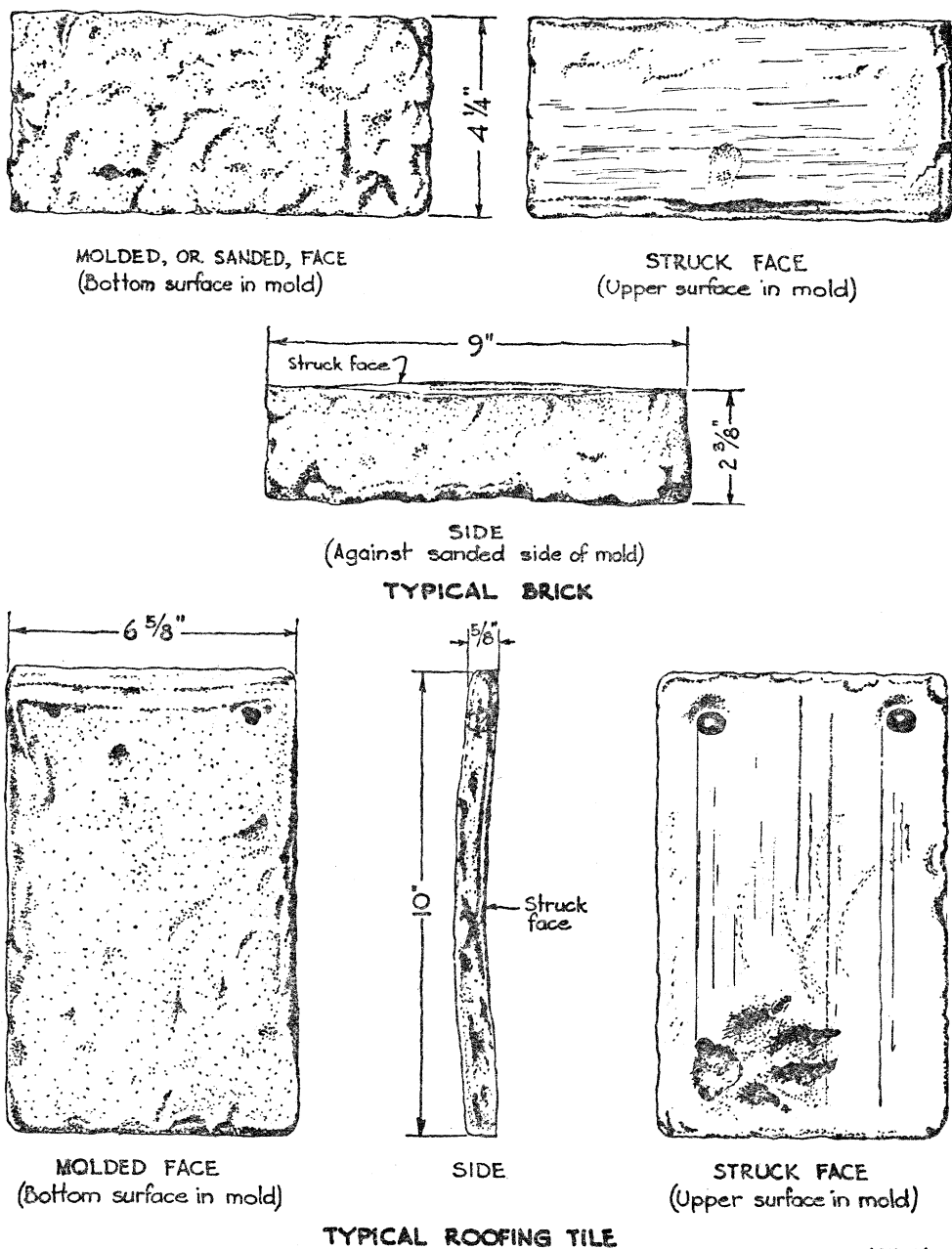


FIGURE 4 — Typical brick and roofing tile from Brick Kiln "B."

the sides of the brick. This, too, added to the naturally random appearance of the finished wall. It is doubtful if the Jamestown masons, except in rare instances, used glazed headers to form patterns, or to produce the monotonous effect resulting from every header being glazed. Almost certainly glazed surfaces were accidental in the manufacturing process and were used at random throughout the wall along with the general run of the kiln.

Hardness and porosity are difficult to describe, and of little value, since the bricks at Jamestown range from the light salmon ones, very soft and porous, to those as hard and dense as paving bricks.

To the author's knowledge no one has ever used an objective method for describing texture, color, and physical properties of handmade bricks. It has been suggested that various laboratory analyses might furnish a clue as to the source of bricks and date of manufacture, but, apparently, no such study has been attempted. Color, density, and refractoriness, of course, vary with the temperature of firing, as well as with the original clay, but this can be corrected for laboratory analyses by refiring to critical temperatures. The success in identifying clay sources of prehistoric Indian pottery in the American Southwest indicates that similar analyses would be feasible with bricks.⁴³

Jamestown roofing tiles, like bricks, vary greatly in size, color, hardness, and surface texture. There seem to be no records available as to statutory limitations on the size of roofing tiles after 1477, when the size was required to be 10½ by 6¼ x ⅝ inches. Those found in the kiln at Jamestown were fairly uniform in size, and ran about 10 by 6½ by ⅝ inches, or very close to the statute size of 1477.

Relatively few whole tiles have been recovered from the excavations at Jamestown, outside of those from the kiln, but a large quantity of broken ones have been found, mostly the flat type, or *shingle tile*. Although considerable quantities of broken *pantiles* have also been found, they were apparently used much less commonly than the shingle tile. Because of their less frequent occurrence, and since there is no evidence that pantiles were made at Jamestown, they will not be discussed in detail here. Those found are the dissymmetrical ogee shape, with a lug on the under surface at the upper end. They are about 14 inches long, 9 inches wide, and ⅝ inch thick. They were made in a sanded mold, struck on one face, as were the flat tiles, with the lug on the bottom, or sanded surface.

⁴³Kidder, A. V. and Anna O. Shepard, *The Pottery of Pecos* (New Haven, 1936), II, 389-445.

The flat tiles from the kiln, in addition to being of a relatively uniform size, are all a light buff, straw, or very light orange-tan color. This, and their relative softness, is probably due to under-burning in the kiln. They are usually warped slightly, leaving the struck side slightly concave. The sanded surface, which is believed to have been the exposed side when laid, is quite uneven, resembling the sanded surfaces of the bricks from the same kiln. The edges on this surface are rounded, unlike the sharp edges on the struck side.

One of the most obvious characteristics of the tiles from the kiln is the uniformity of the position of the nail holes. Like all of the flat tiles, these holes were punched into the partially dried clay, using a circular, tapered tool. There is nearly always some clay left at the bottom of the hole where the punch struck against the ground or other surface on which the tile laid. In the tiles from the kiln these holes were punched quite uniformly one inch from each edge.

The flat tiles found from the excavated foundations are mostly harder and better made than those from the kiln. They run somewhat smaller in size, which may have been due, in part, to better burning.⁴⁴ The nail holes in these tiles are much less uniformly spaced than in those from the kiln, although similar in shape. This feature adds a useful criterion to color, size, texture, and other characteristics as a means of determining the provenience of this type of tile.

Conclusions

It is quite clear, from the documentary records and the archeological remains, that the Jamestown colonists not only made their own bricks, and probably many of their roofing tiles, but that the process, as well as the finished product, followed closely the English tradition. Although the Jamestown bricks depart somewhat from the English statute size for that period, the product of contemporary English kilns appears to have varied as much. The complexity of the process and the influence of the craft guilds, both of which required years of apprenticeship before a man could practice the trade, made it almost inevitable that the English methods be followed.

Some modifications in the various techniques involved in brickmaking undoubtedly came about during the century of Jamestown's growth and decline. Different materials and conditions would naturally cause some

⁴⁴Examples: 9½ by 6 by ½; 9½ by 5½ by 9/16; 10 by 6½ by ½; 10½ by 6¼ by ½.

changes, and the less restricted social and economic atmosphere might have given more opportunity for the expression of individual tastes and whims. On the whole, though, the archeological evidence fits with the accounts in the English records, and makes it possible to give a relatively complete and detailed picture of brickmaking and tilemaking at Jamestown.

APPENDIX

*Sizes of Bricks from Seventeenth Century
Structures at Jamestown*

THE dimensions given below are those of the average brick, or most common size, and not an average of a series of measurements. The structures listed are representative of some 150 separate structures excavated at Jamestown.

	<i>Measurement in Inches</i>		
	<i>Length</i>	<i>Width</i>	<i>Thickness</i>
Statutory size (Eng., before 1625).....	9	4¼	2¼
Statutory size (Eng., after 1625).....	9	4¾	2¼
JAMESTOWN ISLAND:			
Brick kiln (Structure 102).....	9	4¼	2¾
Church tower (c. 1640).....	8¾	4	2¼
First Statehouse (earlier portion; c. 1632).....	9	4¼	2¾
First Statehouse (later portion; 1642-1655).....	8¾	4¼	2¾
Structure 6 (date unknown).....	8¼	4	2¼
Structure 16 (date unknown).....	8½	4	2¼
Structure 19-A (date unknown).....	9½	4¼	2½
Structure 19-B (date unknown; later than 19-A).....	8¾	4¾	2½
Structure 21 (date unknown).....	9	4¼	2¼
Structure 26 (date unknown).....	8¾	4	2½
Structure 31 (c. 1680)*.....	8¾	4¼	2¾
Structure 48 (date unknown).....	8¾	4¾	2¾
Structure 72 (date unknown).....	9	4¾	2½
Structure 86 (1661-1662)**.....	8¾	4¼	2¾
Last Statehouse Group (c. 1665).....	8¾	4½	2½

*Probably William Sherwood's house, built over foundation of earlier "Country House."

**Built by William May, later owned by Henry Hartwell.