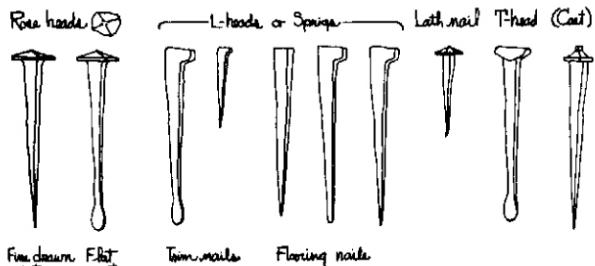




technical leaflet

## HAND WROUGHT NAILS 17<sup>th</sup> 18<sup>th</sup> and early 19<sup>th</sup> centuries



## NAIL CHRONOLOGY

*as an aid to dating old buildings*

By Lee H. Nelson  
National Park Service

The National Park Service in its historic structures restoration program has developed some research techniques in the general field of nail chronology as an aid to dating old buildings. This paper was prepared for a National Park Service Historic Structures Training Conference held in July, 1962. The paper was published, along with a paper on "Paint Color Research and Restoration" by Penelope Hartshorne Batcheler, as Technical Leaflet 15 in the December, 1963, issue of HISTORY NEWS. The Nail Chronology paper has been revised, and put in the new format, and published here in the hope that it will continue to be of use to other restoration projects and that it will stimulate further contributions to these studies. The Paint Color Research paper was revised and reprinted by itself as Technical Leaflet 15.

Dating old buildings from their nails is not a precise technique, but when used with discretion, it has proved generally reliable and useful, for example, in Independence Hall which has been subjected to a complex series of alterations from 1750 to the present time. If a sufficient number of samples are taken from all parts of the building they can be a good indication that (1) the building was built entirely at a given time, or (2) the building has been subjected to additions, alterations, or simple maintenance measures. Nails can help to define the extent of these changes. For this reason we believe it worthwhile to discuss briefly the various nail types that are generally found in American buildings. They are (1) hand-wrought nails, (2) cut nails, and (3) wire nails. Within these major groups there is a surprising variety with subtle differences

in type which enable us to use nails as dating tools with some certainty.<sup>1</sup>

## HAND-WROUGHT NAILS

The study of wrought nails, while interesting, has its limitations for they were used throughout the seventeenth and eighteenth centuries and even into the early nineteenth century. For this period other factors (especially decorative details, hardware, etc.) are better indicators of "period." However, it is useful to become familiar with wrought nails for purposes of identification and comparison with other nail types.

In medieval England nails were made into a great variety of special shapes and sizes and sold by the hundred, e.g., 8d (pence) per 100 nails. From this practice developed the classification of nail sizes according to their price per hundred, a system which seems to have been established by the fifteenth century. After that time nails slowly became standardized by size rather than price. In 1471 for example, "fippenyayl" were only 4d per 100. In 1477 "xpenynayl" were only 8d per 100; and in 1494 "sixpenynayle" were 5d per 100.<sup>2</sup>

During the entire Colonial period nails were an important commodity for importation. In 1684 for example, James

<sup>1</sup>This paper does not encompass tacks or screws. Although they are interesting subjects, they are not especially useful in dating old buildings except in a very general way. Machine-cut tacks were perfected at an early date and thus not helpful as a dating tool, nor can they readily be identified as an original and integral part of a building. Machine-pointed screws with constantly tapered threads seem to have been introduced in the 1830s, but they are not a reliable indication of date because of their limited use in building construction.

<sup>2</sup>Louis Salzman, *Building in England* (Oxford, 1952), 315.

Claypoole (recently arrived in Philadelphia from London) wrote to a London merchant as follows: ". . . send no window glass nor lead, but Iron is much wanted, and nayls very much vist 6d 8d & 10d a Tunn of each sort would quickly sell, I conclude."<sup>3</sup> The scarcity of nails in colonial Virginia was reflected in a statute enacted in 1645 to prohibit settlers from burning down old buildings for their nails.<sup>4</sup> Some nails were made in the colonies in the seventeenth and eighteenth centuries, but despite this local production very large quantities of nails were imported during the same period.<sup>5</sup>

During and after the Revolution, America became more dependent upon local sources for the supply of nails. Perhaps a typical nailery was that operated by John Little in Philadelphia in late 1770s (during the British occupation). His manuscript "Account of Smiths and Sailors Work . . ." includes a variety of things like kettles, chain, tools, etc., but primarily covers the manufacture of nails in sizes varying from 3d to 30d.<sup>6</sup> John Little had several dozen

<sup>3</sup>*The Pennsylvania Magazine of History and Biography*, Vol. X (1886), 412.

<sup>4</sup>Hening, *Statutes*, Vol. I, 291. See "Burning Buildings for Nails," American Notes, *Journal of the Society of Architectural Historians*, Vol. IX, No. 3, 23, showing that an early Kent County, Delaware, courthouse was ordered destroyed in 1691 "to gett the nailes."

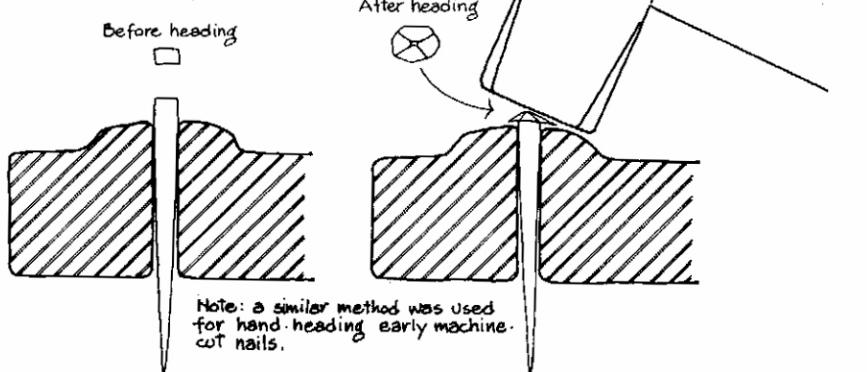
<sup>5</sup>See also J. Didsbury, "The French Method of Nail-Making," *The Chronicle of the Early American Industries Association, Inc.*, Vol. XII, No. 4 (December, 1959), 47-48. On page 48 is an illustration of a nail-heading tool. This latter subject while interesting, is outside the scope of this brief paper.

<sup>6</sup>Peale-Sellers Papers, American Philosophical Society Archives, Philadelphia. Called to the writer's attention by Willman Spawn, Philadelphia.

FIGURE  
1

CROSS-SECTION THROUGH  
NAIL HEADING TOOL

Tapered shank allows nail to become wedged in hole of heading tool. Size of nail and hole must be related to allow enough projection to form the head. Top of nail is heated to "work" the metal. Heading tools came in a variety of designs: some were hand-held and rested on face of anvil - others were mounted in the hardy hole of the anvil - some were equipped with ejection levers.



smiths and nailors working at various times and a typical entry from his accounts reads:

Supr.	Quan.	Cz.			
		in lbs.	Total Weight Pound	Prize of Number	Making
1775	100	58	23	1534	@2/6/Pc
25	34			5000	@1/9/D*
26	100	63	14	882	@2/6/D*
28	20				1/3/Pc
			40		
					2 10

It is important to emphasize that wrought nails continued to be used for several decades following the introduction of the cheaper cut nails. In the 1820s Philadelphia newspaper advertisements of "Nails, Brads and Spikes" often included both cut and wrought nails with prices for each in their respective sizes.<sup>7</sup> Wrought nails continued to

be superior for certain purposes, especially where they required clinching or for trim work. For this reason it is not uncommon to find a few hand-wrought nails used well into the nineteenth century. It is interesting that many buildings of this period utilized both wrought and cut nails in their original construction. The Old Town Hall (built 1798-1800) in Wilmington, Delaware, for example utilized hand-headed machine-cut brads for flooring and crude, machine-cut lath nails, but all the finish woodwork was held with wrought nails.

The several characteristics of wrought nails are illustrated in the drawing in the center of this Leaflet. Included is a cast nail which perhaps does not properly belong in this group but is known

<sup>7</sup>See also a nineteenth century English metal trades catalog which includes wrought joiners sprigs, floor stubs, lath

nails, etc. Catalog No. E.121-1896, *Old English Pattern Books of the Metal Trades*, Victoria and Albert Museum, Pub. No. 87 (1913), 32-33.

to have been used in the eighteenth century and well into the nineteenth.\*

### MACHINE-CUT NAILS

In 1923, Dr. Henry C. Mercer's pioneer study on cut nails was included in a published essay entitled *The Dating of Old Houses* (New Hope, Pennsylvania). Others, including the writer,

1830 encompasses a remarkable technological transition from wrought to cut nails. After the Revolution, many cut nail manufactories were established in New England, New York, New Jersey, and Pennsylvania. These were at first operated by hand power and later by water or steam power. America seems

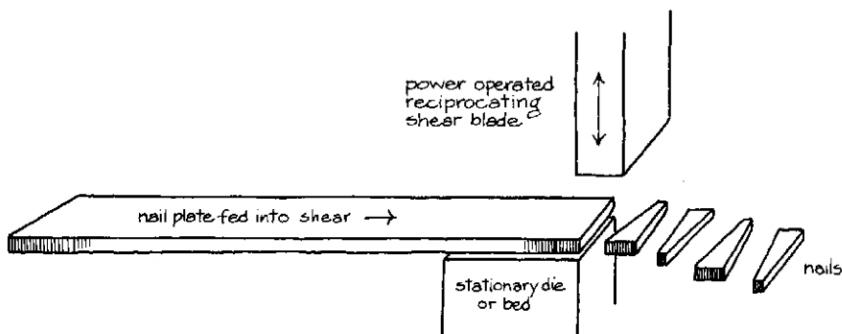


FIGURE 2 SIMPLIFIED DIAGRAM SHOWING THE BASIC PROCESS OF MAKING EARLY CUT NAILS

Nail plate was made in rolling mills, thus cut nails were of uniform thickness, depending on nail size. Thin nail plate (i.e., small nails) was usually hand held while feeding into shear. Thicker nail plate (i.e., larger nails) offered more resistance to shearing - was usually heated and held with tongs while feeding into shear. To compensate for tapered shank, nail plate had to be alternately wiggled or flipped, see Figures 3 and 4.

After cutting, the nails were headed by: (a) hand, after heating them and using a heading tool similar to that used for wrought nails, see Figure 1. This was the earliest method and was used for many years, even after the introduction of (b) machine heading, which gripped the nail instantly (after cutting) and applied great pressure to end of nail, thus forming the head by the displacement of metal.

have only built upon Mercer's early work; however, much research remains to be done in this field.

The study of cut nails is especially useful where late eighteenth and early nineteenth century buildings or alterations are involved. The period 1790-

to have been leading the English in this particular field.

Authorship for the initial invention and specific improvement of cut nails remains largely anonymous. Certain individuals are known to have received patents during the 1780s-90s, but the precise nature and significance of their

\*Cast nails are illustrated in a late eighteenth century English hardware catalog, and there is an 1829 reference in Bishop, *A History of American Manufacturers* (Philadelphia, 1864), Vol. II, 341. Several excellent specimens of cast-iron nails were supplied to the writer (in 1967) by J. R.

Stevens, from a recently demolished c.1820 building in Halifax, Nova Scotia. The sketch and observations regarding cast nails, which accompany this paper, were partly based on the samples generously given by Mr. Stevens to the author.

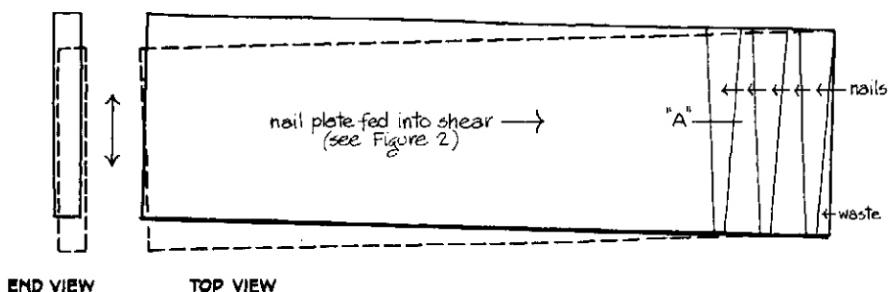


FIGURE 3

SIMPLIFIED DIAGRAM SHOWING HOW NAIL PLATE WAS WIGGLED BACK AND FORTH TO COMPENSATE FOR TAPERED SHAPE OF NAILS

One face of nail plate always remained "up", i.e., nail plate always cut from same side.

Wiggling the nail plate produced nails with: burrs and shear marks on diagonal edges.

Cross-Section through nail: "A"



inventions remains rather vague.<sup>9</sup>

Unfortunately the Patent Office Record's fire of 1836 destroyed a vast amount of primary source material with respect to the invention of cut nail machines. Some of this information has been collected and appended to the scholarly biography *Jacob Perkins* by Greville and Dorothy Bathe.<sup>10</sup> This book

<sup>9</sup>For mention of a sixteenth century "instrument for making of Nails," see Greville and Dorothy Bathe, *Jacob Perkins, His Inventions, His Times, and His Contemporaries* (Philadelphia, 1943), 172, but it seems unlikely that this was in any way related to a cut nail machine.

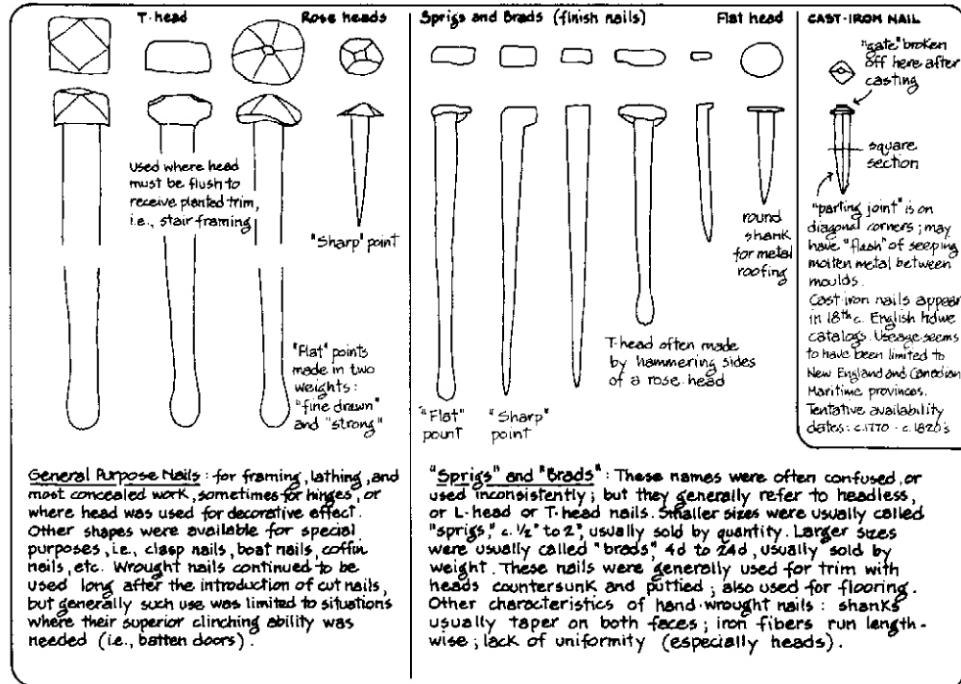
<sup>10</sup>For a more complete listing of inventions and events relating to the evolution of nail-making, see H. R. Bradley Smith, "Chronological Development of Nails," supplement to *Blacksmith's and Farriers' Tools at Shelburne Museum* (Shelburne, Vermont, 1966). See also a general history of nail-making by Arthur S. Tisch, "Modern

provides an excellent background on the development of nail machines and includes a list of 88 patentees between the years 1791-1815. It would appear that the most important contributions were made by Perkins, J. G. Pierson, Jesse Reed, Mark and Richard Reeve.

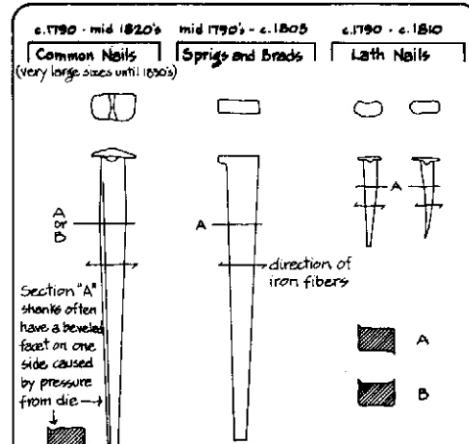
The rapid development and sale of these machines made it possible to manufacture nails on a wide scale in the early nineteenth century. Thomas Jefferson for example, purchased a machine in 1796 and produced nails (for sale) until 1823. Prior to that time (1794-1796) Jefferson manufactured nails that were wrought by hand. His interest in this endeavor is reflected in a letter: "I am myself a nail-maker. . . . my new trade of nail-making is to me in this country

Wood Construction, only as good as its fastening" reprinted as Bulletin No. 1, by the American Society of Precision Nailmakers, 630 Third Avenue, New York.

## HAND-WROUGHT NAILS - TYPES COMMONLY USED IN 17<sup>th</sup>, 18<sup>th</sup>, 19<sup>th</sup> C. AMERICAN BUILDING CONSTRUCTION



## EARLY MACHINE-CUT NAILS WITH HANDMADE HEADS

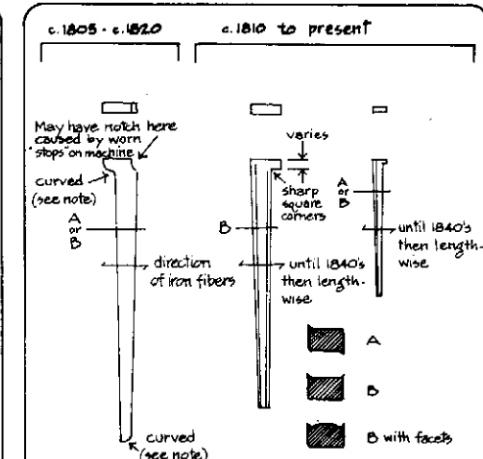


Heads usually have 2 facets, sometimes more. Headed in tool like wrought nails. Earliest nails of this type usually have section "A"; later ones usually have section "B" and are more uniform in manufacture.

Size and shape of heads vary because heads were forged. Smaller sizes called sprigs (2" or less), and larger sizes called brads, but by early 19<sup>th</sup> c., all were often called brads.

Heads vary in size and shape, usually thin and flat (no facets), and eccentric to shank. Shanks vary in length and width and often have a sharp point. Bulge under head often present.

## COMPLETELY MACHINE-CUT SPRIGS AND BRADS



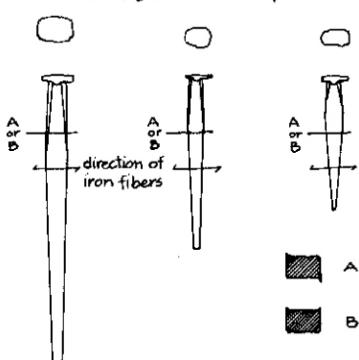
Early completely machine-cut sprigs and brads available in a variety of sizes. Curved corners and points are characteristic of this type.

Perfected machine-cut sprigs and brads were much used for trim and flooring. Once perfected, they have changed little, and are not readily dateable except that the direction of iron fibers offers a general clue (see sketch above). Beveled facets caused by pressure of die, often missing on small nails.

### EARLY MACHINE-HEADED CUT NAILS

1815's to late 1830's

Common Nails - See Sprgs and Brads for early cut finish nails

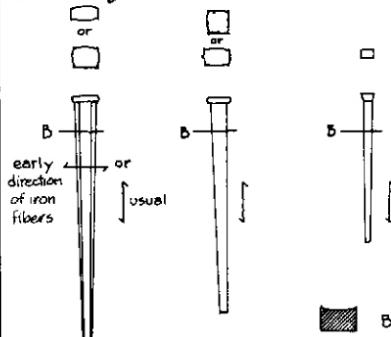


Nails of this period are distinguished by their irregular heads, which vary in size and shape, usually eccentric to shank, though they were more uniform by 1830's. Nails were irregular in length and width, but more uniform at end of period. Nails generally have a rather distinct rounded shank (under head), caused by wide heading clamp. These nails were more readily available than finishing nails, and were often locally modified by hammering the sides of the heads, thus making them into finish nails which could be countersunk.<sup>1</sup> The direction of iron fibers also distinguishes nails of this period from later nails.

### "MODERN" MACHINE-CUT NAILS

late 1830's to present

Box or flooring nails Common Nails Finish Nails

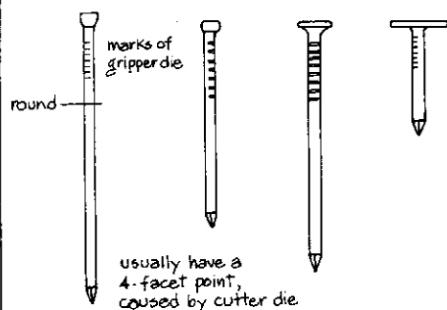


Heads tend to be uniformly convex on each side, and uniform in size and shape, depending on nail style. After c. 1840, cut-nails were generally made with the iron-fibers running lengthwise (and later were annealed), which made them capable of clinching without rupture, thus almost completely displacing the hand-wrought nail for building construction. There are many "modern" nail styles not illustrated here; but after the 1840's, cut-nails are not readily distinguished from those made today, so that other factors, i.e., decorative details, etc., are better indicators for dating purposes.

### MODERN WIRE NAILS

c. 1850's to present

Flooring Brads · Finish Nails · Common Nails · Roofing



These nails are usually manufactured from steel wire, which is held in gripper dies and headed (producing gripper marks on shanks); then wire is advanced and sheared to length with cutter die; and wire stock is then advanced to repeat operation. Earliest wire nails were only available in very small sizes (for picture frames, etc.). Larger sizes were not widely available or used in American building construction until the third quarter of the 19th century. By the late 1880's, they were fast supplanting cut-nails because of their relative cheapness. Wire nails are not readily dateable, though early examples have bulbous heads that are eccentric to shank. In more recent years, wire nails have been made in a great variety of sizes, head shapes and shank designs (e.g., threaded nails), although cut-nails continue to be made for specific purposes.

The sets of nail drawings on these two pages are organized together so that the user will have a visual comparison when he is trying to identify a nail. The cast nail in the right hand corner of the upper drawing on the opposite page may not properly belong in the group but it is known to have been used in the eighteenth century and well into the nineteenth.

what an additional title of nobility or the ensigns of a new order are in Europe."<sup>11</sup>

One of the earliest cut nail machines in Pennsylvania, was one built by William J. Folsome at Harrisburg in 1789. Folsome (lately from New Hampshire) was producing 120,000 nails per week in March of that year.<sup>12</sup> Cut nails made in the 1780s undoubtedly exist, but the writer has not been successful in locating any unquestionably dateable specimens that predate the early 1790s.

In Philadelphia and Trenton, nails were manufactured using prison labor. Jacob Hiltzheimer notes in his diary for 7 March 1797, "went from the State House with John Shoemaker, of the House, and about a dozen members, to the [Walnut Street] gaol, to see the prisoners at work at different trades. We saw six men *cutting nails*, and twelve making heads to them. . ." [italics supplied]. References to the making, sale, and use of cut nails are numerous after the late 1790s.

The development of cut nail manufacturing and their use is marked by at least five distinct phases and the evolution of cut nail types may be roughly outlined as follows:

1. Cut from Common Sides, 1790s-1820s  
Hammered Heads
2. Cut from Opposite Sides, 1810-1820s  
Hammered Heads
3. Cut from Common Sides, 1815-1830s  
Crude Machine-Made Heads
4. Cut from Opposite Sides, 1820s-1830s  
Crude Machine-Made Heads

<sup>11</sup>Edwin M. Betts, ed., *Thomas Jefferson's Farm Book* (Princeton, 1953), 426.

<sup>12</sup>This and several important related items were brought to the writer's attention by Hannah Benner Roach of Philadelphia.

5. Cut from Opposite Sides, Perfected  
Machine-Made Heads

Even the simpler machines continued to be used long after the more sophisticated machines were developed, which creates overlapping in the above chronology. It will be noted that this sequence is contrary to Mercer's theory that (1) early cut nails were sheared from *opposite* sides, and (2) later nails were cut from *common* sides. From an inspection of cut nail "shear marks," Mercer's theory seems correct. Surprisingly enough, nails cut from a common side have "shear marks" on their opposing sides (see Figure 6).<sup>13</sup> It should also be noted that until the 1830s most cut nails are also distinguished by the fact that the iron fibers run crosswise to the shank while later cut nails have a fiber structure parallel to the shank (see drawing). For this reason early cut nails could not be satisfactorily clinched and wrought nails continued to be preferred for clinching.

To use cut nails as a dating tool, several factors must be considered:

1. Identification of the cut nail type must be precise.
2. When did that nail type become available in the area?
3. When was that nail type superseded by a "better" cut nail?
4. Are there similar cut nails in dated houses of the same locale?
5. The existence of several cut nail types in the same building might indicate a transition period of nail improvements, or alterations within the build-

<sup>13</sup>The writer is indebted to Donald Streeter, blacksmith and collector, of Iona, New Jersey, for calling attention to this fact.

ing. Note: Cut nail improvements were first applied to the smaller sizes. For example, lath nails were perfected before the larger framing nails.

6. No attempt should be made to date a building on the basis of a single nail.

7. Cut nails manufactured after c. 1830 are virtually undistinguishable from those made today.

8. Wrought nails were competing with cut nails until at least 1820.

9. Some naileries were contemporaneously offering a more advanced product than others. For example, in 1820 Pierson's nails (New York) were considered superior to those made at the Phoenix Works (Pennsylvania).

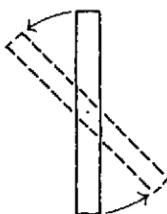
10. Urban areas responded to improved products more readily than did rural areas. The foregoing generalizations and dates are tentative and subject to correction and contributions by others interested in the subject.

In general, the study of cut nails has been quite useful in distinguishing alterations within Independence Hall. In the Assembly Room for example, extensive changes took place both in 1816 and 1831, but the evidence is easily discernible because of the vast improvement in cut nails in the interval.

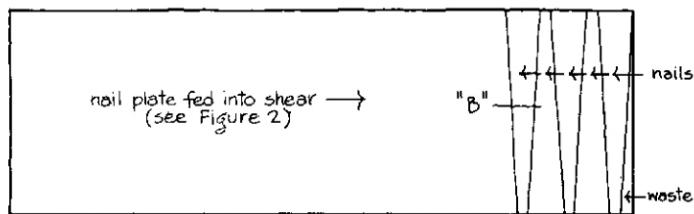
## WIRE NAILS

The introduction and development of wire nails has not been adequately studied. It appears that several manufactoryes were established in New York during the 1850s, following an earlier development in England, France, and Germany. The first American production of wire nails was from machines either imported or adapted from existing European models.<sup>14</sup> The earliest wire

<sup>14</sup>Clark, *History of Manufactures in the United States* (New York, 1949), Vol. I, 518. See also the transcript of an unidentified magazine article (dated 23 April 1896) by John Hassall, entitled "The Early



END VIEW



TOP VIEW

FIGURE  
**4**

SIMPLIFIED DIAGRAM SHOWING HOW NAIL PLATE WAS FLIPPED OVER TO COMPENSATE FOR TAPERED SHAPE OF NAILS

Nail plate was alternately cut from opposite sides.

Flipping the nail plate produced nails with: burrs or shear marks on common edges.

Cross Section through nail: "B"



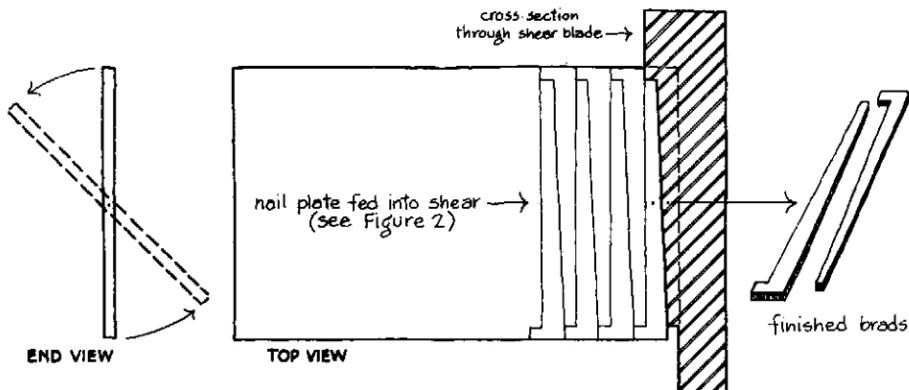


FIGURE 5

DIAGRAM SHOWING ONE EARLY METHOD FOR CUTTING "SPRIGS" AND "BRADS"

Nail plate was flipped over to compensate for tapered shape and to permit nesting pattern.

Nail plate was alternately cut from opposite sides, and produced nails with : burrs or shear marks on common edges.

Cross-Section through nail : "B"



nails were not made for building construction, but rather in the smaller sizes for pocket book frames, cigar boxes, etc. American wire nail machinery was not really perfected until the 1860s and 70s. Machinery for this product was exhibited at the Philadelphia Centennial Exposition of 1876.<sup>15</sup>

An 1888 article which deals mainly with *cut nails*, comments on the "newer" type:

"Nails of a very different kind, manufactured from steel wire, have been in use for a number of years in America and for a longer period in Europe, and in both places they have been very

favorably received and are fast superseding the common cut-nails for many purposes."

Several advantages were claimed and thirteen different varieties were illustrated in this article.<sup>16</sup> By this time wire nails were definitely in the builders' vocabulary and they were made in sizes ranging from 2d to 60d.

Wire nails did not supplant cut nails with the rapidity that wrought nails were replaced. The transition was more gradual. Wire nails did not really become the dominant type until the 1890s, and many builders preferred using cut nails well into the twentieth century. The greater holding power of cut nails was certainly a factor which delayed the quick acceptance of wire nails. In the

*History of Wire Nail Manufacture*,<sup>17</sup> courtesy the Shelburne Museum and Donald Streeter.

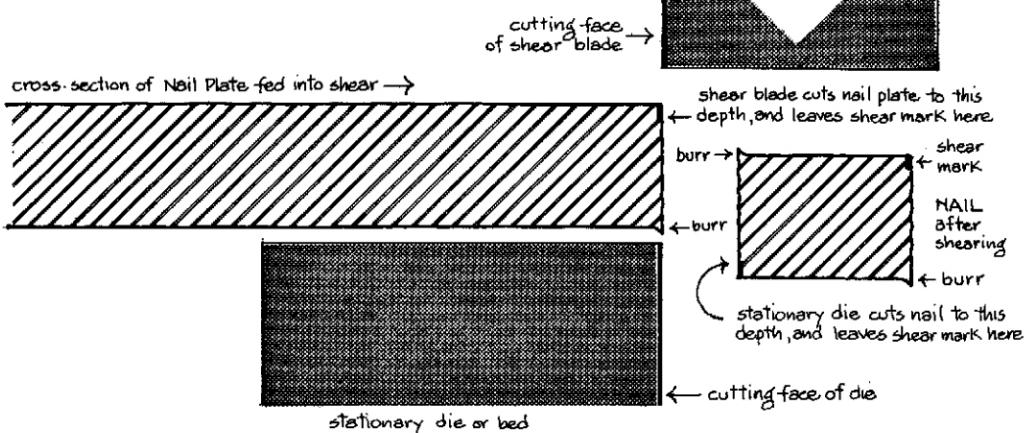
<sup>15</sup>Official Catalogue of the U.S. International Exhibition (Philadelphia, 1876), "Dept. of Manufactures," 137 and *passim*.

<sup>16</sup>"Builders' Hardware—III. Nails," *The American Architect and Building News*, Vol. XXIV, No. 660 (18 August 1888), 73.

FIGURE

6

## CROSS-SECTION SHOWING BEHAVIOR OF METAL DURING SHEARING OPERATION



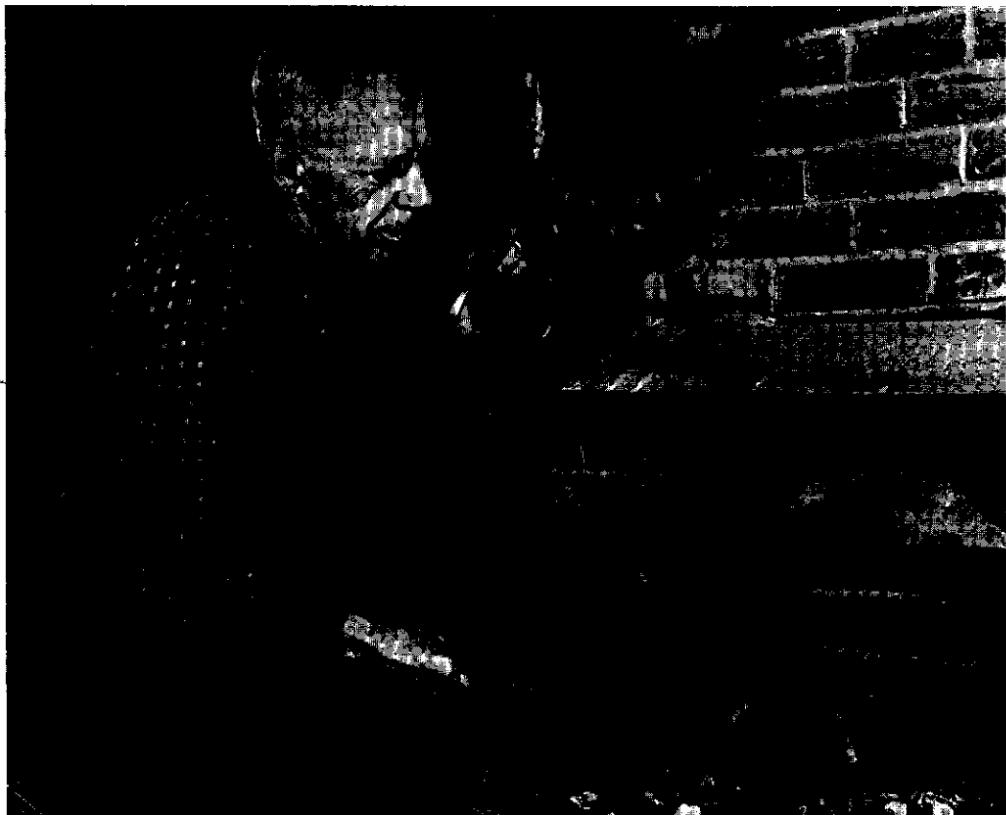
The shear blade and die create equal and opposite forces. Simultaneously, the blade starts to cut the top of the nail plate, while the die starts to cut the bottom of the projecting portion (nail). With this action, the metal stretches beyond its elastic limits — the nail breaks off, and leaves shear marks and burrs on diagonal corners of nails.

Lee H. Nelson 13 Aug '68

1880s, a series of experiments on the adhesion of nails was carried out by the Watertown Arsenal, Massachusetts. These tests confirmed this advantage, but the relative cheapness, ease of handling and the variety of specialized wire nails gave them a gradually increasing preference.<sup>17</sup> The earliest wire

<sup>17</sup>See "Adhesion of Nails, Spikes, and Screws in Various Woods, Experiments on the resistance of cut-nails, wire nails (steel), spikes, wood-screws, lag screws," published in the *Report of the Tests of Metals and Other Materials for Industrial Purposes made with the U.S. Testing Machine at Watertown Arsenal, Mass., 1884* (Government Printing Office, Washington, 1886), 448-71. This interesting publication was brought to the writer's attention by Orville

nails can be distinguished from their modern counterparts by their "heads" being bulbous and generally eccentric with respect to the shank. There is not the clearly defined evolution of development that makes the cut nail so useful in dating buildings. As a generalization, the presence of wire nails indicates late nineteenth century repairs, alterations or maintenance, and to that extent they are useful "dating tools." Although wire nails are in common usage today in a multitude of varieties, cut nails continue to be used by some carpenters for specific functions, such as flooring nails, boat nails, and masonry nails.



Hand-wrought nails were turned out at forges such as this two-man forge operated by a blacksmith at Old Sturbridge Village, Sturbridge, Massachusetts. Latches, hinges, candlestands, foot scrapers, toasting forks, and a myriad of other objects were made by smiths at these forges of yesteryear. (Photo: Old Sturbridge Village.)

Lee H. Nelson, the author of this Leaflet, is an architect with the Office of Archaeology and Historic Preservation, branch of Restorations, of the National Park Service. He is active in the field of historic architecture and is at the Independence National

Historical Park in Philadelphia, Pennsylvania.

For this part of the revision of the original Technical Leaflet 15, Lee H. Nelson did the whole set of new drawings except the front page drawing by G. Dysert.



## TECHNICAL LEAFLET 48

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