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"Mechanic Geniuses and Duckies," A Revision of New England's Cut Nail Chronology before 1820

MAUREEN K. PHILLIPS

New research and recent restoration projects in New England have revealed the use of machine-headed cut nails long before they were believed to have been developed.

Introduction

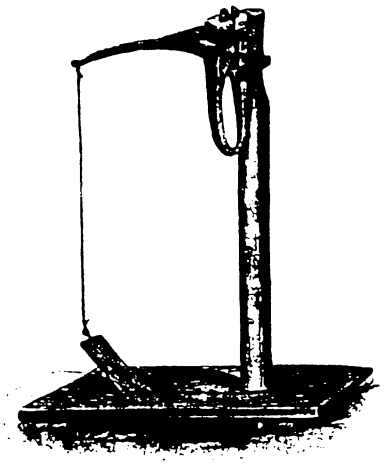
The standard accepted chronology of the manufacture of cut nails used in the field today is based on Henry Mercer's 1923 article "The Dating of Old Houses" and on Lee Nelson's 1968 pamphlet "Nail Chronology as an Aid to Dating Old Buildings."[1] However, restoration work in the New England, New York, and the mid-Atlantic areas performed since the 1970s has led preservationists to theorize that some types of early cut nails may have been manufactured several years earlier than had been postulated by Mercer and Nelson. For example, during recent restoration work at an historic structure in Newbury, Massachusetts, cut nails with characteristics thought to date to post-1815 were found in building fabric known to date to before 1807. It was decided to test this theory by documenting cut-nail manufacturing in New England in the late eighteenth and early nineteenth centuries. Three areas were studied: the operation of nail factories around Boston during that period, the descriptions of early nail machines those factories used, and dateable nail samples from New England structures that the machines may have produced.

Local histories, as well as nineteenth-and twentieth-century tomes on the history of manufacturing in the United States, revealed important information for the study of the location and dates of operation of nail factories, and about the inventors and promoters behind them. Nail samples that were removed from structures in Massachusetts, Maine, and New Hampshire and that were dateable from 1795 through 1815 were generously donated by fellow preservationists. Obtaining accurate descriptions of the early nail machines, however, was not as straightforward. A catastrophic fire in the U.S. Patent Office in Washington, D.C., in 1836 destroyed most of the specifications and drawings of the patents filed to that date. While some records were recreated from copies of patent documentation existing in other repositories, these records are far from complete, and the missing documents created critical gaps in the record.

Fortunately, some of these gaps were filled when copies of specifications and drawings for two important early nineteenth-century cut-nail machine patents were found filed with the case papers of early nineteenth-century patent infringement lawsuits in the regional office of the National Archives in Waltham, Massachusetts. Also found among the case papers were lengthy depositions recounting firsthand the men, machines and developments in the cut-nail industry around Boston during the tumultuous years at the beginning of the nineteenth century. In addition, documentation for a third important early nineteenth-century machine was found in the specifications and drawings of an 1810 English patent that was filed by an American inventor.[2]

The newly-discovered material provided a tantalizing glimpse into the era of early cut-nail technology, and resulted in the development of a revised chronology for cut nails that relates specifically to New England construction for the years between 1790 and 1815.

The Original Tack Machine



THE ABOVE ILLUSTRATION is an exact reproduction of the first Tack Machine operated in America. It was invented by Ezekiel Reed in 1779, and was in constant use for thirty-seven years. It is now at Abington, Mass., and was on exhibition at the Bicentennial, celebrating the incorporation of that town in 1712.

The operation of this machine consisted in the blank being cut with shears from a strip of hoop iron in a wedge shape piece, then placed in the jaw of the machine, point downward, and clamped firmly by pressure on the foot tread, enough of the material being allowed to protrude above the top of the jaw which, when flattened with a hammer, formed the head of the tack.

It was not possible for this machine to produce more than three thousand tacks per day.

Fig. 1. Ezekial Reed's c. 1780 tack machine. Courtesy of Orville Carroll (source unknown).

Early Nail Manufacturing Technology in New England

The development of nail technology at the turn of the nineteenth century was so rapid that it can easily be compared to the rise of calculators and computers in the 1960s and 1970s. Especially in the years between 1790 and 1820, new ideas were constantly being tested, resulting in new machines or in adaptations to machines already in use. The result was a product whose physical profile changed in noticeable stages with the adoption of each new feature to the nail machines. These stages can today be identified by conservators and preservationists as an aid to dating the structures in which these nails are found.

The first step in the developing technology was hand-operated nail-cutting machines. Use of this early technology has been documented south of the Boston area as early as the 1780s.[3] One such machine was invented around 1780 by Ezekiel Reed of Abington and Bridgewater (Fig. 1). The operation of this machine was described in a late nineteenth-century account:

> The mode [of cutting nails] was much improved by moveable dies, placed in an iron frame, in the shape of an ox-bow, the two ends, in which were placed the dies, being brought together by a lever pressed by the foot. This was a great improvement and the inventor, Ezekiel Reed, was entitled to a patent. He made some attempt to conceal the operation, but it was so simple and so easily applied that others soon got it, and it came to general use.[4]

By 1788, Adam Rogers, of Marshfield, had developed a machine that "cut nails from hoops or plates," and by 1792 his nephew, Samuel Rogers, was cutting nails "by hand in a small machine invented by him."[5]

When cut from nail plate, the nails produced by the hand-operated machines would probably have had characteristics similar to those of nails manufactured a few years later, but with less refinement. The earliest cut nails would have had shanks with two tapering and two parallel sides and burrs on diagonally opposite edges (having been cut from the same side of the nail plate), like their later cousins.[6] However, because of the crude, somewhat uncalibrated method of cutting, the shanks in cross-section would probably have appeared as skewed rectangles or parallelograms, rather than true rectangles (Fig. 2). The nails would have had rounded ends (from the edge of the nail plate) and were probably initially hand-headed, sometimes with faceted rose or "T" heads found on wrought nails, other times the upper end simply bent over to produce a brad. Eventually, crude heading machines may have been used.

Fig. 2. Early machine-cut clapboard nail from west wall of original Rider-Wood House, Strawbery Banke, New Hampshire, c. 1800-03. Produced by early hand-powered or water-powered machine. Hand-headed. Burrs on opposite-side edges, skewed shank, and rounded end .

Developing Technologies

Two government actions dramatically changed the pace of developing nail technology. In 1789, Congress imposed a duty on imported nails as an inducement to develop independence from foreign sources, to increase the supply of nails, and to lower their cost. In 1790, Congress passed the first U.S. Patent Act, giving federal protection to new inventions in place of the haphazard and varying regulation of the individual states. As a result, competition intensified in the 1790s and early 1800s among inventors and their promoters in a race to develop the first commercially-viable nail machines.[7] The first successful devices that cut and headed nails used "two-operation" machines. In effect, two machines were used, one for cutting and one for heading the nails. From almost the beginning, however, the impetus was toward developing a "one-operation" machine that would accomplish both functions.

In the Boston area, the competition appears to have centered mainly around three men and their inven-

Fig 3. Early machine-cut lath nail from original stairwall of Spencer-Pierce-Little House addition, Newbury, Massachusetts, c. 1800-05. Cut and headed by early two-operation machine. Burrs on opposite-side edges, "neck" under flat, irregular head, rounded end.

tions. North of the city, Jacob Perkins had nail-cutting and nail-heading machines in production in Byfield in 1794, and he helped establish a major factory along the Powow River in Amesbury in 1796. In Danvers, down the coast from Amesbury, Nathan Read was among a group of investors who organized the Salem Iron Factory, which began producing machine-cut and headed nails using Read's invention in 1798. Jesse Reed, of Bridgewater, son of Ezekiel Reed (and no known relation to Nathan Read), and his promoters, the Odiorne brothers, were to revolutionize the nail industry with Reed's 1807 invention for a one-operation machine and its 1810 and 1814 improvements.[8] It was the Odiornes' patent infringement lawsuits against competitors in 1814 and 1819 that produced the case papers that have survived in the National Archives in Waltham and yielded much valuable information on the early cut-nail industry.

Jacob Perkins and the Amesbury Nail Factory. The early 1790s found Jacob Perkins working on a water-powered nail-cutting machine. Perkins's machine was in production by 1794, and he received a patent for the invention in 1795, the first New England patent for a nail-cutting machine.[9] No model or drawings of the machine have been located, but the specifications for Perkins's patent application have survived; in the specifications, Perkins describes his machine in terms that are somewhat general but helpful for our purposes:

> I ... have invented and discovered a mode of making Nails by which much manual labor may be saved by means of an Ostrich, or revolutionary cutting Engine, and a Vulcan or heading Engine. The principle of the cutting Engine is that of a revolutionary motion i.e., a roller with 2 cutters fix'd in it 1/2 of the circumference of the roller apart, which passing by another die in a standard or plate, cuts or presses off whatever may be placed between either of the dies on the roller, and the die in the plate, directly above which is an aperture or slit, sufficient for a piece of flat iron to pass thro'— the roller being turned in a skew shape tho' exceedingly true, acts also as a guide to the shifting plate, and brings it in that direction with each die in the roller, so as to cut up the whole strip of iron without any manual assistance, after it is once put in the aperture of the shifting plate — the heading Engine is worked by the revolution of a tappet wheel, having three tappets, each of which lifts up a hammer, which gives three strokes each revolution of the wheel, on the nail which is fixed in a vise directly under the hammer, the three strokes forming the head of the nail; there is also affixed to the tappet wheel, a piece in a curv'd form, which catching the tail of a lever forces the jaws of the vise so as to take hold the nail sufficiently firm for the purpose of heading it; when the curv'd piece ceases to operate on the vise-lever, a spring pulls open the vise, between which time, and the tappets again catching the tail of the lever, another nail is put in, the headed nail dropping down immediately on the jaws of the vise opening. It is to be observed one cutting Engine may with ease be drove by water 250 revolutions in a minute each revolution produces 2 nails and one Boy of ten or twelve years of age can with ease supply six Engines so that the labor of one Boy can cut *three thousand* Nails per minute, the heading Engine will head sixty nails per minute, by the assistance of one Boy, or more if it was possible for the Boy to hand them.[10]

This description provides several valuable clues to the type of nail this invention would have produced:

1. Perkins describes using two machines, an "Ostrich or revolutionary cutting Engine" and a "Vulcan or heading Engine." Thus, it appears that Perkins's first machine was cutting *and* heading nails by 1794. The fact that machine-headed nails were in production by 1795, twenty years before they were previously thought available, was confirmed by the firsthand accounts of several men who worked with Perkins at Amesbury.[11]
2. A roller was equipped "with 2 cutters fix'd in it one-half the circumference of the rollers apart." This roller turned "in a skew shape" which acted not only to guide and advance the nail plate after each cut, but also to shift the plate back and forth to obtain a tapering shank. In other words, the nail plate was not flipped over for each cut.
3. The heading apparatus worked by machine-hammering the nail with three hammer-strokes while it was being gripped tightly in a vise.

These clues indicate that a nail manufactured from Perkins's invention would have the following characteristics (Fig. 3):

1. The nail shank would be rectangular in cross-section, have two tapering sides and, because the cuts were always made on the same side of the nail plate, have burrs on diagonally opposite edges.

2. With the top of the nail receiving three energetic whacks of a machine-driven hammer, the nail head would be very flat and thin, irregular, and eccentric to the shank.

3. The shank under the head would be rounded and have a neck-like form caused by the pressure of the vise which held it during heading.

There are some definite curiosities about Perkins's description of this machine. For one thing, the process of having the cutters affixed to a roller seems to be a singular occurrence, at least among the more commercially successful machines yet to come. Most other machines would have a moving cutter operate in an up-and-down (or side-to-side) motion and would rely on some other contrivance (manpower or a "feeder") to shift the nail plate back and forth and move it through the machines. In fact, it appears that Perkins soon adapted his machine to cut nails in what was to become the conventional manner by 1799.[12]

Second, the first newspaper advertisement placed by Perkins's company in 1795 contained this startling claim for its cut brads:

> [Their] superiority to other cut nails consists in their being cut with the grain of the iron, whereas others are cut across the grain, consequently these are much tougher, and in general, will clench equal to any wrought brads.[13]

There is nothing in Perkins's 1795 patent specifications that would indicate that the machine described would cut nails with a longitudinal grain. According to Mercer and Nelson, and all other commentators, until around 1835-40 nail plate was manufactured, and machine-made nails were cut, so that the iron fiber ran across the shank, rather than with the grain as Perkins had advertised. As of this writing, testing and examination of pre-1840 machine-cut nails bear this out without exception: all had cross-grain direction.

An explanation may be found in the specifications to a patent application that an associate of Perkins filed in England in 1810 for an invention Perkins had just patented in the United States, an improved version of a machine that Perkins had patented in 1799.[14] In the specifications, Perkins claimed that the quality of the nails manufactured by the new invention was equal to wrought nails "except, perhaps, for some kinds of work which require nails to be clenched." For those nails he described a process of producing nail plate that would result in cut nails with a longitudinal grain direction:

> [B]ut in order to provide for this quality, also, in my said cut nails, when it is intended to make cut nails that is required to be clenched, I have the iron or other metal rolled into plates as wide as they can conveniently be made, and then have these plates slit or divided transversely into strips or plates, and the nails cut from these strips or plates will have their strata or fibres of the metal disposed longitudinally or lengthwise of the nails, which will render them as flexible as those which are wrought from nail rods, and equally susceptible of being clenched.[15]

With this statement Jacob Perkins is shown to have anticipated the technological advances of iron production by more than twenty years. Thus in 1810 Perkins was proposing a brilliantly simple method to produce cut nails with longitudinal grain by using nail plates or strips that had themselves been slit from wider nail plate. He may have also used this method in Amesbury in 1795 without describing it in the patent specifications for the two-operation machine. If so, this would explain why the 1795 advertisement made the claim of longitudinal grain for cut brads but not for the nails cut and headed using the two-operation machine. However, Perkins's proposed method of using nail plate that had been slit from larger plate depended upon the ability of mills to roll nail plate wide enough to slice off the strips from which the nails were cut. The lack of extant physical evidence for longitudinal-grain cut-nail shanks prior to 1835 indicates that this process did not prove to be practical with the quality of the iron produced in 1795 or in 1810 and remained an idea in Perkins's inventive mind.[16]

Perkins also developed and patented a one-operation machine in 1799 (eight years before Jesse Reed's 1807 machine) that employed two major variations from the two-operation machines: the nail plate was flipped ("turned one-half turn at every cutting"); and the head was formed by "pressing a head to the nail" instead of striking it, at that time the only method of machine-heading nails.[17] Because of jamming problems, however, this machine was disassembled in 1799 and, because of busines complications, was not reassembled until 1805. It operated only briefly before the Amesbury Nail Factory was destroyed by fire in December, 1805. By the time the factory was rebuilt and the advanced machine again operating, Amesbury was in intense competition with a factory established by Thomas Odiorne in Malden that operated Jesse Reed's machines.

Nathan Read and the Salem Iron Works. Jacob Perkins's nail factory was in full production in 1798 when Nathan Read of Salem, Massachusetts, received a patent for a nail machine that he immediately began using in his Salem Iron Factory. Although patent specifications and drawings have not survived, Read's surviving correspondence provides information about the machine. While approval of his patent was pending, Read became concerned that some "unscrupulous characters"

had obtained enough information about his invention to apply for a patent. In order to preserve his priority, Read sent a letter dated August 21, 1797, to U.S. Secretary of State Timothy Pickering pleading his case. Read's letter contains a description of the machine that probably repeated to some extent the description in the specifications:

My Machine consists of a cutting lever of the common form, which vibrates to cut, head, & pound, of two vices & two hammers, & a stage upon which the Nail plate is placed & forced into the jaws of the cutters by a pair of rippers & a small pulley.

Directly under the cutting tool is a small trough on which the nail drops. The machine is so constructed as to make a certainty of throwing one nail into one vice & the next nail that is cut into the other vice, - the nails drop head foremost into the vices, of which one is inverted. Under each vice is a sliding gage, which prevents the nail from dropping too far & conveys it by a secondary movement directly under the fixed jaw of the vice, where it is held till the vice gripes it, then the sliding gage moves back & the hammer, which strikes upward, heads the nail at two strokes,-the vice then opens & the nail drops,-the other vice, hammer & sliding gage in turn perform the same operations, & so on alternately, two nails being cut & headed at every revolution of the wheel, which gives a regular & equable movement to the whole machine, which feeds itself & cuts & heads the nails without any other manual labour than what is required to place one nail plate upon the stage where the machine is fed...

The capacity of the machine is about ten thousand nails daily. With the same machine nails of any size from a 4d to a 20d can be made by adjusting the weights which move the hammers to the size of the nail.[18]

Read's invention was one of the first attempts to construct a machine that would cut and head in one operation. From the description and an investigation of a surviving model of Read's machine in the collection of the Peabody Essex Museum in Salem

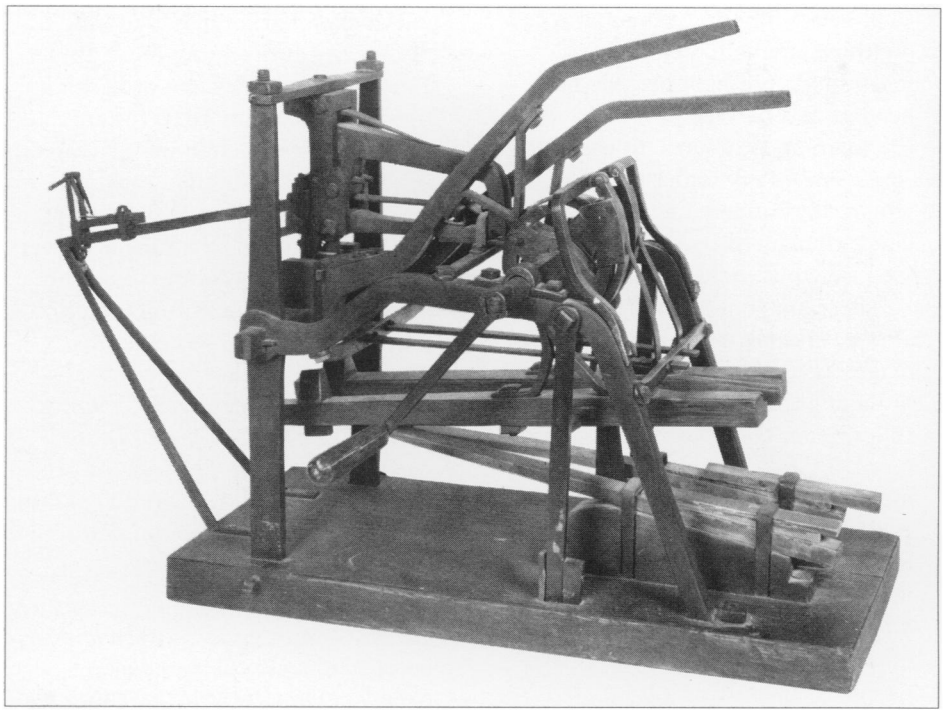


Fig. 4. Working model of Nathan Read's 1798 nail cutting and heading machine. Courtesy, Peabody Essex Museum, Salem, Massachusetts.

(Fig. 4), one can see that his machine cut a nail by moving a nail plate between a cutter (or die) that moved up and slammed down against a stationary die to shear off the nail. After being cut, the nail was meant to drop head-end down into one of two openings, then be gripped by a vise and be hammer headed. It appears that each cut was made to the same side of the nail plate, the plate being "forced into the jaws of the cutters by a pair of rippers and a small pulley." A nail made by Read's machine would therefore have had characteristics similar to those produced by Perkins's machine: burrs on diagonally opposite edges, a flat, thin, irregular and eccentric head, and a neck under the head where the vise clasped the shank during the heading process.

It is doubtful that Read's one-operation machine was used for its original purpose for long. A local minister, the Reverend William Bentley, noted in 1810 that the heading device was not being used at Read's factory "since the first experiment,"[19] and it is easy to conclude from Read's description and from viewing the model that there would be jamming problems. The nail was cut on its side (e.g., horizontally) and then had to fall wide end down in order to be headed. Weight and gravity were relied upon to pull the correct end of the nail down to the header. This would not always have succeeded, especially if the nail, having been cut from hot iron, stuck to the cutter. It is probable that the heading portion of the machine was soon discarded and that the Salem factory used separate heading machines like those being used in Amesbury and elsewhere.

Clearly then, two-operation machines were producing machine-cut and machine-headed nails before 1800 in at least two factories north of Boston. Within a few years these machines were operating in Newburyport, Portsmouth, and in other towns in the area.[20] The typical nail produced from these two-operation machines would have had the characteristics

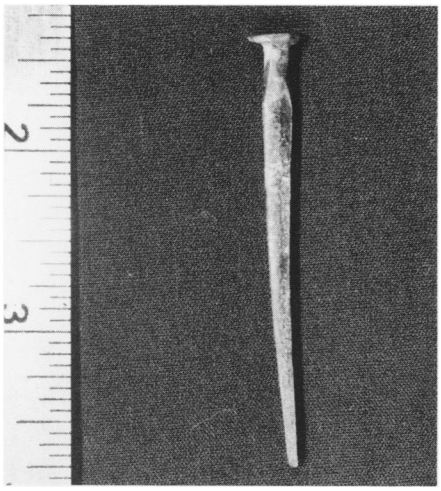


Fig. 5. Early machine-cut tread nail from original steeple stairs of Unitarian Church, Carlisle, Massachusetts, 1810-11. Cut and headed by later two-operation machine. Same characteristics as Fig. 3 nail, but more regular shank, thicker, and more concentric head.

described above (see Table 1 and Figs. 3, 5).

Jesse Read, the Odiornes, and the Malden Nail Factory. In 1807 a nail machine invention was patented that was to revolutionize the nail industry and set the standard against which all machines conceived in the next 30 years were compared. A young joiner from Bridgewater by the name of Jesse Reed had invented a one-operation machine that, along with Perkins's reassembled 1799 machine, became the most used and well-known nail-manufacturing devices in the United States until well into the 1820s.[21]

The years between 1798 and 1807 were, however, by no means quiet. Young "mechanic geniuses and duckies," as Reverend Bentley referred to them,[22] were developing refinements to the cutting apparatus and separate heading components of two-operation machines and trying to find a solution to the header-jamming problems that had so far made the one-operation machines unworkable. There were 40 patents registered in the 12-year period between Perkins's 1795 patent and Reed's 1807 patent,

Table 1. Revised Chronology of Cut Nails in New England: Wrought and Cut Nail Characteristics

Hand-Wrought Nails	
Period of Use	• 17th century through early 19th century
Shank	• Irregular rectangle in cross section • Longitudinal grain (fiber) direction • Tapers on all 4 sides • No burrs
Head	• Hand hammered with 2 to 6 facets; most common were rose-head (4 facets) and T-head (2 facets)
End	• Pointed or flat bill
Early Machine-Cut Nails	
Period of Use	• Post-1790 to c. 1820
Shank	• Regular rectangle in cross section (earliest cut nails are parallelogram in cross- section) • Horizontal grain direction (cross-grain) • 2 sides tapered, 2 sides parallel • Burrs on diagonally opposite edges • Distinct pinched neck under head when machine-headed

Head	• Hand-headed
	• Rose-head or (more common) T-head; or bent over to form brad
	• Machine-headed, "Two-Operation" machine
	  • Separate machine used to head nail
	  • Flat, thin and irregular, sometimes with jagged edges; eccentric to shank

End	• Rounded
Transitional Machine-Cut Nails	
Period of Use	• Post-1810 to c. 1840 (possibly as early as 1807)
Shank	• Regular rectangle in cross section • Horizontal grain direction (cross-grain) • 2 sides tapered, 2 sides parallel • *Burrs on common (same) side edges • *Bevel under head no more than one-quarter down shank

Head	• Machine-headed, "One-Operation" machine
	  • One machine used to cut and head nail
	  • *Thicker than previous generation
	  • *Regular in shape and size
	  • *Concentric to shank

End	• Rounded
Modern Machine-Cut Nails	
Period of Use	• C. 1835 to c. 1890
Shank	• Regular rectangle in cross section • *Longitudinal grain direction • 2 sides tapered, 2 sides parallel • Burrs on common (same) side edges • *Bevel under head one-third or more down shank

Head	• Machine-headed
	  • One machine used to cut and head nail
	  • *Uniform, thick, convex on each side
	  • *Form of shank may show through due to intensity of concussion

End	• *Square (sheared)

Based on research of dated nail samples and corporate, patent, and court records.
* Indicates change from previous generation of cut nail

as well as many improvements that were not being officially recorded.[23]

Other nailmakers, among them inventors Samuel Rogers and Melville Otis, of East Bridgewater, describe several such unpatented devices in their depositions taken for the Odiornes' patent infringement cases. Many of these new devices found their way into Reed's invention: a "forcing slide" or "clearer" used to clear the nail from the cutter and into the header, a balance mechanism to operate the machine more efficiently, gauges to calibrate the size and shape of the head, and mechanisms to advance the nail plate into the cutters. In fact, it is not at all clear that Reed was totally responsible for all the improvements that made his machine a success. Otis and Rogers both claimed that Reed was particularly inquisitive about their devices while all three worked in Bridgewater around 1805. It is also interesting to note that the nailmonger from Bridgewater who reassembled Jacob Perkins's 1799 one-operation machine in Amesbury in 1805 was Briggs R. Reed, Jesse Reed's younger brother.

Jesse Reed, however, did have the mechanical genius to assemble all improvements into one efficient machine. The addition of the clearer was the improvement that made Reed's machine commercially feasible, but he had also incorporated several other adjustments that led to the invention's success. Reed's machine combined balance adjustments with devices such as a screw gauge to feed the nail plate into the machine for more efficient operations. And like Perkins's 1799 invention, Reed's machine headed nails by pressure (displacement), a more controllable process than the earlier hammer devices. Thus, the size and shape of nail heads could now be regulated with more consistency. In addition, the old method of gripping the nail in a vise during the heading operation was replaced. The nailmakers' accounts in the patent

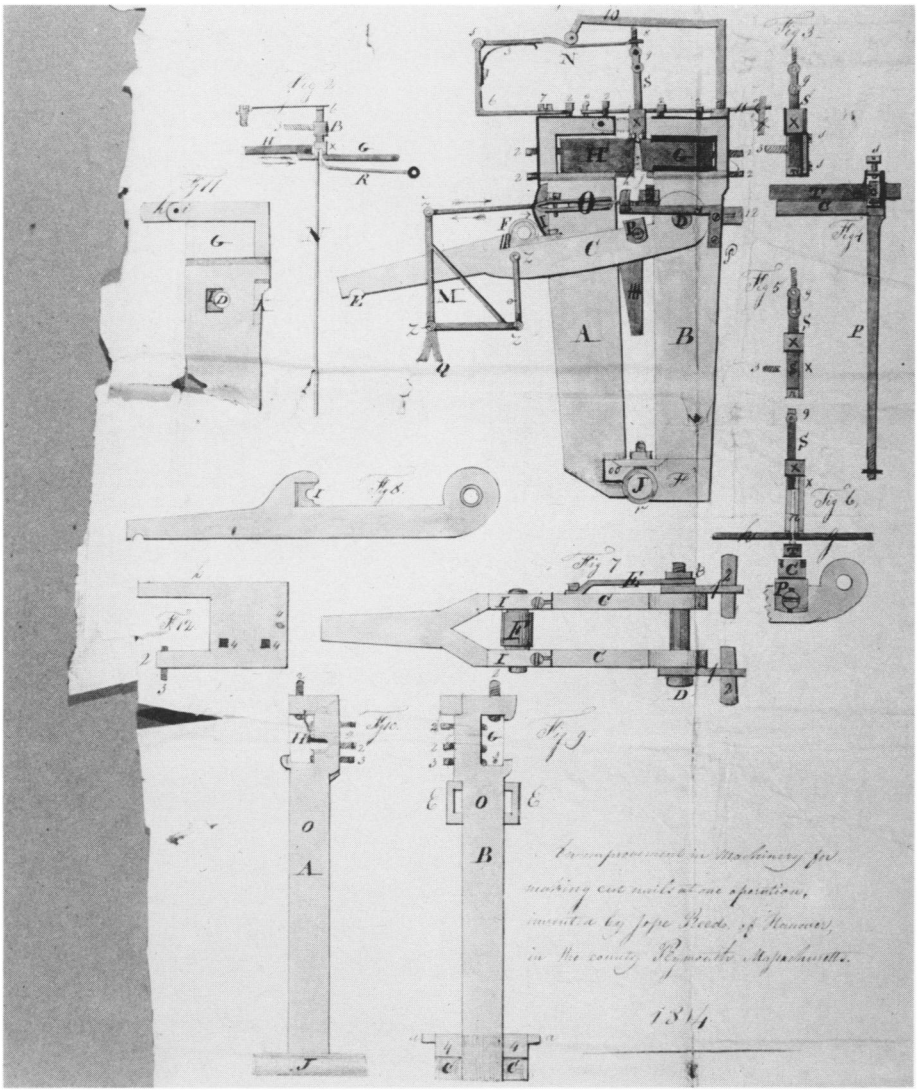


Fig. 6. 1814 patent drawing of Jesse Reed's invention for "making cut nails at one operation," In case papers for *Odiorne v. Amesbury Nail Factory* (1819), at the regional office of the National Archives, Waltham, Massachusetts.

infringement cases, and Reed's 1807 and 1814 patent specifications and drawings (Fig. 6), all used the term "gripping dies" for the apparatus that held the nail during the heading operation. These gripping dies, as seen in the surviving patent drawings, were wider than the vise-like clamps of the earlier machines and would produce a nail shank under the head that was less neck-like and more bevelled.

Both Perkins's and Reed's machines were described as flipping the nail plate after each cut.[24] It is possible only to speculate why machinists wanted to flip the nail plate while feeding it into the cutters instead of shift it back and forth. Two reasons can be advanced. For one thing, the development in nail manufacturing was inexorably toward more mechanization and away from manual labor. While it may have been easier for a boy or man to shift the nail plate as he fed it into the cutters, mechanically it was much easier to devise an apparatus using the machine's rotating gears and levers and gravity, which could flip a plate over for each cut.

Fig. 7. Nail from original roof sheathing of Custom House, Salem, Massachusetts, 1818. Cut and headed by transitional one-operation machine. Burrs on same-side edges, thick uniform head, bevel under head instead of "neck."

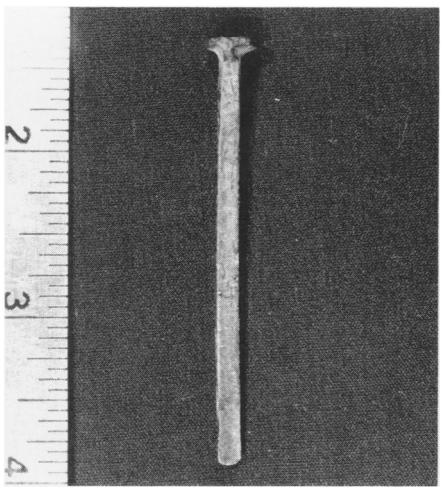


Fig. 8. Cut-side view of sheathing nail in Fig.7. Note bevels under head, rounded end.

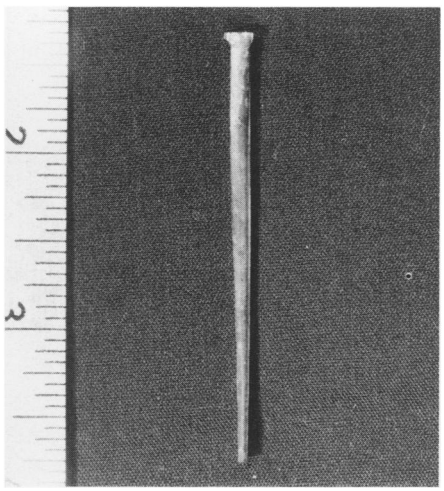


Fig. 9. Finishing nail from pew in 1852 loft of 1810-11 Unitarian Church, Carlisle, Massachusetts, Modern machine-cut nail. Burrs on same-side edges, long bevel, squared end.

However, as late as 1876, state-of-the-art nail-cutting machines that used manpower to feed the nail plate also used manpower to flip the plate.[25] It is more likely that the method of flipping the nail plate for each cut was preferred because it always left the wider end, the end which was to become the head, aimed in the same direction towards the heading device below, thereby making it a relatively simple matter to push the nail down into the heading die with the clearer. The specifications for Perkins's 1810 English patent describe just such a process, with the nail plate being held edgewise with the head end inclined downward and the shears operating horizontally to cut the plate.[26]

Another key to Reed's success was financial backing. A wealthy Boston merchant named Thomas Odiorne and his two brothers bought the patent rights to Reed's inventions and set up the Malden Nail Factory in 1807. Thus, the year 1807 saw the first commercial usage by two independent factories in the Boston area (Amesbury and Malden) of one-operation machines. Within a year, the Odiornes established two additional nail factories using Reed's machines in Phoenixville, Pennsylvania, known as the Old Sable Forge Works.[27]

The one-operation machines used in Malden and Amesbury in 1807 cut nails from opposite sides of the nail plate, formed heads by displacement instead of percussion, and used gripping dies instead of vises during the heading operation. Therefore, the documentation clearly indicates that by 1808 nails were being produced that would have burrs along the same-side edges of the shank, bevels on the shank under the head, and heads of standard thickness and shape (Figs. 7, 8), rather than the opposite-side burrs, pinched necks, and irregular, flat heads of the previous generation of nails.

The intense activity surrounding the invention of nail-making machines slowed considerably after 1815. The twenty previous years had seen almost 100 patents registered; in the next 20 years there were only half as many, several of which applied only to parts such as feeders or nippers adaptable to the more successful one-operation machines.[28] Thus, the gross characteristics of cut nails did not change significantly except to evidence more and more standardization, until around 1835 when iron technology had developed sufficiently so that nails could be cut with a longitudinal grain direction. Nails produced after the mid-1830s had driving ends that were squared or sheared off, reflecting the fact that the nail plate had been twice cut and had no rounded edges. At the same time, newly-developed machines grasped a longer portion of the shank while heading the nail, leaving very uniform bevels fully one-third or more down the shank of the nail (Fig. 9). There were few additional changes after the mid-1830's, and the characteristics of machine-cut nails manufactured after 1850 are virtually indistinguishable from those made in the 1890s, when steel wire nails began to compete in earnest.

Dated Nail Samples

The written documentation cited above that was found in patent application specifications and drawings and in firsthand accounts of cut-nail manufacturing indicates that machine-cut and machine-headed nails were generally available in the Boston area before 1800, earlier than the previously accepted 1810 date. The documentation also indicates that nails cut from one-operation

machines, resulting in same-side burrs and beveled shanks, were manufactured in quantity in both New England and in Pennsylvania before 1810, again earlier that had been estimated.

In order to test whether these conclusions could be applied generally to dating cut nails in early nineteenth-century New England buildings, several samples of machine-cut nails were collected from structures in the area for analysis. Only nail samples that were removed from original dated material were analyzed for their physical characteristics. The dates of the samples ranged from 1795 through 1815 (with a few later samples included for comparison purposes); they were taken from buildings in Newbury, Quincy, Carlisle and Salem, Massachusetts; Shaker Village in Canterbury and Strawbery Banke in Portsmouth, New Hampshire; and Mt. Desert Island and Kennebunkport, Maine.

Spencer-Pierce-Little House. The nails that triggered this inquiry were removed from a c. 1800-05 addition to the early seventeenth-century Spencer-Pierce-Little House in Newbury, Massachusetts, during restoration work in February, 1988.[29] These nails were taken from original clapboards, split-board lath, and trim in the addition. The lath and clapboard nails have shanks that are rectangular in cross section, taper on two sides, and come to a rounded driving end. Burrs are visible and palpable on diagonally opposite edges of each nail shank. The heads are flat, thin, irregularly shaped and eccentric to the shank, with a noticeable rounded "neck" on the shank just under each head (Fig. 3). These nails clearly are early machine-made nails which had been cut from the same side of the nail plate and whose heads were formed by an early machine-driven hammering device. In fact, given the proximity of the house to Amesbury and the known business connections between the house's owner and other backers of the nail factory, there is a good chance that these nails were manufactured at the Amesbury Nail Factory using Jacob Perkins's nail machine.[30]

The finishing nails found in the addition were sprigs (small brads) that had the same characteristics as the lath and clapboard nails except for the heads, which were bent over to give the sprigs an "L" shape. Suprisingly, the inside and outside corners of the heads are squared, indicating that the heads had been cut of a piece with the shanks, rather than bent over by hand-hammering. The sprigs must have been manufactured using a very advanced or singular early-era machine, since the earliest machine-cut brads and sprigs all had curved corners and points.[31] If these sprigs were also manufactured by the Amesbury Nail Factory, it is possible that the machine used was the one described in Perkins's 1795 patent specification that used "a roller with 2 cutters fix'd in it 1/2 of the circumference of the roller apart."

Strawbery Banke. A particularly useful group of samples was gathered from Strawbery Banke in Portsmouth, New Hampshire. They were removed from six different structures dating from 1792 to 1815, thereby giving a microcosmic view of cut-nail technology development over that very critical period.[32] Lath nails from the Winn House (c. 1795) and clapboard nails from the original portion of the Rider-Wood House (c. 1800-03, Fig. 2) show that very crude cut nails were being used in the Portsmouth area by 1795. The heads on some of these samples seem to have been made by a few blows to the side of the top to bend it over, and the shanks are skewed. These nails were probably cut with early hand-operated nail-cutting devices, similar to that which Ezekiel Reed invented in 1786, or by the earliest water-powered machines and either hand-headed or headed with a primitive heading machine.

Other samples of lath nails from the Drisco House (c. 1795) and clapboard nails from the original portion of the c. 1800-03 Rider-Wood House exhibit the characteristics of having been cut and headed using early machines — shanks with opposite-side burrs, rounded ends, and necks under the head; and heads that were flat, thin, irregular and eccentric to the shank. By contrast, samples of lath nails from the Shapley Townhouse (c. 1815-16) and lath and clapboard nails from the c. 1815-18 addition to the Rider-Wood House all have same-side burrs and show more regular shanks and head shapes and sizes, clearly indicating that by this time the newer technology had been adapted in the area.

There is only one sample from the Strawbery Banke collection that dates to the critical period between 1803 and 1815, and it does not support the theory that the new technology was available before 1810. This sample is a cut flooring brad from the c. 1811 Goodwin mansion. These brads are larger than the SPL sprigs, but they are hand-headed and still have the opposite-side burrs.

Post-1807 Sites. Nail samples datable to the transitional period of 1803-15 were found in Massachusetts sites but again do not support an earlier date for nails produced by one-operation machines. Nails from an 1810 remodeling of the John Adams Birthplace in Quincy and from the Unitarian Church in Carlisle (1810-11), also show the early two-operation machine characteristics. These nails have been machine-headed, display necks under the heads and have the opposite-side burrs characteristic of earlier nails (Fig. 5).

Singular Samples. Of the samples analyzed from outside Strawbery Banke and Newbury, the earliest was taken from the Gardner-Pingree House in Salem, tentatively dated to c. 1804-05,

the year the house was built. This one lath nail exhibits the opposite-side burrs and rounded end of the early cut nail, but instead of having a neck under the head, the shank is marked with what could be better described as a crude bevel approximately one-fourth down the length of the shank. In addition, the head is quite regular, thick, and almost concentric to the shank when compared to the c. 1800-03 samples taken from the Rider-Wood House, or even to the SPL nails. It is dangerous to arrive at conclusions based on one nail from a structure. The sample is intriguing nevertheless, even more so when one considers the fact that Samuel McIntire was the architect-builder of the Gardner-Pingree House, as he was of Nathan Read's House in Danvers, built around the same time. So far, nothing has been found to link McIntire to Read's nails, and it will be an interesting thread to pursue at some later date.

Included in the collection are samples from the c. 1818 Custom House in Salem (Figs. 7, 8) and from the c. 1830 Brethren House at Canterbury Shaker Village in New Hampshire. Both samples exhibit the same-side burrs, beveled shank and regular, concentric heads of the pre-1835 period. Also included for comparison purposes are a nail removed from a pew at the Carlisle Unitarian Church installed in 1852 (Fig. 9), and flooring nails from an 1898 addition to the Captain Lord Mansion in Kennebunkport, Maine. These two examples of "modern" cut nails both have same-side burrs, shanks with long bevels, and square ends, indications of how few variations occurred in cut-nail characteristics after 1840.

Observations. Analysis of the nail samples confirmed that machine-headed nails were indeed available and being used in New England as early as 1795. In comparing all the pre-1815 samples, it is interesting to note that certain characteristics became less irregular and more uniform, until by c. 1810 nails made from two-operation machines had shank shapes and lengths that were more standardized, and heads that were thicker, more regular and less eccentric than the earliest machine-produced nails (Figs. 3, 5).

It is also interesting to note that the earliest larger-sized machine-cut nail collected during the study was the brad found in the c. 1811 Goodwin Mansion at Strawbery Banke. In the c. 1800-05 Spencer-Pierce-Little House addition, the lath and sheathing nails were machine-cut, while the larger nails, such as the brads used for flooring, were wrought. It is possible that the larger-size cut nails were not available before 1810 because the earlier machines did not have the power to cut them. However, by 1798 both Jacob Perkins and Nathan Read were claiming that their machines were manufacturing cut nails and brads of sizes up to 20d in large quantities, and Perkins was advertising his for sale.[33] It seems more likely that the larger cut nails were available, but that acceptance of larger nails was slower than for the smaller sizes. This may have been due to the mistaken belief (still held) that wrought nails were stronger than cut nails because the horizontal orientation of the iron fibers on the shanks of the cut nails supposedly make them more vulnerable to breakage when being hammered into wood.[34] An example of this belief in the greater strength of wrought nails can be found in several structures at Strawbery Banke, where up until the 1810s a carpenter would fasten each clapboard or lath board using several machine-cut nails, but adding one larger wrought nail in the middle of each board, making a line of wrought nails up the wall.

In any event, in structures built around 1800 large wrought nails such as flooring nails were frequently used at the same time as machine-cut lath and clapboard nails. Well into the 1820s and 1830s, wrought nails continued to be used for fastening work such as batten doors and hinges where it was thought necessary for the nail to clench (curl into) and grasp the wood. Therefore, the mere presence of wrought nails in a structure would not definitively date it, but the exclusive use of wrought nails in a structure should lead one to suspect that it pre-dates 1800, especially if it is in or near an urban center.

As for revising the date of the transition from two-operation to one-operation machines to before 1810, the sample evidence so far gathered does not support the documentary evidence that nails produced from one-operation machines were available as early as 1807. The cut nails from the Adams Birthplace in Quincy, the Unitarian Church in Carlisle, and the Goodwin Mansion in Strawbery Banke, which all displayed the two-operation machine characteristics, are clearly dateable to 1810-11. Coincidentally, 1810-11 was the pivotal year when Jesse Reed obtained his second successful nail machine patent and Jacob Perkins introduced his "new and improved" version of his 1799 invention. The record indicates that both of these machines immediately replaced their predecessors[35] and would have produced nails with same-side burrs and a crude bevel under the head in place of the neck — in other words, one-operation machine features.

This fact considered together with the presence of two-machine nails in three towns to the north, west, and south of Boston that date to 1810-11 support Lee Nelson's conclusion that nails found with same-side burrs are datable to after 1810.[36] We now know, however, that the method of flipping the nail plate after each cut was being used as early as 1807 in Odiorne`s factory in Malden and in the Amesbury factory. A working

hypothesis to be drawn from these incongruent facts would be that finding cut nails with one-operation machine characteristics in original material of a structure would probably date that structure to post-1810 but may not rule out a date as early as 1807 or 1808. Several nail samples that can be dated to the 1807-10 period need to be gathered and their features analyzed to either confirm or refute this hypothesis.

In summary, therefore, analysis of dated nail samples confirmed the theory that machine-cut and machine-headed nails were being manufactured and used in New England by 1795, but no samples were found that would verify that one-operation machines were producing nails before 1810. Based on these findings, a chronology for cut-nail use in New England is herein proposed that revises Nelson's chronology in some respects for the period 1790 to 1815 as it applies to New England structures. The revised chronology (Table 1) reflects the evidence found in the written documentation that could be confirmed by the dated nail samples. It also, however, leaves room for further revision should nail samples dateable to the 1807-1810 period be found that show the unmistakeable imprint of Jesse Reed's or Jacob Perkins's one-operation machines.

Conclusion

The discovery of the SPL nails in Newbury, Massachusetts, led to new research into the history of early nail technology around Boston and to the collection and analysis of nail samples from New England structures that were dateable to before 1815. This research resulted in a revision of the chronology of types and characteristics of machine-cut nails found in New England structures built between 1790 and 1820. Hopefully, this revised chronology will be useful to preservationists in the dating of late-eighteenth and early-nineteenth century New England buildings.

As always, a caveat is in order. Dating structures by analyzing its nails is not an exact science. Frequently, it is difficult to determine if nails are being removed from a structure's original material or if the nails had been used for later improvements, alterations, or repairs to original fabric. It is also important to try to determine when certain nail types may have been available in the area. Older machines may have been used well after the introduction of newer technology and urban centers may have had the newer technology sooner than rural areas. Documentary information, such as histories of the structure and its occupants and a knowledge of detail styles and methods of construction of different periods, can be critical to a thorough analysis of a building's evolution.

However, the fact that nail technology changed rapidly between 1790 and 1820 means that characteristics of the cut nails produced by the nail machines changed in noticeable stages with the adoption of each new feature to the machines, stages that are beginning to be documented and dated within definable parameters. The characteristics that reflect these stages are easily identifiable by the conservator or preservationist, and analyzing the cut nails found in a building's fabric can be extremely useful in helping to date the construction of or alterations to that building. And while the revised chronology presented here is based on data from the New England area and is therefore specifically applicable to New England structures, it may be that it has broader applicability to other areas that were part of, or influenced by, the United States in the early nineteenth century.

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Notes

1. Dr. Henry Mercer, "The Dating of Old Houses," *Bucks County Historical Society, Papers*, Vol. 5 (1923; reprint, New Hope Pa.: Bucks County Historical Society, 1973); Lee H. Nelson, "Nail Chronology as an Aid to Dating Old Buildings," American Association for State and Local History Technical Leaflet 48, History News (November 1968).

2. My thanks to E. Blaine Cliver, Chief of the Preservation Assistance Div. of the National Park Service in Washington, D.C., for copies of these specifications and drawings.

3. J. Leander Bishop, *A History of American Manufactures from 1608 to 1860*, Vol. 1 (Philadelphia: Edward Young & Co., 1868; reprint, New York: Johnson Reprint Corp. 1967), 388. William Allen, "The History of East Bridgewater, Massachusetts," *History of Plymouth County, Massachusetts*, D. Hamilton Hurd, ed. (Philadelphia: J.W. Lewis & Co. 1884), 854. Deposition of Samuel Rogers, June 19, 1819, Essex County Registry, Executions, Book 3, Leaf 150, taken in connection with Odiorne v. Amesbury Nail Factory, Federal Circuit Court, Massachusetts District (May term, 1819).

4. Charles F. Meserve, "History of Abington Massachusetts," *History of Plymouth County, Massachusetts* (1884), 464-465.

5. Nahum Mitchell, *History of the Early Settlement of Bridgewater in Plymouth County, Massachusetts* (1840; reprint Boston: Kidder & Wright 1897). Deposition of Samuel Rogers, June 19, 1819, Essex County Registry, Executions, Book 3, Leaf 150 taken in connection with Odiorne v. Amesbury Nail Factory.

6. Lee Nelson demonstrated this seemingly anomalous fact in 1962 in his "Nail Chronology" pamphlet, reversing what had previously been assumed. See Mercer, "The Dating of Old Houses," for a discussion of the previously accepted theory.

7. Bishop, 499; Amos J. Loveday, Jr., *The Rise and Decline of the American Cut Nail Industry* (Westport, Conn.: Greenwood Press, 1983), 5.

8. For a discussion of the history of these men and the nail-making industry in New England at the turn of the 19th century, see Maureen K. Phillips, "A Revised Chronology of Cut Nails in New England 1790-1820: A Case Study of the Spencer-Pierce-Little House Addition," (Master's thesis, Boston University, Department of American and New England Studies Preservation Program, 1989).

9. There were only three patents for nail-cutting machines registered before Jacob Perkins's 1795 patent. See *Digest of Patents Issued by the United States from 1790 to January 1, 1839* (Washington, D.C.: 1840). *Early Unnumbered United States Patents 1790-1836: Index and Guide to the Microfilm Edition* (Woodbridge Conn.: Research Publications, Inc. 1980). *Index of Patents Issued from the United States Patent Office from 1790-1873*, 3 vols. (Washington, D.C.: 1874). The Digest appears to have been the source for Bishop, which in turn, has been the source for most subsequently appearing reports. See, for instance, James M. Swank, *History of the Manufacture of Iron in All Ages and Particularly in the United States from Colonial Times to 1891* (1892; reprint, New York: Burt Franklin, 1965), 134.

10. *Early Unnumbered United States* Patents 1790-1836, Reel 1S, No. 29.

11. Deposition of Michael Morrison, May 21, 1814, taken in connection with Odiorne v. Winkley, Federal Circuit Court, Mass. District (October term, 1814), case papers at National Archives, Waltham, Mass. Deposition of David Johnston (n.d.), taken in connection with Cutter v. Reed, filed with case papers for Odiorne v. Winkley. Deposition of David Mooers, July 27, 1819, taken in connection with Odiorne v. Amesbury Nail Factory, Essex County Registry, Executions, Book 3, Leaf 155.

12. Ibid.

13. *The Impartial Herald* (Newburyport, Mass.), November 24, 1795.

14. English Patent No. 3365, application dated July 26, 1810; specifications filed January 26, 1811.

15. Ibid.

16. The circa-1805 machine-cut brads found at the Spencer-Pierce-Little House in Newbury, thought to have been produced at Amesbury, have rounded driving ends, an indication of cross-grain iron direction.

17. Deposition of David Johnston, April 23, 1810, taken in connection with Odiorne v. Winkley. Deposition of Timothy Allen, June 18, 1819, taken in connection with Odiorne v. Amesbury Nail Factory. Specifications to Jesse Reed's 1807 patent, as incorporated into the court record for Odiorne v. Winkley.

18. Francis B.C. Bradlee, "The Salem Iron Factory," *Essex Institute Historical Collections*, 54 (April 1918): 110-111. *The Diary of William Bentley, D.D.*, vol. 2 (1905; reprint Salem: Essex Institute, 1962), 239, entry dated October 4, 1797: "Dr. Reed supposed that Newhall of Stow, has stolen part of his machinery & not gotten a patent for it."

19. *The Diary of William Bentley, D. D.*, vol. 3, p.497. Reverend Bentley (1759-1819) was a Unitarian minister for East Church in Salem. Bentley traveled widely in the Essex county area and meticulously recorded in his diary his observations of the people and places he encountered during those travels, to the delight of 20th-century historians.

20. See, for instance, *Diary of William Bentley*, vol. 2, 393, entry for September 15, 1801.

21. Bishop, vol. 1, 498; vol. 2, 125-126. Loveday, 25. Swank, p. 448.

22. *The Diary of William Bentley*, vol. 2, 239, entry dated November 4, 1797: "The little squabbles of these mechanic geniuses and duckies are as curious as between our itinerant Baptist and Methodist preachers."

23. *Digest of Patents. Early Unnumbered United States Patents. Index of Patents.* A chronological and alphabetical compilation of nail patents from 1790 to 1850 is included in Phillips, "A Revised Chronology of Cut Nails in New England."

24. Specifications to Jesse Reed's 1807 patent, as incorporated into the court record for Odiorne v. Winkley. Deposition of David Johnston, Odiorne v. Winkley. Deposition of Timothy Allen, Odiorne v. Amesbury Nail Factory.

25. *Edward H. Knight, Knight's American Mechanical Dictionary*, vol. 2 (Cambridge: Hurd & Houghton, 1877), 1508-1509.

26. See Lee Nelson's "Nail Chronology" pamphlet for helpful diagrams illustrating the cutting of nails from same and opposite sides.

27. Anthony F. C. Wallace, *Rockdale: The Growth of an American Village in the Early Industrial Revolution* (New York: Knopf, 1978), 207.

28. *Digest of Patents. Early Unnumbered United States Patents. Index of Patents.*

29. The Spencer-Pierce-Little House is the property of the Society for the Preservation of New England Antiquities. For a history of the house and its occupants, see Phillips, "A Revised Chronology of Cut Nails in New England."

30. See Phillips, "A Revised Chronology of Cut Nails in New England."

31. Nelson, p. 6.

32. My thanks to John Schnitzler of Strawbery Banke, Portsmouth, New Hampshire, for sharing his nail collection.

33. Advertisement for Armstrong & Perkins in *The Newburyport Herald*, May 8, 1798. Bradlee, 110-111. See also advertisement in *The Impartial Herald*, June 6, 1795, in which Wingate & Clark General Store offered cut and wrought nails up to 20d.

34. This belief may have originated partly from the British attempt to flood the American market with cut nails manufactured using American machines and low-quality iron. See extract from Report from the Secretary of the Treasury to the House of Representatives on American Manufactures (April 17, 1810). Specifications from Jacob Perkins's English patent (1810).

35. See advertisement in *Portsmouth (N.H.) Oracle*, May 25, 1811, for Amos Winkley offering "a large assortment of Perkins' newest Patent cut nails".

36. Nelson, p. 6.

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