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Preserving The History of Worcester's Wire Industry

An Interactive Qualifying Project Report

submitted to the Faculty

of the

WORCESTER POLYTECHNIC INSTITUTE

in partial fulfillment of the requirements for the

Degree of Bachelor of Science

by

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Date: May 5, 2006

Professor David A. Rawson, Major Advisor

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May 5, 2006

Dear Professor Rawson:

Attached is one copy of the Interactive Qualifying report: Preserving the History of Worcester's Wire Industry, Project Number DZR 1001.

Sincerely,

Jeffrey LaPierre

Preface:

This report serves as an explanation of the importance of Worcester and its county in the development of the American wire drawing industry. The report will assist William A. Wallace, Director of the Worcester Historical Museum in the construction of an exhibit at the Blackstone Valley Heritage Corridor Visitor Center.

I would like to give thanks to both the Worcester Historical Museum and Harvard Business School Baker Library Staffs for their cooperation in aiding me in the research of this topic.

Abstract:

This project will entail a study of the wire drawing industry in Worcester Massachusetts. The Worcester Historical Museum will ultimately use this research to establish an exhibit for its new home in the Blackstone Valley Corridor Visitor Center. Historical recourses relating to the wire drawing process will be located, analyzed and compiled. At one time Worcester was the worlds largest wire producer. Moreover, wire manufacturing was Worcester's largest industry and therefore played a crucial role in molding the social foundation of the city. The Wire industry influenced technological innovation and brought prosperity to Worcester.

STRANDS OF TIME

by Jeff LaPierre

Wire was essential to the growth of American technology throughout the nineteenth and twentieth centuries revolutionizing the transportation, communication and energy industries in America. Additionally wire assisted in the taming of the western United States by providing an affordable means of controlling cattle and setting boundaries in areas where there were few natural resources.

At one time, Worcester, Massachusetts, was the world's largest producer of wire, thus making it Worcester's largest industry. Wire manufacturing played a crucial role in forming the social and economic foundation of the city, influencing technological innovation and bringing prosperity to the city. There are however, questions which remain unanswered. What was the demand for wire early on, before the introduction of barbed wire? Why was wire manufacturing centered in Worcester? Furthermore, what led to the demise of the wire industry in the late 1970s?

WHY WIRE

In order to study the origins of the wire industry in America, one must first understand the importance of wire to the early American's. The Colonists found themselves in a new world filled with abundant resources such as arable land, minerals, and timber. Although the Colonists were forbidden by the English to manufacture goods for sale or export, from the very beginning they made clothing, tools, furniture, and other goods for personal use or for bartering. Early textiles were made of wool which was sheared from sheep that grazed in back of or sometimes in front of the homes of many Colonists. The wool was then carded by hand using hand carders to remove debris that the sheep had recently encountered and to align the fibers allowing the wool to be spun

on a spinning wheel to make yarn. The yarn could then be woven into clothing or countless other textile goods.

The demand for wire lies in the hand carders which were two blocks of wood with a handle attached to one side and a matrix of hundreds of pieces of fine wire prongs attached to the reverse side. Although the Colonists had a plentiful supply of wood for the body and handle of the carders, there was not a single wire maker in the United States to provide the wire required to produce the prongs. All wire had to be imported from England and the Colonists not only had to pay a premium due to its scarcity, but they also had to pay the infamous British tariff. The reason for the lack of wire makers in America remains uncertain. There is evidence that owners of wiredrawer's tools and equipment wrote to the General Courts of Massachusetts and Connecticut as early as 1640 (Lewis, 29) asking for compensation in return for establishing a wire business. One has to wonder if there was a demand for wire during this time period, then why was it not profitable enough to start a business, especially considering they already had the equipment. Ironically, although it appears the Court never responded to these requests, later records show that the Courts sometimes offered wiredrawer's tools to anyone who cared to set up a mill, however it appears there were no takers. (Lewis, 29).

The dawn of the American wire maker was driven out of necessity in response to the 1774 Coercive Acts passed by English Parliament which cut off all shipping in to and out of Boston Harbor. Simply put, without imported wire from England, Americans would have no wire or many other goods for that matter.

Wire cards didn't last forever, the wire teeth would eventually either pull out or succumb to metal fatigue from being worked back and forth and break off. Additionally, the Coercive Acts of Parliament which halted all trade with England meant that there would be no imported textile

products. This shortage of imported textiles therefore resulted in a greater demand for locally made textiles which in turn required the production of more wire cards.

The Colonist's solution to this dilemma was the micro-wire drawing operation. Local craftsman such as blacksmiths who already had access to many of the resources needed to draw wire would make their own specialized tools and dies to produce small quantities of wire on a part time basis throughout the Revolutionary war. Slabs of iron were first heated red hot and hammered out into flat sheets which were then cut into long strips. The strips were then hammered into slender, cylindrical bars and pulled by hand through a heavy die with tapered holes using blacksmith tongs. The tapered hole of the die would compress the iron, thereby reducing its diameter. Although these small operations allowed Americans to subsist during the war, it must not have been cost effective, because soon after 1783 the importation of wire from England resumed.

The importance of becoming an industrially independent nation in terms of wire and wire card production was realized during the war. This is demonstrated in the following manuscript from the records of the General Assembly of South Carolina.

In the General Assembly, the 22nd day of August 1777.

> "Report of the committee to whom the Petition of Thomas Lenoir was referred, as amended and agreed to by the House. "That they have considered the Petition of Mr. Lenoir, and have had sufficient evidence to convince your committee that the said Petitioner is qualified to carry on business both of drawing the wire and making as good wool and cotton cards are usually imported into this State, and do therefore recommend that the sum of Two hundred pounds be immediately given to Mr. Lenoir, as reward, he being the first Person that has begun business, and a farther sum of Eight hundred pounds advanced him on his giving an obligation to deliver to Joseph Kershaw, Esquire, at Camden, and in case of his death or absence from the State, to such Person as may be appointed by the President for the time being to receive the same, to be sold on account of the public, after giving twenty days Public notice of such Sale, forty pair of good cotton cards at the end of one year, and forty pair equally good at the end of the second year, proved upon oath to have been all manufactured by Thomas Lenoir within this State.
>
> "Ordered, That the Commissioners of the Treasury be served with a copy of the foregoing Report, and that they advance the sums of money and take the obligation therein mentioned (Lewis, 31-32).

Clearly, it was becoming evident that in order to be economically successful, American's needed to become industrially self sufficient and be able to produce their own wire cards. It is also evident, once again that the cost of starting a wire making business must have been exorbitant in proportion to the returns. Perhaps the most telling account describing the hefty cost and close profit margins associated with producing cards is a letter dated 1789 to Pliny Earle of Leicester Massachusetts from a textile manufacturer, asking for a quote on re-covering the drums of their carding machine. In the letter from Almy & Brown they include the specifications of their carding drums to be covered, then they go on to explain how they have already obtained prices from another card maker which they thought was too high. They say "We are not desirous of beating thee down in thy price, or thou should do it below what thou could reasonably afford, but …" (Lewis, 33). Despite the fact that this letter was written only 15 years since there was practically no wire making in America, evidently card wire makers were becoming more common.

As the industrial revolution began to take hold in America beginning with the first successful textile mill built in Pawtucket Rhode Island, by Samuel Slater in 1793 the demand for card wire increased. On February 14, 1812 Oliver Evans, a mechanical genius, entrepreneur, and former micro wire maker himself wrote an article in the Philadelphia Aurora "urging Americans to revive the U.S. textile industry by going into the manufacture of card wire" (Lewis, 35). This statement implies that the short supply of card wire was hampering the textile industry in America.

THE SPENCER COMPANIES

Oliver Evan's article demanding American industrial self-sufficiency was further reinforced when War broke out in 1812. In the War of 1812 the British formed a blockade, once again severing United States trade from the rest of the world. Many Americans agreed with Evans, and that same year several wire operations were established. One of the first and most significant wire

mills of this time period was the Spencer Wire Company which was founded by Jacob Watson, who started his business drawing wire in his kitchen in Spencer Massachusetts. By 1812 Watson's business had become profitable enough to take on a partner named Windsor Hatch. Watson and Hatch set up a formal mill on the outskirts of Spencer Massachusetts where the Turkey Hill Brook meets the Seven Mile River.

Just after Jacob Watson and Windsor Hatch completed their mill in 1812, they received some competition from another wire drawer named Elliot Prouty from nearby Cherry Valley. Elliot Prouty also decided to build his wire mill on the Seven Mile River, located immediately downstream from the Watson and Hatch mill. Records of both these early ventures are vague, and it appears that due to economic conditions they did a combination of farming and wire drawing off and on (Lewis, 43-44). In 1820 Elliot Prouty returned from New York after a brief abstinence from wire drawing to join his brother Russell Prouty and resume wire making in Spencer. The two brothers appeared to have been financially successful and in 1822 Russell Prouty was granted a U.S. patent for "an improvement in the art of wire drawing." Unfortunately, we do not know what his "improvement" was, because apparently the U.S. Patent Office destroyed all records pertaining to this patent. Although the exact sources of the iron which supplies these early companies remains unknown, it is believed to have been refined locally. Jonathan and Nicholas Jenks operated a forge on the Five Mile River which refined Iron Ore that was left in bog deposits in and around Lakes Quabog and Wickabog (Lewis, 46). Considering the close proximity of this forge to the two wire mills and the fact that the area was very remote making transportation difficult it is highly likely this was the source of iron billet.

Spencer, an area which soon became known as "Wire Village" was located in the epicenter of the early American textile industry. There were textile mills in nearby Worcester, North Uxbridge, and Rhode Island all of which were in need of a reliable supply of card wire for their carding

machines. This area also had an ample supply of hardwoods, timber, and streams with fast moving water current. As a result of these resources the area attracted many mechanically inclined, skilled craftsmen, who built saw mills, grist mills, fulling mills, flax mills, and trip hammers. Many of these same skills could be applied to the manufacturing of wire, and in a then relatively unindustrialized, agriculturally based society this alone was a major contributing factor. As one author states "Worcester county never lacked sons of hers ready to ransom themselves from poverty and obscurity by mechanical skill" (Smith, 13). Without doubt it is largely the geographic location of Spencer and the surrounding community which made Wire Village. Although the exact date is unclear it appears as though Foster and his brother Rosell Bisco took control of the Watson and Windsor mill in Spencer around 1820. The earliest known records which mention ownership of both the Watson and Winsor mill and the Prouty mill by the Bisco brothers are dated 1847 (Lewis,45).

The Washburn & Moen Wire Company

Ichabod Washburn was born August 11, 1798 in Kingston, Massachusetts. As a young boy Ichabod became fascinated by mechanical things and in 1814 he moved to Leicester Massachusetts to start a blacksmith apprenticeship under the direction of Jonathan and David Trask. Ichabod worked very hard and he soon excelled at his trade, however he continually yearned for "a higher order of mechanical business" (Washburn/Cheever, 41). After completing his apprenticeship Washburn first went to work for an Armory in Millbury where he forged parts for firearms. Word of Washburn's talents circulated about the region and in July of 1819 a machinery manufacturer in Worcester named William Hovey approached Washburn with a job offer. Ichabod willingly accepted the offer as it was the answer to his dream of tinkering with mechanisms and machinery. While working for Hovey, Washburn learned to forge and finish machinery parts; he "soon acquired

a practical knowledge of all the different kinds of work on machinery" (Washburn/Cheever, 43). The following year Washburn decided to go into business with William H. Howard, exercising his new found knowledge in the manufacture of woolen machinery and lead pipe. Despite their best efforts the business was dwindling and in 1822 Washburn's partner, Howard, decided that he wanted out. Ichabod decided that he did not want to give up, so he bought out Howard's share of the company. Washburn's disparity is displayed in the following quote "I had only enough to employ myself and one man" (Washburn/Cheever, 43). Times were tough for Ichabod, but he was determined to make his business a success and he continued to toil away.

Then one day Washburn's luck seemed to change for ever. After seeing a subscription paper, he was coaxed in to subscribing by a man named Dr. Melvin who seems to have had some sort of political connections. Melvin said "Put down fifty cents, young man, and you will soon see it come back to you again" (Washburn/Cheever, 43). Miraculously, within weeks he was swarming with business and had a very large, lucrative order for lead pipe. The demand for Ichabod's wool machinery also increased and Ichabod claimed that "From that time to this, I have never lacked work, or the opportunity of facing a subscription paper, and am a confirmed believer in the scripture truth that "he which sowith bountifully shall reap also bountifully" (Washburn/Cheever, 44).

At this point Ichabod decided that he had enough business at this point to form a partnership with Benjamin Goddard. This new partnership resulted in the creation of the Washburn & Goddard Company. After selling the lead pipe and wool machinery business, Washburn and Goddard purchased a water power site in Northville (present day North Worcester) and constructed a facility to manufacturing wire and wood screws. In 1831 Washburn and Goddard began drawing iron wire. The first wire machine Washburn and Goddard used was typical of the time period. The machine had self-acting pinchers that grabbed the wire and pulled it through the die, however it was limited to pulling only about one foot of wire at a time. Although the machine was more efficient

than hand drawing wire, it was only capable of producing approximately fifty pounds of wire per day. Having an eye for mechanical innovation, Washburn saw many ways of improving the machine. The results of Washburn's improvements to the machine's output were phenomenal. The length of wire that could be drawn was increased to fifteen feet per pass, and wire output was boosted to 500 pounds per day. Despite this vast improvement in the wire drawing process, Ichabod still was not satisfied. Ichabod explains "We soon, however, substituted the Drawing Block, which has never since been improved. With this, a man can conveniently get off twenty-five hundred pounds in a day" (Washburn/Cheever, 46). The "drawing block" that Washburn refers to is a wedge device that grabs onto the wire protruding from the die and pulls the rod through the opposite side. Utilization of the block's wedge that retained the wire generated a significantly greater clamping force, allowing larger wire reduction steps per pull. With the ability to reduce the wires diameter in fewer steps the wiredrawer could produce more linear feet of wire per day. Wire making proved to be a thriving business endeavor for the partners and they were rapidly outgrowing their small mill in Northville. Ichabod said "This business we pursued there about three years, when we had so far out-grown the water power, that we were obliged to remove to where we could obtain more" (Washburn/Cheever, 44). For some reason, at this point Washburn and Goddard decided to go their separate ways.

In 1834 Washburn moved into the newly constructed Grove Mill complex, located on Grove Street in Worcester. The complex had been built by Stephen Salisbury II specifically for wire drawing under the guidance of Washburn himself. By 1835 Washburn was employing about 25 workmen and occupied approximately 7,000 square feet of space in the Grove Mill complex and the business continued to grow. In order to take advantage of his innovations in the wire drawing process, Washburn was faced with the problem of efficiently producing suitable bars of reasonable length which could be cold drawn into wire. The solution to this predicament was to construct a water and steam powered bar mill at the south end of Lake Quinsigamond called the South Works.

The bar mill was comprised of four rolling stands equipped with flat rolls between which the heated iron billet would pass through and become narrower in cross section and elongated lengthwise. The bar rolling mill required a skilled labor force to operate. Expedient workmen had to carefully grab the hot steel rod as it passed through one set of rolls using tongs and feed it into the next pair of rolls where the diameter would be further reduced. If a worker went to slow the bar would cool before passing through the rolls and jam. On the other hand, if he were careless and at any time inadvertently come into contact with the red hot bar, he would be severely burned.

Another problem which presented itself was how to efficiently remove the scale and slag that formed on the surface of the bars after being subjected to the extreme heat involved in the hot rolling process in the bar mill. The residual scale and slag had to be removed from the bars prior entering the wire drawing dies. Due to the extreme pressure exerted any slag or irregularities left on the surface of the bar could potentially damage either the die or the wire itself. There was an old saying amongst well seasoned wire drawers that "A rod well cleaned is half drawn" (Lewis, 85). The problem of cleaning hot rolled bars was not new, in early days this process was accomplished by hand. Women and children would remove the scale from the freshly rolled bars using either a brick or a wet rag covered in sand. Production had now reached a level where this was no longer cost effective therefore alternative methods had to be found. The solution was to tumble the bars lengthwise, in long drums filled with water and sand.

Once again Ichabod found himself flooded with work, and in 1842 Ichabod Washburn went into partnership with his brother, Charles Washburn. The partnership between the two brothers only lasted seven years, and in 1849 Ichabod Washburn and his brother Charles Washburn decided to split up. The following year Ichabod Washburn formed a partnership with his son in law, Phillip L. Moen who had experience with business management. In reference to Moen, Ichabod said

> "I have had a most efficient aid in bringing up the business to its present mammouth size. While he makes no claim to be a practical mechanic, he has by his exactness, promptitude, and

> aptness for business generally, supplied a deficiency in myself indispensable to success. He has managed with rare ability our finances, a department of the business for which I never had the taste or inclination, always preferring to be among the machinery, doing the work and handling the tools I was used to, though oftentimes at the expense of smutty face and greasy hands" (Washburn/Cheever, 48).

Though the partners clearly had different strengths, their skills complimented each other nicely, leading to the Company's ultimate success. By 1850 the Washburn & Moen Company was turning out over six-thousand pounds (Erskine, 3) of wire per day and they were now competing on an international level. They began making wire for the Chickering Piano Company of Boston which had previously purchased exclusively Webster wire that had been imported from England for over eighty years.

The increased volume and demand for longer lengths of wire during the 1850s was once again placing a strain on the bar cleaning methods. The bars of increased length, that were required in order to produce longer lengths of wire were becoming so long that they would become twisted and entangled in the abrasive tumblers. In dire need of an alternate scale removal process, Washburn & Moen began using vitriol, a highly concentrated solution of sulfuric acid. After passing through the bar rolling mill at the South Works, the rods would be placed in huge vats and left for a period of time to pickle the bars. The process eliminated damaged rods and the resulting surface was much cleaner than that produce with tumbling. Although pickling solved many of the production problems associated with slag removal, the used of acid opened a can of worms. One of the problems resulting from the use of acid in the pickling process is the dissociation of hydrogen from the acid solution into the steel. This influx of hydrogen into the steel caused the steel to become brittle and prone to failure, an effect known as hydrogen embrittlement. This mysterious effect resulted in many catastrophic failures of wire products early on and as a result, the study of metallurgy to minimize the occurrence of these failures became increasingly important. Hydrogen embrittlement was however, only one of the many problems associated with the acid pickling

process. Kenneth B. Lewis who was later an engineering consultant for the Washburn & Moen Company said "Nothing can be found in the shape of a description of early cleaning houses, but if they were any worse than the ones I found when I started, and instinct tells me they probably were, you wouldn't believe it anyway" (Lewis, 93-94). The caustic sulfuric acid attacked everything in site. The workers in the cleaning house wore exclusively rubber boots because the acid would disintegrate normal shoes, and one can only imagine the toll the acid took on the workers health. More often than not the workers had no teeth, and in more severe cases, after working in the houses for extended periods of time many workers found themselves without a respiratory system.

At some point in (1850?) the Washburn & Moen Company purchased the English patent rights from Bessemer who had developed a lime baking process that eliminated the hydrogen embrittlement associated with the acid pickling of the bars. The result of this process was a 12.5 percent increase in tensile strength increase over previous the methods (Washburn/Cheever, 51). Washburn & Moen also held the patents for galvanized wire, making them the sole galvanized wire maker in the United States. Galvanized steel wire became the wire of choice for the upcoming telegraph movement, and the fact that Washburn & Moen had the patent for galvanized wire combined with the ability to make wire while avoiding hydrogen embrittlement, meant that they would be the primary supplier for the telegraph movement.

As the Washburn & Moen Company grew and production soared, the Grove Mill complex was becoming outdated and inefficient. Additionally the partner's were faced with a shortage of round hot rolled bars from which the wire could be cold drawn from.

In 1864 the original Washburn and Moen Wire mill, built in 1834 by Stephen Salisbury II was torn down and replaced with a larger building employing new technology. In order to benefit from the new mill's full potential both Ichabod Washburn and Philip W. Moen realized they were in need of a highly skilled superintendent. After an extensive search for a new superintendent, friends of

Washburn from nearby Clinton Massachusetts recommended a resourceful young man named Charles Hill Morgan.

Morgan had previous experience working as a draftsman for both the Lawrence Machine Company and the Clinton Wire Cloth Mills. In an 1860 business venture with his brother, Francis H. Morgan, Charles Morgan had also invented the machine used to form the square bottoms of brown paper grocery bags, which is still in use today.

Washburn and Moen knew Charles Morgan was the man for the job, and after interviewing him he was hired as the superintendent of the Washburn & Moen Wire mill.

One of Morgan's first tasks when he came to Washburn & Moen was to build a bar rolling mill that would efficiently produce rods of consistent size and quality. After some research Morgan discovered a bar mill that had been developed in England in 1862 by George Bedson. Bedson's rolling mill was a continuous rolling mill which was much more efficient in comparison to Washburn's current reverse rolling mill located at the South Works. By 1866 the Washburn & Moen Company employed between 650 and 700 workmen, and occupied approximately 100,000 square feet of space in the new mill complex. Furthermore, annual production had reached well over 2 million dollars (Washburn/Cheever, 52). It appeared as though the inefficiency of the bar mill was the primary limiting factor as far as growth of the company was concerned.

In 1868 the treasurer of the Washburn & Moen Company, William E. Rice, traveled to England and purchased a Bedson mill along with the American rights to the Bedson mill. Morgan had the new Bedson mill up and running in Worcester on May 30, 1869. The Bedson Mill was powered via a single steam engine which drove 32 opposing horizontal and vertical grooved rollers. The horizontal rolls were driven by an overhead line shaft which transmitted power through bevel gear sets with ratios which increased in proportion to the elongation of the bar as it traveled to subsequent rollers. The vertical rolls were powered in a similar fashion from a line shaft located

beneath the floor. Although the Bedson mill was an immense improvement over the previous mill, the flaw in its design is that the water used to cool the rolls and keep them free of abrasive mill scale fell directly onto the line shafts, bevel gear sets, and the support bearings. As one may deduce, this led to extensive corrosion, and premature wear of all lower mechanical components. Morgan said that the Bedson Mill "entailed vast annoyance in the care and management of the mill" (Erskine, 7). Morgan determined that there were clearly many shortcomings in the Bedson Mill, therefore when Washburn and Moen needed an additional mill he made significant alterations to the design. Morgan's redesigned bar rolling mill, later dubbed the Morgan Mill eliminated the need for a second set of horizontal opposing rolls by rotating the bar along its center axis as it passed between two vertical opposing rollers. This revolutionary rotation of the bar was made possible through the use of Morgan's patented twist guide (U.S. Patent No. 220,033) which is still in use today. This was an important development as it meant the elimination of all lower rollers, bearings, and gears, virtually eliminating all the problems associated with the Bedson mill design. Furthermore, the twist guide boosted production by permitting several rods to be passed through the rolling mill, side by side, simultaneously. The Morgan bar mill allowed the production of wire coils weighing as much as 150 lbs. and up to five times the length of previous coils. Once again, wire coils of increased length were essential in the development of the telegraph, and having the capability to produce coils of this length gave the Washburn & Moen Company an edge over the competition.

Following the end of the Civil War, Washburn donated a building to Worcester Polytechnic Institute (WPI) which opened on November 10, 1868. This building, which was named Washburn Shops, is the fulfillment of Ichabod Washburn's vision. The Washburn Shops is an industrial facility designed with the intent of providing students the ability to apply theory in practice. Unfortunately, Ichabod Washburn's health deteriorated following a paralytic stroke he had earlier that year on February 4, 1868. On December 10, 1868 Ichabod rode out to the shop to see it in operation.

Tragically, that night Ichabod turned to his brother Charles and said, "It's all right" and he died. The completion of the shops was symbolic of a new era in New England. During this time there was an abrupt movement from rural farm life to an industrialized society. According to Erskine the wire mill was the "keystone" of this growth (Erskine, 5). Following Ichabod Washburn's death, his brother Charles took over his responsibilities at the wire mill.

After graduating from WPI in 1873, Fred Daniels was hired by Washburn & Moen to work under the direction of Charles Morgan. Daniels' first assignment was to assist in the further improvement of the Bedson mill in addition to the inadequate Sieman's furnace which was used to heat the steel billet before entering the mill. The following year, in 1874, Washburn & Moen sent Fred Daniels to Lafayette Collage in Pennsylvania to study metallurgy, thereby enabling the company to improve the quality of their product.

Time passed and the demand for wire increased, as did its applications and specifications. Wire production was no longer primarily for textile cards. Telegraph wire, hoop skirts, wire fence, and wire nails required wire of increased length, and of larger diameter. Furthermore, wrought iron which had previously been used was becoming obsolete, in favor of Bessemer steel, that offered higher tensile strength, a and greater product consistency. With the establishment of technical institutions such as the nearby Worcester Polytechnic Institute, the use of chemistry, metallurgy, and pyrometry was becoming more common. The Wire Village back in Spencer soon found itself behind the curve and unable to meet the modern day industrial demands.

The next major movement in the wire industry was driven as a result of the American westward expansion. Farmers and Ranchers were attracted to the western states due to the surplus of cheap flat land, with rich rock free soil, and extended growing season. Despite the advantages to the west, resources such as timber were scarce in comparison to the east coast. The area was also full of unwanted critters that could wreak havoc on crops and farm animals. Cost effective fencing was a

problem for western settlers and without timber to make split rail fencing, they were forced to seek alternatives. Charles Washburn saw a demand for wire fencing as he believed it would assist the settlers in the taming of the West. The first wire used for fencing was simply smooth wire, stretched taught and stapled to supporting posts. Although these fences were an improvement over nothing, they were in many cases futile against halting the passage of hungry predators and farm animals. The settlers eventually began affixing sharp pieces of wood and metal to the wire, and the modification proved effective. In 1873 Joseph Glidden filled a patented for "barbed wire" which consisted of two twisted wires that prevented the barbs from moving. Glidden began purchasing wire from the Washburn & Moen Company to manufacture his barbed wire and they soon learned of his product. Eager to diversify, Washburn & Moen purchased the patent rights for Glidden barbed wire in 1876 for $60,000 (Ellwood, 1).

On July 17th, 1876 the Washburn & Moen Manufacturing Company sold its first coil of barbed wire to Kinnicutt & Company. Other than the obvious differences between this product and the wire the company had previously manufactured, this wire sported an important technological breakthrough. The barbed wire referred to as #12 fence wire was made of Bessemer 0.10 percent carbon steel. Prior to the production of barbed wire, wire fencing was either made of #8 or #9 wire drawn from the "cheapest kind of iron" (Hall, 1). The iron was scrap that was heated and run through the rod mills at Quinsigamond. The #12 Bessemer steel wire had a tensile strength of about 614 lbs. in comparison to the #12 iron wire which had a tensile strength of only 408 lbs. The significance of this was that the wire having increased tensile strength per unit area could be drawn to a smaller cross section in order to achieve the same total strength. By enabling the use of smaller diameter wire, less steel was needed for a given length of wire, thereby reducing both the cost and weight of the wire. Because the wire weighed less per linear foot, coils were cheaper to ship and wire could span a greater distance without the aid of supporting posts.

In 1882 Oscar C. Johnson emigrated to the U.S. from Sweden as an expert in metallurgy. He had heard of the Wire Village in Spencer along the way, however upon arrival he found no work. He turned around and returned to Worcester where he was hired by Washburn & Moen. Areas of Sweden shared many of the same traits as Worcester County, having a plethora of brooks and streams and during the long winter months farmers would go to work in makeshift mills set up in their barns. Many of these mills produced wire, and the Swedes were true artisans of the trade, having a good feel for the wire. Washburn and Moen recognized this and they encouraged many wire drawers to come to America to work in the Worcester mills.

By 1884 the total annual wire production in the United States had reached 135,000 tons. The North Works alone accounted for about 25 percent of this or 33,750 tons (Henry M. Smith, pg3). The Washburn & Moen Manufacturing Company was outgrowing Worcester altogether, and on January 16, 1891 they purchased land in Lake County Illinois to construct another wire mill called the Waukegan Works. Construction of the new mill began in March of 1891. By September of 1891 the Waukegan Works wire galvanizing division had been completed and became operational. The wire drawing portion of the Waukegan Works began drawing its first wire in December of 1892. The Works soon became an important staple to Lake County Illinois. Production increased at the mill, and people were drawn by the grove to work in the mills. The Waukegan Works attracted many related industries and businesses that would turn the mill's wire into finished goods. The mills also attracted many European immigrants from Finland and Sweden. Thomas Edison's perfection of the incandescent light bulb in 1879 had created an entire wire dependant industry that had begun to take hold by the 1890s. With the increased demand for copper electrical wire, Washburn & Moen constructed a copper refinery at the Waukegan Works in 1892. The construction of the refinery was justified by the fact that they could not obtain high quality pure copper necessary for its conductive

properties elsewhere. Once again Washburn & Moen would have a distinct advantage over the competition.

In 1899 The Washburn & Moen Manufacturing Company was purchased by The American Steel and Wire Company forming the largest wire corporation in the United States.

The 20th century ushered in many significant improvements for the first time since the late 1860s. Many of these improvements came in the way of safety and efficiency of the mill. The rod cleaning house was perhaps, the most in need of reform. Lewis claims that while working for Washburn & Moen as a consultant who often had to visit the cleaning house "it was only after several weeks of acclimating that I was able to stay inside the crane circle long enough to follow a load all the way around" (pg 94). Clearly, although bar cleaning was essential to the wire drawing industry, the pickling operation left a lot to be desired in terms of the welfare of the workers. Beginning in the 1920s the cleaning house began to see many improvements. From a production standpoint the adoption of the overhead gantry crane which would dip the bars into the acid baths boosted efficiency and allowed better utilization of cleaning house floor space. At the same time the gantry crane also kept the crane operator at a safer distance from the acid bath. The application of the hairpin hook to the overhead gantry crane around 1927 was perhaps one of the most significant innovations for the worker's sake. Prior to the use of the hairpin hook, bundles of bars were attached to the cranes cables via a yoke which workers would have to manually secure to each bundle while standing directly over the acid baths. With the hairpin hook, the bundles of rods could be placed into baskets with a lifting hook and lowered into the acid bath. Once in the bath the cable could then be slackened by the crane operator at a safe distance, freeing the hook in order to place the next load. Improvements in the ventilation of cleaning houses were also made throughout the 1920s, which both improved the working environment and prolonged the life of the structure surrounding the acid baths.

Another problem associated with the pickling process was the disposal of the copious amounts of highly concentrated sulfuric acid. In the beginning waste acid was simply dumped on the ground, typically near the corner of the property where it would run away from the premises. The problem with this practice is that the sulfuric acid did not evaporate over time; instead it was absorbed into the ground and would work its way into the local aquifer. In some cases wells drilled near or down stream from bar cleaning operations turned up highly concentrated levels of acid despite reaching hundreds of feet into the ground. Eventually, local officials began to frown upon the dumping of acid and users began looking into alternative methods of disposal. One technique was to react the acid with scrap pieces of fine wire which would then form hydrogen gas and leave behind crystals containing iron and salts. The resultant hydrogen gas was expelled into the atmosphere and the crystals could either be dumped somewhere, now having been neutralized or heated in a kiln to produce red oxide. Red oxide was sold as a pigment known as Venetian Red which was used to make paint. The problem with making red oxide for resale is that the supply of red oxide far exceeded the demand and it became unprofitable to produce. Most wire mills which attempted this form of acid disposal soon reverted to their previous method of dumping despite continuing pressure from public authorities. Authorities were well aware of the expenses involved with proper acid disposal and knew that the mills could not survive if the exercised them, therefore they looked the other way. Acid disposal was a very shady topic and most were very reluctant to discuss the issue. When Lewis was working as a consultant for Washburn & Moen in 1935 he curiously inquired about their method of acid disposal. Upon asking the mill's managers they looked at each other and said "Lewis, we put it in a hole in the floor." Lewis then replied "where is the other end of the hole?" The manager then responded "The man who used to know is dead" (Lewis, 111). The replacement of dangerous acid pickling operations with foam inhibitors began to creep into the cleaning houses during the 1920s. Foam inhibitors were discovered as replacements for the pickling

process during the First World War when there was an acid shortage. There were several different inhibitor concoctions that were commonly used one of the most common was a mixture of sulfuric acid and nitrogenous waste which was a byproduct of oil refining. Another common mixture contained sulfuric acid, coal tar, and crude anthracite. Although the foam blankets still contained high concentrations of acid, the acid vapors which would rise from the acid baths were contained in the foam. Many of the acid baths were heated and on cold days, because the cleaning houses were practically open to the outdoors except for a roof, the acid would rise to the rafters as fog, then condense and precipitate on the workers below. Inhibitor foams greatly improved the working conditions for the workers and also allowed them to see what they were doing for the first time.

The age of the automobile and the mass production assembly line also motivated new innovations in the wire industry. The mass production of automobiles beginning with Ford in 1908 demanded consistent high quality raw materials. Wire was used for countless automotive components such as electrical wiring, control rods, springs, wire spokes, and blanks for machine screws and rivets. Manufacturers wanted to maximize components by using as little material as possible in an effort to conserve cost and reduce weight. In order to satisfy the demands and receive contracts from Ford, wire manufacturers began investing in metallurgy and experimenting with high strength alloys. The mid 1920s also saw advances of the dies which the rods were drawn through in order to reduce their diameter. The Carboloy Company pioneered the use of carbide inserts in wire drawing dies which were able to stand up to the new high strength alloys.

The wire industry continued to prosper for the next thirty years, however increased labor coasts combined with environmental restrictions eventually brought the Worcester wire industry to its knees. By the late 1970s Worcester could no longer compete with southern wire manufacturers and by the close of the decade wire in Worcester was no more.

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Appendix

Database for a Timeline of the Worcester Wire Industry

Item: 001

Event Year: 1814

Bibliographic Data: *Barbed Wire: Ichabod Washburn*
Antique Barbed Wire Society

Page: 1

Publication Data:

Item Location: Internet:See Bibliography

Why Worcester:

Importance of Item

Historically: In 1814 Ichabod Washburn moved to Leicester Massachusetts to start his blacksmith apprenticeship under the direction of Jonathan and David Trask.

Technologically:

People Associated: Ichabod Washburn

Key Words:

Item: 002

Event Year: 1833

Bibliographic Data: *Barbed Wire: Ichabod Washburn*
Antique Barbed Wire Society

Page: 1

Publication Data:

Item Location: Internet:See Bibliography

Why Worcester:

Importance of Item

Historically: In 1833 Ichabod Washburn refined his wire drawing process and he also invented the wire drawing block which boosted wire production to 2500 lbs per day.

Technologically:

People Associated: Ichabod Washburn

Key Words:

Item: 003

Event Year: 1835

Bibliographic Data: *Barbed Wire: Ichabod Washburn*
Antique Barbed Wire Society

Page: 1

Publication Data:

Item Location: Internet:See Bibliography

Why Worcester:

Importance of Item

Historically: On January 30, 1835 the Washburn & Goddard company was sold and Ichabod Washburn moved to Grove Mill Massachusetts where he started a new wire company.

Technologically:

People Associated: Ichabod Washburn, Benjamin Goddard

Key Words:

Item: 004

Event Year: 1920

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 131

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: In the 1920's the replacement of dangerous acid pickling operations with foam inhibitors began to creep into the cleaning houses. Foam inhibitors were discovered as replacements for the pickling process during the First World War when there was an acid shortage. There were several different inhibitor concoctions that were commonly used one of the most common was a mixture of sulfuric acid and nitrogenous waste. Another common mixture contained sulfuric acid, coal tar, and crude anthracite. Although the foam blankets still contained high concentrations of acid, the acid vapors which would rise from the acid baths were contained. This greatly improved the working conditions for the workers and also allowed them to see what they were doing.

Technologically:

People Associated:

Key Words: Acid Pickling, Inhibitors

Item: 005

Event Year: 1923

Bibliographic Data:

1

Page:

Publication Data: American Steel & Wire Company, Worcester MA
1908-1923

Item Location: Worcester Historical Museum

Why Worcester:

Importance of Item

Historically: Extensive photos of the first 15 yrs. 1908-1923 of the Industrial Museum of The American Steel & Wire Company. Photos of exhibits included are not limited to the following: Wire Nail Machine, Huge Section of N.Y. Hudson River Bridge cable, Bar Mill, and a portion of what is believed to be Ichabod Washburn's first Wire Drawing Frame on Grove Street which was installed in about 1845 and remained in use until 1910.

Technologically:

People Associated:

Key Words: American Steel & Wire Museum

Item: 006

Event Year: 1880

Bibliographic Data: *Industrial Museum Barbed Wire*

Page: 3

Publication Data: American Steel & Wire Company, Worcester MA
1929

Item Location: Worcester Historical Museum

Why Worcester:

Importance of Item

Historically: Photos and descriptions of Early Barbed Wire Specimens.

Technologically:

People Associated:

Key Words: Barbed Wire

Item: 007

Event Year: 1876

Bibliographic Data: *The First Wire Sold By Washburn & Moen Mfg. Co.*
G. S. Hall

Page: 1

Publication Data:

Item Location: Baker Library Case 3

Why Worcester:

Importance of Item

Historically: This is a letter from G. S. Hall to Charles G. Washburn written on Nov. 24th, 1888 regarding the first barbed wire the company sold. It is stated that the first barbed wire (#12 Fence Wire) was sold by the Washburn & Moen Mfg. Co. to Kinnicutt & Co. on July 17th, 1876.

Technologically:

People Associated: G. S. Hall, Charles G. Washburn, Kinnicutt & Co.

Key Words: Barbed Wire

Item: 008

Event Year: 1876

Bibliographic Data: *The First Wire Sold By Washburn & Moen Mfg. Co.*
G. S. Hall

Page: 1

Publication Data:

Item Location: Baker Library Case 3

Why Worcester:

Importance of Item
Historically:

Technologically: In the letter to Charles Washburn G.S. Hall explains that #12 wire made of Bessemer .10 percent carbon steel did not come into use until the production of barbed wire at Washburn & Moen Co. Prior to the production of barbed wire, wire fencing was either made of #8 or #9 wire drawn from the "cheapest kind of iron." The iron was scrap which was heated and run through the billet and rod mills at Quinsigamond. Hall also mentions that the #12 Bessemer steel wire had a tensile strength of about 614 lbs. in comparison to the #12 iron wire which had a tensile strength of 408 lbs.

People Associated: G. S. Hall, Charles G. Washburn, Kinnicutt & Co.

Key Words: Barbed Wire

Item: 009

Event Year: 1874

Bibliographic Data: *The History of Barbed Wire*
The Ellwood House Association

Page: 1

Publication Data: The Ellwood House Association, Dekalb Illinois
2004

Item Location: Internet

Why Worcester:

Importance of Item

Historically: In October of 1873 Joseph Glidden applied for a patent on his wire and it was finally approved on November 24, 1874. Later that same year Glidden and Isaac Ellwood formed a partnership and began manufacturing barbed wire by hand in Dekalb Ilinois. By the end of the year the company had produced over 10,000 lbs of barbed wire.

Technologically:

People Associated: Joseph Glidden, Isaac Ellwood

Key Words: Barbed Wire Patent, Joseph Glidden

Item: 010

Event Year: 1875

Bibliographic Data: *The History of Barbed Wire*
The Ellwood House Association

Page: 1

Publication Data: The Ellwood House Association, Dekalb Illinois
2004

Item Location: Internet

Why Worcester:

Importance of Item

Historically: In 1875 Joseph Glidden and Isaac Ellwood built a factory that was equipped steam powered, automated machinery. With the improved production of the new factory they were able to make over 600,000 lbs of wire by the end of 1875.

Technologically:

People Associated: Joseph Glidden, Isaac Ellwood

Key Words: Barbed Wire Patent, Joseph Glidden

Item: 011

Event Year: 1876

Bibliographic Data: *The History of Barbed Wire*
The Ellwood House Association

Page: 1

Publication Data: The Ellwood House Association, Dekalb Illinois
2004

Item Location: Internet

Why Worcester:

Importance of Item

Historically: In 1876 Joseph Glidden sold his half of the barbed wire patent to the Washburn & Moen Company for $60,000 plus royalty rights. That year Washburn & Moen and Isaac Ellwood & Company produced 2,840,000 lbs of wire.

Technologically:

People Associated: Joseph Glidden, Isaac Ellwood, Washburn & Moen Company

Key Words: Barbed Wire Patent, Joseph Glidden

Item: 012

Event Year: 1877

Bibliographic Data: *The History of Barbed Wire*
The Ellwood House Association

Page: 1

Publication Data: The Ellwood House Association, Dekalb Illinois
2004

Item Location: Internet

Why Worcester:

Importance of Item

Historically: In 1877 barbed wire output by the Washburn & Moen Company and The Isaac Ellwood & Company reached 12,863,000 lbs.

Technologically:

People Associated: Washburn & Moen Company, Isaac Ellwood

Key Words: Barbed Wire Patent, Joseph Glidden

Item: 013

Event Year: 1878

Bibliographic Data: *The History of Barbed Wire*
The Ellwood House Association

Page: 1

Publication Data: The Ellwood House Association, Dekalb Illinois
2004

Item Location: Internet

Why Worcester:

Importance of Item

Historically: In 1878 barbed wire output by the Washburn & Moen Company and The Isaac Ellwood & Company reached 26,655,000 lbs.

Technologically:

People Associated: Washburn & Moen Company, Isaac Ellwood

Key Words: Barbed Wire Patent, Joseph Glidden

Item: 014

Event Year: 1879

Bibliographic Data: *The History of Barbed Wire*
The Ellwood House Association

Page: 1

Publication Data: The Ellwood House Association, Dekalb Illinois
2004

Item Location: Internet

Why Worcester:

Importance of Item

Historically: In 1879 barbed wire output by the Washburn & Moen Company and The Isaac Ellwood & Company reached 50,337,000 lbs.

Technologically:

People Associated: Washburn & Moen Company, Isaac Ellwood

Key Words: Barbed Wire Patent, Joseph Glidden

Item: 015

Event Year: 1892

Bibliographic Data: *The History of Barbed Wire*
The Ellwood House Association

Page: 1

Publication Data: The Ellwood House Association, Dekalb Illinois
2004

Item Location: Internet

Why Worcester:

Importance of Item

Historically: The Washburn & Moen Company teamed up with the and The Isaac Ellwood & Company and bought up every barbed wire patent they could get there hands on in order to take control of the market. Many lawsuits broke out between patent holders who claimed they had the sole patent because they had filed before Glidden. In 1892 the United States Supreme court finally awarded the patent to Joseph Glidden because it was his patent that specifically claimed the twisting of the two wires held the barbs in place.

Technologically:

People Associated: Joseph Glidden, Washburn & Moen Company, Isaac Ellwood

Key Words: Barbed Wire Patent, Joseph Glidden

Item: 016

Event Year: 1876

Bibliographic Data: *Barbed Wire Patent Material*

Page:

Publication Data:

Item Location: Baker Library Case 7 DOC-819

Why Worcester:

Importance of Item

Historically: Clear Detailed Photograph of one of the first Barbed Wire Machines.

Technologically:

People Associated:

Key Words: Barbed Wire, Barbed Wire Machine

Item: 017

Event Year: 1873

Bibliographic Data: *The History of Barbed Wire*
The Ellwood House Association

Page: 1

Publication Data: The Ellwood House Association, Dekalb Illinois
2004

Item Location: Internet

Why Worcester:

Importance of Item

Historically: In 1873 Joseph Glidden visited the Dekalb County Fair in Dekalb Illinois where he learned of a new fencing product, made by a local farmer named Henry Rose. The product consisted of a wooden strip with protruding nails that was to be fastened to fence posts to deter animals. Glidden was inspired by Rose's invention and he believed that he could improve upon his idea by fastening the spikes to wire which would be easier to handle and would have greater longevity. Glidden went to work in his kitchen using a coffee mill, he twisted pieces of wire to form barbs which he slid onto a strand of wire. He then attached the wire strand with barbs and another piece of wire the same length to the shaft of his grinding and by rotating the grinding wheel he twisted the two strands around each other, locking the barbs in place.

Technologically:

People Associated: Joseph Glidden

Key Words: Barbed Wire, Joseph Glidden

Item: 018

Event Year: 1876

Bibliographic Data: *Morgan Milestones*
Erskine Margaret

Page: 9

Publication Data: Morgan Construction Company
1988

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: Charles F. Washburn saw a demand for wire fencing as he believed it would assist the settlers in the taming of the West. In 1876 upon hearing of a new fence product called barbed wire, Washburn purchased the patents for its manufacture.

Technologically:

People Associated: Charles F. Washburn

Key Words: Barbed Wire, Patents, Charles F. Washburn

Item: 019

Event Year: 1862

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 70

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: George Bedson of Manchester England invented the first continuous bar mill. This breakthrough eliminated the need for constant rod changes which was both inefficient and required excessive labor.

Technologically:

People Associated:

Key Words: Bedson Mill

Item: 020

Event Year: 1864

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 71

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: Washburn & Moen purchased a Bedson rod mill for 1000 pounds sterling. Four years later the mill was installed and in operation at the Worcester North Works.

Technologically:

People Associated: Ichabod Washburn, Philip W. Moen, Charles Morgan, Bedson

Key Words: Bedson Mill

Item: 021

Event Year: 1878

Bibliographic Data: *Morgan Milestones*
Erskine Margaret

Page: 9

Publication Data: Morgan Construction Company
1988

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically:

Technologically: After visiting the Paris Exposition in 1878 Morgan decided that the use of horizontal rolls in his continuous rolling mill was the answer to the dilemma of producing high quality rods at high speed. An added benefit to Morgan's new design was that all the rolls could be driven via bevel gear from a single shaft. Because this single shaft could be mounted above the floor it would no longer be subjected to the harsh environment of water and mill scale, thereby eliminating all the maintenance problems of the Bedson Mill.
The development of the new continuous rolling mill required the invention of the twist guide which turned oval shaped rods 90 degrees for correct alignment to enter the next set of rolls. Thereafter, Charles Morgan patented his designs for the new continuous mill and the twist guide. During an interview prior to the writing of Morgan Milestones, Philip Morgan said "Without doubt the invention of the twist guide was Charles Morgan's great contribution to the continuous mill. To produce rods the steel must be rolled alternately vertically and horizontally; Bedson, knowing this, employed alternate horizontal and vertical rolls in his continuous train. Instead, Charles Morgan accomplished the same result by a device called a twist guide which rotated the bar around its own axis to present it correctly to the rolls, all of which were horizontal. This simplified the details of construction of the continuous train and, what is more important, made possible the rolling of more than one strand of rods simultaneously. In this twist guide was a tool to give further emphasis to mass production"(pg 9).

People Associated: Charles Morgan

Key Words: Bedson Mill, Continuous Rolling Mill, Twist Guide

Item: 022

Event Year: 1881

Bibliographic Data: *Morgan Milestones*
Erskine Margaret

Page: 11

Publication Data: Morgan Construction Company
1988

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: Charles Morgan and his brother Francis founded the Morgan Spring Company and began to manufacture helical springs.

Technologically:

People Associated: Charles Morgan

Key Words: Charles Morgan

Item: 023

Event Year: 1885

Bibliographic Data: *Morgan Milestones*
Erskine Margaret

Page: 13

Publication Data: Morgan Construction Company
1988

Item Location: Gordon Library

Why Worcester:

Importance of Item
Historically:

Technologically: Following Morgan's departure from the Washburn & Moen Company he decided to continue to tinker by himself while operating the spring company with his brother. He invented the power driven automatic coiling reel (Patent No. 224,787) which would automatically coil the rods as they exited the rolling mill. Prior to this development rods had to be man handled and fed into a traction reel using tongs. This process was not only terribly inefficient, but also a dangerous process.
At some point, before filing for the patent on the automatic coiling reel, Morgan returned to work for Washburn & Moen and naturally they attempted to claim that the patent was their. Morgan became increasingly angry and he built and sold several of the machines for other wire companies. A long and lengthy lawsuit ensued, and in 1894 the United States Supreme Court finally ruled in Morgan's favor.

People Associated: Charles Morgan

Key Words: Charles Morgan

Item: 024

Event Year: 1885

Bibliographic Data: *Morgan Milestones*
Erskine Margaret

Page: 11

Publication Data: Morgan Construction Company
1988

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: After the Washburn & Moen Company failed to back Charles Morgan in a patent infringement case involving the Cleveland Rolling Mill Company's use of a wire drawing lubrication/coating method that he had developed, Morgan became upset. The writing was on the wall, Morgan was sick of being taken advantage of by Washburn & Moen that and in 1885 he resigned from the Company.

Technologically:

People Associated: Charles Morgan

Key Words: Charles Morgan

Item: 025

Event Year: 1891

Bibliographic Data: *Morgan Milestones*
Erskine Margaret

Page: 23

Publication Data: Morgan Construction Company
1988

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: After selling his Washburn & Moen Company stock, Charles Morgan decided to start his own business manufacturing and selling rolling mill equipment. The Morgan Construction Company was incorporated in September, 1891.
The three corporators were Charles Morgan, Charles Beagary Morgan (his son), and Victor E. Edwards.

Technologically:

People Associated: Charles Morgan, Charles Beagary Morgan, Victor E. Edwards

Key Words: Charles Morgan

Item: 026

Event Year: 1900

Bibliographic Data: *Morgan Milestones*
Erskine Margaret

Page: 23

Publication Data: Morgan Construction Company
1988

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: In 1900 Charles Morgan became president of the American Society of Mechanical Engineers and said "Watts (steam) engine is the Hercules, but the rolling mill is his club"(Erskine, 23).

Technologically:

People Associated: Charles Morgan

Key Words: Charles Morgan

Item: 027

Event Year: 1911

Bibliographic Data: *Morgan Milestones*
Erskine Margaret

Page: 39

Publication Data: Morgan Construction Company
1988

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: Charles Morgan died in 1911.

Technologically:

People Associated: Charles Morgan

Key Words: Charles Morgan

Item: 028

Event Year: 1878

Bibliographic Data: *Morgan Milestones*
Erskine Margaret

Page: 9

Publication Data: Morgan Construction Company
1988

Item Location: Gordon Library

Why Worcester:

Importance of Item
Historically:

Technologically: After visiting the Paris exposition in 1878, Charles Morgan invented the twist guide (U.S. Patent No. 220,033) which rotated the bar along its center axis as it passed between two opposing rollers. This was an important development as it eliminated the need for a second set of rollers horizontal rollers, thereby reducing the problems associated with the Bedson mill design.

People Associated: Charles Morgan

Key Words: Charles Morgan, Twist guide

Item: 029

Event Year: 1892

Bibliographic Data: *Washburn & Moen Annual Report To the Stock Holders*
Washburn & Moen Mfg. Co.

Page: 1

Publication Data:

Item Location: Baker Library Case 3

Why Worcester:

Importance of Item
Historically:

Technologically: With the increased demand for copper electrical wire, Washburn & Moen constructed a copper refinery in 1892. The construction of their own copper refinery was justified by the fact that they could not obtain high quality pure copper necessary for its conductive properties elsewhere.

People Associated: Washburn & Moen

Key Words: Copper Wire

Item: 030

Event Year: 1640

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 29

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: Lewis has found correspondence to the General Courts of Massachusetts and Connecticut from owners of wiredrawer's tools looking for compensation in return for setting up an establishment. Although the Court never responded to these requests. Later records show that the Courts sometimes offered wiredrawer's tools to anyone who cared to set up a mill, however, there were no takers.

Technologically:

People Associated:

Key Words: Demand for Wire

Item: 031

Event Year: 1876

Bibliographic Data: *The First Wire Sold By Washburn & Moen Mfg. Co.*
G. S. Hall

Page: 1

Publication Data:

Item Location: Baker Library Case 3

Why Worcester:

Importance of Item
Historically:

Technologically: Bessemer steel, having a .40 to .50 percent carbon content cam into use with the increased demand for spring wire for use in the furniture industry. Rejected Bessemer steel wire was used for less critical applications such as wire cloth for locomotive smoke stacks.

People Associated: G. S. Hall, Charles G. Washburn, Kinnicutt & Co.

Key Words: Demand for Wire, Bessemer Steel, Spring Wire, Bed Springs, Locomotive smoke stack screens.

Item: 032

Event Year: 1892

Bibliographic Data: *Washburn & Moen Annual Report To the Stock Holders*
Washburn & Moen Mfg. Co.

Page: 1

Publication Data:

Item Location: Baker Library Case 3

Why Worcester:

Importance of Item

Historically: This is an annual report dated May 31, 1892 to the stock holders of the Washburn & Moen Mfg. Co. Aside from mentioning that the annual sales exceeded that of any previous year, the report also mentions the addition of insulated copper wire for electrical uses and the manufacture of furniture springs to its product line.

Technologically:

People Associated: Washburn & Moen

Key Words: Demand for Wire, Insulated Copper Wire, Springs.

Item: 033

Event Year: 1855

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 3

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Telegraph

Importance of Item

Historically: Lewis refers to the "great revolution" sparked by the telegraph that fueled the growth of the wire industry in the U.S.

Technologically:

People Associated:

Key Words: Demand for Wire, Telegraph

Item: 034

Event Year: 1834

Bibliographic Data: *Fifty Years of Wire Drawing*
Henry M. Smith

Page: 13

Publication Data:
1884

Item Location: Baker Library Case 7

Why Worcester:

Importance of Item

Historically: The textile infrastructure in nearby Lowell and Fall River had been thriving for over a decade by 1834. This heavily wire dependant industry was most likely the primary driving force behind the founding of the wire factories in Worcester. Another factor which made the Worcester area an attractive location was both a direct and indirect result of the area's natural resources. The Worcester county area had an ample supply of hardwoods, timber, and fast running streams. As a result of these resource the area attracted many mechanically skilled craftsman who set up saw mills, grist mills, fulling mills, flax mills, and trip hammers, etc. In 1793 Worcester county had 115 grist mills, 115 saw mills, 32 fulling mills, 5 forges, 18 trip hammers, 2 paper mills, and 3 oil mills. Smith says "Worcester county never lacked sons of hers ready to ransom themselves from poverty and obscurity by mechanical skill" (13).

Technologically:

People Associated:

Key Words: Demand for Wire, Textile industry, Lowell, Carding

Item:	035
Event Year:	**1935**
Bibliographic Data:	*Wire & Wire Products* January
Page:	3
Publication Data:	Wire & Wire Products Magazine 1935
Item Location:	Worcester Historical Museum
Why Worcester:	
Importance of Item Historically:	
Technologically:	Sleeper & Hartley Inc. of Worcester advertisement for and Automotive Casings machine which has the capability of winding control cable sheathing and small diameter springs.
People Associated:	
Key Words:	Demand, Springs, Automotive Parts

Item: 036

Event Year: 1867

Bibliographic Data: *Industrial Museum*

2
Specimen of Wire Fencing
Page: 319+

Publication Data: American Steel & Wire Company, Worcester MA
1908

Item Location: Worcester Historical Museum

Why Worcester:

Importance of Item

Historically: Timeline of barbed wire including pictures and advertisements beginning.

Patent No. 67,117 issued July 23, 1867 to William D. Hunt, whose claim read: "providing the wires of a wire fence with a series of spur-wheels."

Technologically:

People Associated:

Key Words: Demand,Barbed Wire,Patent

Item: 037

Event Year: 1842

Bibliographic Data: *Industrial Museum*
Ralph Crooker
2
Cost of Making Nails
Page: 160

Publication Data: American Steel & Wire Company, Worcester MA
1908

Item Location: Worcester Historical Museum

Why Worcester:

Importance of Item

Historically: Information including pictures pertaining to the transition from cut to wire nails during the mid 1800's.

Technologically:

People Associated:

Key Words: Demand,Wire,Nails

Item: 038

Event Year:

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 2

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Reduction of labor Costs / Higher Strength Wire

Importance of Item

Historically: According to Lewis one of the earliest known examples of wire (at the time of the books publication) was discovered in the tomb of an Egyptian Pharaoh. Archeologists of the time were adamant that the wire had been drawn due to lateral scratches in the surface indicating that the wire had passed through a die plate. Upon closer inspection by the author, a wire expert it was determined that the wire was actually a tube with 0.010" outside diameter and a 0.0025" inside diameter. This tube was believed to have been rolled from small sheets of gold and then pushed through tapered holes in most likely a bronze plate, in order to tighten up the roll. Subsequent sections, approximately three inches long were then brazed together to form the final strand. Lewis claims the fact that the "wire" was not drawn came to no surprise to him. He says "I had already figured that the Egyptians would have no occasion to invent wire drawing. All their wire was of gold and silver and was for the ornamenting of the appurtenances of royalty. What incentive could there have been for saving labor when all labor belonged to the king? Invention does not flourish in a vacuum."

Technologically:

People Associated:

Key Words: Early Wire

Item: 039

Event Year: 1873

Bibliographic Data: *Morgan Milestones*
Erskine Margaret

Page: 7

Publication Data: Morgan Construction Company
1988

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: After graduating from WPI, Fred Daniels was hired by Washburn & Moen to work under the direction of Charles Morgan.

Technologically: Daniels first assignment was to assist in the further improvement of the Bedson mill, in addition to the inadequate Sieman's furnace which was used to heat the steel billet before entering the mill.

People Associated: Fred Harris Daniels, Washburn & Moen

Key Words: Fred Harris Daniels, Washburn & Moen

Item: 040

Event Year: 1874

Bibliographic Data: *Morgan Milestones*
Erskine Margaret

Page: 7

Publication Data: Morgan Construction Company
1988

Item Location: Gordon Library

Why Worcester:

Importance of Item
Historically:

Technologically: In 1874 Washburn & Moen sent Fred Daniels to Lafayette Collage in Pennsylvania to study metallurgy, thereby enabling the company to improve the quality of their product.

People Associated: Fred Harris Daniels, Washburn & Moen

Key Words: Fred Harris Daniels, Washburn & Moen

Item: 041

Event Year: 1882

Bibliographic Data: *Industrial Museum Photos*

1

Page: 149

Publication Data: American Steel & Wire Company, Worcester MA
1908-1923

Item Location: Worcester Historical Museum

Why Worcester:

Importance of Item

Historically: Photo and Specs. of the 1200 H.P. Harris – Corliss Engine located at the North Works facility.

Installed in 1882 by the Washburn & Moen Manufacturing Company

Flywheel Reinforced in 1904

Replaced by an Electric Motor and Scrapped by American Steel & Wire in 1924.

A working model of the engine was constructed in 1924 for the museum under the direction of John Johnson, foreman of the North Works pattern shop.

Technologically:

People Associated:

Key Words: Harris – Corliss Engine, North Works

Item: 042

Event Year: 1864

Bibliographic Data: *Morgan Milestones*
Erskine Margaret

Page: 1+

Publication Data: Morgan Construction Company
1988

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: In 1864 the original Washburn and Moen Wire mill, built in 1834 by Stephen Salisbury II was torn down and replaced with a larger building employing new technology. In order to benefit from the new mill's full potential both Ichabod Washburn and Philip W. Moen realized they were in need of a highly skilled superintendent. After an extensive search for a new superintendent, friends of Washburn from nearby Clinton Mass recommended a resourceful young man named Charles Hill Morgan.

Morgan had previous experience working as a draftsman for both the Lawrence Machine Company and the Clinton Wire Cloth Mills. In an 1860 business venture with his brother, Francis H. Morgan, Charles Morgan had also invented the machine used to form the square bottoms of brown paper grocery bags still used today.

Washburn and Moen knew Charles Morgan was the man for the job, and after interviewing him he was hired as the superintendent of the Washburn & Moen Wire mill.

Technologically:

People Associated: Ichabod Washburn, Philip W. Moen, Charles Morgan

Key Words: History of Wire Industry

Item: 043

Event Year: 300

Bibliographic Data: *Wire & Wire Products*
Kenneth Burnham Lewis
December

Page: 4-65

Publication Data: Wire & Wire Products Magazine
1931

Item Location: Worcester Historical Museum

Why Worcester:

Importance of Item

Historically: Article by Kenneth B. Lewis, a Morgan Construction Wire Mill Engineer

According to Lewis the earliest known example of a die was discovered in France and is believed to date back to the 3rd century.

The first known written reference to wire drawing via. die appears in a 1000 A.D. Latin manuscript written in a German Monastery. The author Theophilius refers to dies as a piece of equipment common in metal working shops. Theophilius describes the equipment as a plate having several tapered holes of varying sizes.

Physical dies resembling those described by Theophilius have been found dating back to the Vikings in Norway (approximately 700-800 A.D.). The fact that these specimens are much more refined in comparison to the die found in France adds to the veracity the French die was around much earlier.

Technologically:

People Associated:

Key Words: History of Wire, Wire Industry

Item: 044

Event Year:

Bibliographic Data: *Wire & Wire Products*
Kenneth Burnham Lewis
December

Page: 4-65

Publication Data: Wire & Wire Products Magazine
1931

Item Location: Worcester Historical Museum

Why Worcester:

Importance of Item

Historically: Article by Kenneth B. Lewis, a Morgan Construction Wire Mill Engineer

Complete history of the production of wire dating back to the Roman time period.

Lewis says that the "recorded history of wire drawing is so scanty and the chances for digression and argument are so many, that in a brief talk of this sort I can do nothing but touch the high spots."

The first wire was sheared or twisted from plate and hammered by hand into a cylindrical shape. Lewis says there is also some evidence that some wire was made out of thin sheets which were first cut into strips, rolled into scrolls, and then pulled through tapered dies to roll the scroll tight. He says there is no evidence early wire was formed by cold work such as drawing due to the fact that specimens of the time period do not exhibit evidence of elongation. Early wire was made in relatively short sections, not exceeding a few inches in length. In order to make long sections of wire multiple short sections were soldered or brazed together.

Technologically:

People Associated:

Key Words: History of Wire, Wire Industry

Item: 045

Event Year: 1798

Bibliographic Data: *Barbed Wire: Ichabod Washburn*
Antique Barbed Wire Society

Page: 1

Publication Data:

Item Location: Internet:See Bibliography

Why Worcester:

Importance of Item

Historically: Ichabod Washburn and his twin brother Charles Washburn were born on August 11, 1798 in Kingston Massachusetts.

Technologically:

People Associated: Ichabod Washburn, Charles Washburn

Key Words: Ichabod Washburn

Item: 046

Event Year: 1835

Bibliographic Data: *Autobiography And Memorials of Ichabod Washburn*
Henry T. Cheever

Page: 52

Publication Data: B. Lothorp and Company

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: By 1835 the Washburn employed about 25 workmen, and occupied approximately 7,000 square feet of space in the Grove Mill complex.

Technologically:

People Associated: Ichabod Washburn

Key Words: Ichabod Washburn

Item: 047

Event Year: 1798

Bibliographic Data: *Forty Immortals of Worcester And Its County*
The Worcester Bank & Trust Company

Ichabod Washburn
Page: 33-34

Publication Data: Walton Advertising & Printing Company, Boston MA
1920

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: Ichabod Washburn died on December 30, 1868 in Worcester.

Technologically:

People Associated: Ichabod Washburn

Key Words: Ichabod Washburn

Item: 048

Event Year: 1798

Bibliographic Data: *Forty Immortals of Worcester And Its County*
The Worcester Bank & Trust Company

Ichabod Washburn
Page: 33-34

Publication Data: Walton Advertising & Printing Company, Boston MA
1920

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: Ichabod Washburn was born in Kingston Massachusetts in 1798. When he was 16 years old he left home to become blacksmith.

Technologically:

People Associated: Ichabod Washburn

Key Words: Ichabod Washburn

Item: 049

Event Year: 1868

Bibliographic Data: *Morgan Milestones*
Erskine Margaret

Page: 4

Publication Data: Morgan Construction Company
1988

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: Ichabod Washburn's health deteriorated following a paralytic stroke he had on February 4, 1868. Although he was unable to supervise the completion of the Washburn Shops himself, he was able to see the finished product. On December 10, 1868 Ichabod rode out to the shop to see it in operation. Tragically, that night Ichabod turned to his brother Charles and said, "It's all right" and he died.

Technologically:

People Associated: Ichabod Washburn

Key Words: Ichabod Washburn

Item: 050

Event Year: 1834

Bibliographic Data: *Autobiography And Memorials of Ichabod Washburn*
Henry T. Cheever

Page: 47

Publication Data: B. Lothorp and Company

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: In the fall of 1834 Ichabod Washburn started his own wire drawing business in the Grove Mill complex which was built by Stephen Salisbury.

Technologically:

People Associated: Ichabod Washburn, Stephen Salisbury

Key Words: Ichabod Washburn,

Item: 051

Event Year: 1831

Bibliographic Data: *Autobiography And Memorials of Ichabod Washburn*
Henry T. Cheever

Page: 44

Publication Data: B. Lothorp and Company

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: After Ichabod Washburn and Benjamin Goddard sold their lead pipe and wool machinery business in (-1831?) to Messrs. March, Goulding, Smith and Hobart. The partners purchased a water power site in Northville, and constructed a facility to manufacturing wire and wood screws. Ichabod said "This business we pursued there about three years, when we had so far out-grown the water power, that we were obliged to remove to where we could obtain more" (pg 44).

Technologically:

People Associated: Ichabod Washburn, Benjamin Goddard

Key Words: Ichabod Washburn, Benjamin Goddard

Item: 052

Event Year: 1831

Bibliographic Data: *Autobiography And Memorials of Ichabod Washburn*
Henry T. Cheever

Page: 46

Publication Data: B. Lothorp and Company

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: "In the year 1831, some two years before the dissolution of our co partnership, we commenced the manufacture of iron wire, at a time when but little of this important article had been manufactured in this country. The first coarse wire machine I ever saw, was one of self-acting pinchers, drawing out about a foot, then passing back, and drawing another foot; so crude and ill adapted for the work was this machine that no man could draw more than fifty pounds a day. We improved on this machine, so as to draw out about fifteen feet at each pass, increasing the product at least ten fold" (pg 46).

Technologically:

People Associated: Ichabod Washburn, Benjamin Goddard

Key Words: Ichabod Washburn, Benjamin Goddard

Item: 053

Event Year: 1831

Bibliographic Data: *Autobiography And Memorials of Ichabod Washburn*
Henry T. Cheever

Page: 46

Publication Data: B. Lothorp and Company

Item Location: Gordon Library

Why Worcester:

Importance of Item
Historically:

Technologically: With the success of the Washburn & Goddard wire mill and improving the output of their current process from 50 to 500 lbs. per day Ichabod Washburn still was not satisfied. Ichabod explains "We soon, however, substituted the Drawing Block, which has never since been improved. With this, a man can conveniently get off twenty-five hundred pounds in a day. Other important improvements have since been made, aside from the drawing block, which I do not claim, both in coarse and fine wire-drawing, as also in the annealing process" (pg 46).

People Associated: Ichabod Washburn, Benjamin Goddard

Key Words: Ichabod Washburn, Benjamin Goddard

Item: 054

Event Year: 1833

Bibliographic Data: *Autobiography And Memorials of Ichabod Washburn*
Henry T. Cheever

Page: 46

Publication Data: B. Lothorp and Company

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: In 1833 Ichabod Washburn and Benjamin Goddard decided to go their separate ways.

Technologically:

People Associated: Ichabod Washburn, Benjamin Goddard

Key Words: Ichabod Washburn, Benjamin Goddard

Item: 055

Event Year: 1842

Bibliographic Data: *Autobiography And Memorials of Ichabod Washburn*
Henry T. Cheever

Page: 48

Publication Data: B. Lothorp and Company

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: In 1842 Ichabod Washburn went into partnership with his brother, Charles Washburn.

Technologically:

People Associated: Ichabod Washburn, Charles Washburn

Key Words: Ichabod Washburn, Charles Washburn

Item: 056

Event Year: 1849

Bibliographic Data: *Autobiography And Memorials of Ichabod Washburn*
Henry T. Cheever

Page: 48

Publication Data: B. Lothorp and Company

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: In 1849 Ichabod Washburn and his brother Charles Washburn decided to split up.

Technologically:

People Associated: Ichabod Washburn, Charles Washburn

Key Words: Ichabod Washburn, Charles Washburn

Item: 057

Event Year: 1850

Bibliographic Data: *Autobiography And Memorials of Ichabod Washburn*
Henry T. Cheever

Page: 48

Publication Data: B. Lothorp and Company

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: In 1850 Ichabod Washburn formed a partnership with his son-in-law Phillip L. Moen. Ichabod said "One year after, in 1850, I took as a partner, my son-in-law, P.L. Moen. In him, I have had a most efficient aid in bringing up the business to its present mammouth size. While he makes no claim to be a practical mechanic, he has by his exactness, promptitude, and aptness for business generally, supplied a deficiency in myself indispensable to success. He has managed with rare ability our finances, a department of the business for which I never had the taste or inclination, always preferring to be among the machinery, doing the work and handling the tools I was used to, though oftentimes at the expense of smutty face and greasy hands" (pg 48).

Technologically:

People Associated: Ichabod Washburn, Phillip L. Moen

Key Words: Ichabod Washburn, Phillip L. Moen

Item: 058

Event Year: 1850

Bibliographic Data: *Autobiography And Memorials of Ichabod Washburn*
Henry T. Cheever

Page: 49

Publication Data: B. Lothorp and Company

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: In 1850 the Washburn & Moen Company started making wire for the Chickering Piano Company. Icabod says "I was urged by Mr. Chickering of Boston, the piano-forte maker, to try my hand at making steel wire for the strings to his instruments. Until then, that business had been entirely in the hands of Webster, of England, for eighty years" (pg 49).

Technologically:

People Associated: Ichabod Washburn, Phillip L. Moen

Key Words: Ichabod Washburn, Phillip L. Moen

Item: 059

Event Year: 1850

Bibliographic Data: *Autobiography And Memorials of Ichabod Washburn*
Henry T. Cheever

Page: 50-51

Publication Data: B. Lothorp and Company

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: At some point in (1850?) the Washburn & Moen Company purchased the English patent rights from Bessemer who developed a baking process that elimenated the hydrogen embrittlement associated with the acid pickling of the bars.
Washburn & Moen also held the patent for galvanized wire, making them the sole galvanized wire maker in the United States. The fact that Washburn & Moen had the patent for galvanized wire combined with the ability to make wire while avoiding hydrogen embrittlement (resulting in a reliable tensile strength increase of 12.5%) meant that they would be one of the primary suppliers for the telegraph era.

Technologically:

People Associated: Ichabod Washburn, Phillip L. Moen

Key Words: Ichabod Washburn, Phillip L. Moen

Item: 060

Event Year: 1866

Bibliographic Data: *Autobiography And Memorials of Ichabod Washburn*
Henry T. Cheever

Page: 52

Publication Data: B. Lothorp and Company

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: By 1866 the Washburn & Moen Company employed between 650 and 700 workmen, and occupied approximately 100,000 square feet of space in the Grove Mill complex. At this time annual production had reached well over 2 million dollars.

Technologically:

People Associated: Ichabod Washburn, Phillip L. Moen

Key Words: Ichabod Washburn, Phillip L. Moen

Item: 061

Event Year: 1820

Bibliographic Data: *Autobiography And Memorials of Ichabod Washburn*
Henry T. Cheever

Page: 43

Publication Data: B. Lothorp and Company
1878

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: In 1820 Ichabod Washburn and William H. Howard went into business making woolen machinery and lead pipe.

Technologically:

People Associated: Ichabod Washburn, William H. Howard

Key Words: Ichabod Washburn, William H. Howard

Item: 062

Event Year: 1822

Bibliographic Data: *Autobiography And Memorials of Ichabod Washburn*
Henry T. Cheever

Page: 43

Publication Data: B. Lothorp and Company
1878

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: After William H. Howard decided that he wanted to leave town in 1822, Ichabod Washburn bought out William H. Howard's share of the wool machinery and lead pipe company. At first he claims "I had only enough to employ myself and one man" (pg 43). Then one day after meeting a man named Dr. Melvin who had some sort of connections, Ichabod was encouraged to contribute fifty cents to a "subscription paper" and miraculously he soon after had a "very large and lucrative order for lead pipe. The demand for wool machinery also increased and Ichabod decided to form a partnership with Benjamin Goddard. Ichabod claims that "From that time to this, I have never lacked work, or the opportunity of facing a subscription paper, and am a confirmed believer in the scripture truth that "he which sowith bountifully shall reap also bountifully" (pg 44). Ichabod decided that he had enough business at this point to formed a partnership with Benjamin Goddard. This new partnership resulted in the creation of the Washbun and Goddard Company.

Technologically:

People Associated: Ichabod Washburn, William H. Howard, Jacob Watson, Windsor Hatch

Key Words: Ichabod Washburn, William H. Howard

Item: 063

Event Year: 1823

Bibliographic Data: *Autobiography And Memorials of Ichabod Washburn*
Henry T. Cheever

Page: 56

Publication Data: B. Lothorp and Company
1878

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: Ichabod Washburn was married to Ann G. Brown on October 6, 1823.

Technologically:

People Associated: Ichabod Washburn, Ann G. Brown

Key Words: Ichabod Washburn, William H. Howard

Item: 064

Event Year: 1882

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 116

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: In 1882 C. Oscar Johnson immigrated to the U.S. from Sweden as an expert in metallurgy. He had heard of Wire Village in Spencer along the way, however upon arrival he found no work. He turned around and returned to Worcester where he was hired by Washburn & Moen.

Technologically:

People Associated: C. Oscar Johnson

Key Words: Metallurgy, Swedish

Item: 065

Event Year: 1864

Bibliographic Data: *Morgan Milestones*
Erskine Margaret

Page: 5+

Publication Data: Morgan Construction Company
1988

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically:

Technologically: One of Morgan's first tasks when he came to Washburn & Moen was to build a bar rolling mill that produced rods of consistent size and quality. After some research Morgan discovered a bar mill that had been developed in England in 1862 by George Bedson. Bedson's rolling mill was a continuous rolling mill which was much more efficient in comparison to Washburn's reverse rolling mill. In 1868 the treasurer of Washburn and Moen, William E. Rice traveled to England and purchased a Bedson mill along with the American rights to the Bedson mill. Morgan had the new Bedson mill up and running in Worcester on May 30, 1869.

Morgan's Bedson Mill was powered via a single steam engine which drove 32 opposing horizontal and vertical grooved rollers. The horizontal rolls were driven by an overhead line shaft which transmitted power through bevel gear sets with ratios which increased in proportion to the elongation of the bar as it traveled to subsequent rollers. The vertical rolls were powered in a similar fashion from a line shaft located beneath the floor. The flaw in this design is that the water used too cool the rolls and keep them free of abrasive mill scale fell directly onto these line shafts, bevel gear sets, and the bearings that supported them. As one may deduce, this led to extensive corrosion, and premature wear of all lower mechanical components. Morgan said that the Bedson Mill "entailed vast annoyance in the care and management of the mill" (pg7).

See detailed drawing of Bedson Mill on page 6
Morgan determined that there were clearly many shortcomings in the Bedson Mill, therefore when Washburn and Moen needed an additional mill he made significant alterations to the design. Morgan's improved bar mill allowed the production of wire coils weighing as much as 150 lbs. and up to five times the length of previous coils. Wire coils of increased length were necessary to the development of the telegraph.
See Drawing of Morgan's Continuous Rod Mill on Page 8

People Associated: Charles Morgan, Ichabod Washburn, Philip W. Moen

Key Words: Morgan, Bedson Mill

Item: 066

Event Year: 1860

Bibliographic Data: *Morgan Milestones*
Erskine Margaret

Page: 7

Publication Data: Morgan Construction Company
1988

Item Location: Gordon Library

Why Worcester:

Importance of Item
Historically:

Technologically: Morgan developed a process for oil tempering wire at Washburn & Moen, an innovation which enabled the production of wire springs.

People Associated:

Key Words: Morgan,Springs

Item: 067

Event Year: 1882

Bibliographic Data: *Industrial Museum Photos*

1

Page: 293

Publication Data: American Steel & Wire Company, Worcester MA
1908-1923

Item Location: Worcester Historical Museum

Why Worcester:

Importance of Item

Historically: Great 1882 Photo of Washburn & Moen Grove Street Works Main Yard (later re-named North Works).

Technologically:

People Associated:

Key Words: North Works, Washburn & Moen

Item: 068

Event Year: 1927

Bibliographic Data: *Industrial Museum Photos*

1

Page: 294

Publication Data: American Steel & Wire Company, Worcester MA
1908-1923

Item Location: Worcester Historical Museum

Why Worcester:

Importance of Item

Historically: Great 1927 Photo of Washburn & Moen North Works Main Yard can be compared to the 1882 photo on page 293 to depict the growth of the company.

Technologically:

People Associated:

Key Words: North Works/ Washburn & Moen

Item: 069

Event Year: 1850

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 85

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically:

Technologically: After the hot rolled bars left the bar rolling mill, the residual scale and slag had to be removed from their surfaces before entering the wire drawing dies. Due to the extreme pressure exerted any slag or irregularities left on the surface of the bar could potentially damage either the die or the wire. In early days this process was accomplished by hand. Women and children would remove the scale from the freshly rolled bars using either a brick or a wet rag covered in sand. By the 1850's these methods became to costly and time consuming and it became common practice to tumble the bars in a drum filled with abrasive and water. There was an old saying amongst well seasoned wire drawers that "A rod well cleaned is half drawn."

People Associated:

Key Words: Pickling, Acid

Item: 070

Event Year: 1860

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 88-91

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester:

Importance of Item Historically:

Technologically: Although pickling solved many of the production problems associate with slag removal the acids involved opened a can of worms. One of the problems resulting from the use of acids in the pickling process is the dissociation of hydrogen from the acid solution into the steel. This influx of hydrogen into the steel causes the steel to become brittle and prone to failure, an effect known as hydrogen embrilttlment. This mysterious effect resulted in many catastrophic failures of wire products early on and as a result, the study of metallurgy to minimize these failures became increasingly important.

People Associated:

Key Words: Pickling, Acid

Item: 071

Event Year: 1860

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 86-87

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically:

Technologically: As the bars grew in length they became too long to be cleaned using the tumbling process and wire drawers began to search for alternative methods. In about 1860 there is evidence found in a letter to George Bedson of England that Ichabod Washburn was using vitriol to pickle the bars after passing through the Bedson Mill. Although Bedson realized the benefits of the process he claimed that because of the high cost of acid in England it would not be cost effective in his situation.

People Associated:

Key Words: Pickling, Acid

Item: 072

Event Year: 1920

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 95

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically:

Technologically: Beginning in the 1920's the cleaning house began to see many improvements. From a production standpoint the adoption of the overhead gantry crane boosted efficiency and allowed space to be better utilized inside the cleaning house. At the same time the gantry crane also kept the crane operator at a safer distance from the acid bath. One of the most significant innovations for the worker's sake that appeared around 1927 was the application of the hairpin hook to the overhead gantry cranes which would dip the bars into the acid baths. Previously the bundles of bars were attached to the cranes cables via a yoke which workers would have to manually secure to each bundle while standing directly over the acid. With the hairpin hooks, the bundles of rods could be placed into baskets with a lifting hook and lowered into the acid bath. Once in the bath the cable could then be slackened by the crane operator at a safe distance, freeing the hook in order to place the next load. Improvements in the ventilation of cleaning houses were also made throughout the 1920's, which both improved the working environment and prolonged the life of the structure surrounding the acid baths.

People Associated:

Key Words: Pickling, Acid

Item: 073

Event Year: 1920

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 103

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically:

Technologically: Another problem associated with the pickling process was the disposal of the copious amounts of highly concentrated sulfuric acid. In the beginning waste acid was simply dumped on the ground, typically near the corner of the property where it would run away from the premises. The problem with this practice is that the sulfuric acid did not evaporate over time, instead it was absorbed into the ground and would work its way into the local aquifer. In some cases wells drilled near or down stream from bar cleaning operations turned up highly concentrated levels of acid despite reaching hundreds of feet into the ground

Eventually, local officials began to frown upon the dumping of acid and users began looking into alternatives. One technique was to react the acid with scrap pieces of fine wire which would then form hydrogen gas and leave behind crystals containing iron and salts. The hydrogen gas was expelled into the atmosphere and the crystals could either be dumped somewhere, now having been neutralized or heated in a kiln to form red oxide. The red oxide was then sold as a pigment known as Venetian Red which was used to make paint.

People Associated:

Key Words: Pickling, Acid, Acid Disposal

Item: 074

Event Year: 1860

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 93-94

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically:

Technologically: Hydrogen embrittlement was only one of the many problems associated with the acid pickling process. Lewis says "Nothing can be found in the shape of a description of early cleaning houses, but if they were any worse than the ones I found when I started, and instinct tells me they probably were, you wouldn't believe it anyway" (pgs 93-94). The workers in the cleaning house wore exclusively rubber boots because the acid would attack normal shoes and in most cases they had no teeth left, additionally after working in the houses for any length of time many workers also found themselves without a respiratory system. Lewis says "it was only after several weeks of acclimating that I was able to stay inside the crane circle long enough to follow a load all the way around" (pg 94).

People Associated:

Key Words: Pickling, Acid, Hydrogen Embrittlement

Item: 075

Event Year: 1851

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 92

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester:

Importance of Item
Historically:

Technologically: By 1851 the telegraph was becoming commonplace and there was a new found demand for large quantities of coarse wire having much larger diameters than what was previously common.

People Associated:

Key Words: Telegraph

Item: 076

Event Year: 1866

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 160-161

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: The Wickwire Brothers Company of Cortland New York was founded in as a hardware store in 1866 by Theodore H. and Chester F. Wickwire. The brothers purchased a carpet loom in 1873, and after discovering they were unable to turn a profit making carpets, they soon became disgusted. One day Chester, who was determined to make some money with the machine decided to attempt to adapt the machine to weave wire screening that they were importing from England.

Technologically:

People Associated: Theodore H. Wickwire, Chester F. Wickwire

Key Words: Theodore H. Wickwire, Chester F. Wickwire

Item: 077

Event Year: 1908

Bibliographic Data: *The Life of Henry Ford*
The Henry Ford

Chronology
Page: 1

Publication Data: The Henry Ford
2003

Item Location: Internet

Why Worcester:

Importance of Item
Historically:

Technologically: In 1908 Henry Ford's first Model T car rolled of the assembly line, marking the new age of the mass produced automobile. Henry Ford required vast amounts of resources to fuel his production line and Wire was one of them. Additionally he required suppliers to meet his quality standards which were higher than ever before.

People Associated: Washburn and Moen, Henry Ford

Key Words: Washburn & Moen, Henry Ford, Model T, Demand for Wire

Item: 078

Event Year: 1850

Bibliographic Data: *Morgan Milestones*
Erskine Margaret

Page: 3+

Publication Data: Morgan Construction Company
1988

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: A 100 year history of the Morgan Construction Company, and the company's involvement in the construction of bar rolling mills used in the wire industry.

Although this book was written in the 1980's by Margaret Erskine, it is based on the previous research of Dr. James Conrad. Information was compiled from Morgan historical files and interviews of Myles, Paul B. Jr., Weld, and Paul S. Morgan during the 1970's.

When Washburn began to draw wire in the 1930's, he was in need of hot rolled rounds that the wire could then be cold drawn from. In order to solve this dilemma, Washburn built a water and steam powered bar mill at the south end of Lake Quinsigamond called the South Works.

"By 1850, Washburn was producing six thousand pounds of wire a day. He produced the first piano wire in the United States for the Chickering Piano Company. His primary market was the textile industry, producing wire cards which were used to comb the cotton, wool, and flax to be made into cloth."

The bar rolling mill required skilled labor. Expedient workmen had to carefully grab the hot steel rod as it passed through one set of rolls using tongs and feed it into the next pair of rolls where the diameter would be further reduced. If a worker went to slow the bar would cool before passing through the rolls and jam, or careless and at any time came into contact with the red hot bar, he or she would be badly burned.

Technologically:

People Associated: Washburn

Key Words: Washburn & Moen, Morgan, Bar Rolling

Item: 079

Event Year: 1899

Bibliographic Data: *Washburn and Moen Manufacturing Company*
The Illinois State Historical Society

Page: 1

Publication Data: The Illinois State Historical Society
2005

Item Location: Internet: See Bibliography

Why Worcester:

Importance of Item

Historically: The Washburn & Moen Manufacturing Company was purchased by The American Steel and Wire Company in 1899.

Technologically:

People Associated: Charles G. Washburn, Phillip W. Moen

Key Words: Washburn and Moen

Item: 080

Event Year: 1891

Bibliographic Data: *Washburn and Moen Manufacturing Company*
The Illinois State Historical Society

Page: 1

Publication Data: The Illinois State Historical Society
2005

Item Location: Internet: See Bibliography

Why Worcester:

Importance of Item

Historically: The Washburn & Moen Manufacturing Company purchased land in Lake County Illinois on January 16, 1891 to construct a the Waukegan Works wire mill. Construction of the new mill began in March of 1891.

Technologically:

People Associated: Charles G. Washburn, Phillip W. Moen

Key Words: Washburn and Moen, Waukegan Works

Item: 081

Event Year: 1891

Bibliographic Data: *Washburn and Moen Manufacturing Company*
The Illinois State Historical Society

Page: 1

Publication Data: The Illinois State Historical Society
2005

Item Location: Internet: See Bibliography

Why Worcester:

Importance of Item

Historically: The Waukegan Works wire mill began galvanizing steel wire by September of 1891.

Technologically:

People Associated: Charles G. Washburn, Phillip W. Moen

Key Words: Washburn and Moen, Waukegan Works

Item: 082

Event Year: 1892

Bibliographic Data: *Washburn and Moen Manufacturing Company*
The Illinois State Historical Society

Page: 1

Publication Data: The Illinois State Historical Society
2005

Item Location: Internet: See Bibliography

Why Worcester:

Importance of Item

Historically: The Waukegan Works wire mill began drawing its first wire in Decemer of 1892. The Waukegan Works soon became an important staple to Lake County Illionis. As production increased at the the mill people were drawn to the area to work in the mills and other business which supported the mills soon followed. The mills also attracted many European immigrants from Finland and Sweeden. By the 1950's the Waukegan Works became Lake County's largest employer. The mill was closed in 1979.

Technologically:

People Associated: Charles G. Washburn, Phillip W. Moen

Key Words: Washburn and Moen, Waukegan Works

Item: 083

Event Year: 1892

Bibliographic Data: *Washburn & Moen Annual Report To the Stock Holders*
Washburn & Moen Mfg. Co.

Page: 1

Publication Data:

Item Location: Baker Library Case 3

Why Worcester:

Importance of Item

Historically: The Waukegan plant was completed in 1892. The mill included a galvanizing dept, rolling and drawing mills, and barbed wire manufacturing. Equipment.

Technologically:

People Associated: G. S. Hall, Charles G. Washburn, Kinnicutt & Co.

Key Words: Waukegan

Item: 084

Event Year: 1812

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 30-31

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: Some of the earliest American wire producers, which serviced the demand for card wire were Washburn & Moen, Spencer Wire, and The Thompson Wire Co.

Technologically:

People Associated:

Key Words: Wire Drawing

Item: 085

Event Year: 1777

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 31-32

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: One of the most significant historical documents referring to the importance of wire is found in a manuscript which quotes records from the General Assembly of South Carolina.

In the General Assembly, the 22nd day of August 1777.
"Report of the committee to whom the Petition of Thomas Lenoir was referred, as amended and agreed to by the House. "That they have considered the Petition of Mr. Lenoir, and have had sufficient evidence to convince your committee that the said Petitioner is qualified to carry on business both of drawing the wire and making as good wool and cotton cards are usually imported into this State, and do therefore recommend that the sum of Two hundred pounds be immediately given to Mr. Lenoir, as reward, he being the first Person that has begun business, and a farther sum of Eight hundred pounds advanced him on his giving an obligation to deliver to Joseph Kershaw, Esquire, at Camden, and in case of his death or absence from the State, to such Person as may be appointed by the President for the time being to receive the same, to be sold on account of the public, after giving twenty days Public notice of such Sale, forty pair of good cotton cards at the end of one year, and forty pair equally good at the end of the second year, proved upon oath to have been all manufactured by Thomas Lenoir within this State. "Ordered, That the Commissioners of the Treasury be served with a copy of the foregoing Report, and that they advance the sums of money and take the obligation therein mentioned. The

Technologically:

People Associated: Thomas Lenoir

Key Words: Wire Drawing

Item: 086

Event Year: 1831

Bibliographic Data: *Fifty Years of Wire Drawing*
Henry M. Smith

Page: 3

Publication Data:

Item Location: Baker Library Case 7

Why Worcester:

Importance of Item

Historically: In 1831 Ichabod Washburn and Benjamin Goddard set up business in north Worcester. By 1834 they had been successful enough to construct a factory specifically for the production of wire. The fact that the New England economy was severely lagging in 1834, putting people out of work may have influenced the construction of the new facility.

Technologically:

People Associated: Ichabod Washburn, Benjamin Goddard

Key Words: Wire Drawing

Item: 087

Event Year: 1350

Bibliographic Data: *Fifty Years of Wire Drawing*
Henry M. Smith

Page: 1

Publication Data:
1884

Item Location: Baker Library Case 7

Why Worcester:

Importance of Item
Historically:

Technologically: According to this source "The process of wire drawing, instead of hammering, was the invention of Rudolph, a Nuremburg wire smith, in 1320, but in 1660 , when the British Navigation Act was passed, there was not a wire mill in England. To encourage what was then a new industry, the importation of wire into England was prohibited by Charles I, and even its transfer from old to new cards was prohibited." The first wire products in England are believed to be pins made of copper and card wire made out of Yorkshire iron.

People Associated:

Key Words: Wire Drawing

Item: 088

Event Year: 1775

Bibliographic Data: *Fifty Years of Wire Drawing*
Henry M. Smith

Page: 2

Publication Data: 1884

Item Location: Baker Library Case 7

Why Worcester:

Importance of Item
Historically:

Technologically: White & Hazard, a relatively large wire drawing mill at Schuylkill Falls discovered the usefulness of anthracite coal in iron working.

People Associated:

Key Words: Wire Drawing

Item: 089

Event Year: 1775

Bibliographic Data: *Fifty Years of Wire Drawing*
Henry M. Smith

Page: 2

Publication Data: 1884

Item Location: Baker Library Case 7

Why Worcester:

Importance of Item

Historically: In 1775, Nathaniel Niles set up a manufacturing facility for iron wire in Norwich Connecticut. The assembly of Conn. Granted Niles a loan of L300 for a period of four years.

Technologically:

People Associated: Nathan Niles

Key Words: Wire Drawing

Item: 090

Event Year: 1777

Bibliographic Data: *Fifty Years of Wire Drawing*
Henry M. Smith

Page: 2

Publication Data:
1884

Item Location: Baker Library Case 7

Why Worcester:

Importance of Item

Historically: "In 1777, Oliver Evans of Philadelphia, made proposals to establish, under State patronage, a factory for wire drawing."

Technologically:

People Associated: Oliver Evans

Key Words: Wire Drawing

Item: 091

Event Year: 1834

Bibliographic Data: *Fifty Years of Wire Drawing*
Henry M. Smith

Page: 3

Publication Data:
1884

Item Location: Baker Library Case 7

Why Worcester:

Importance of Item

Historically: In 1834 there were only three wire manufacturers in the United States, producing a total of approx. 15 tons per day or 4500 tons per year. By 1884 the total annual wire production had reached 135,000 tons, about 25 percent of which came from Worcester.

Technologically:

People Associated:

Key Words: Wire Drawing

Item: 092

Event Year: 1775

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 29

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: Lewis claims he has found no evidence of any wire operations in America prior to the revolutionary war. In this time period the primary use of wire was for carding equipment, necessary for the production of wool products. During the war when the supply of wire from England was cut off, the first American wire drawer's began to appear. Once the war had ended, it appears that these operations receded and the importation of English wire resumed.

Technologically:

People Associated:

Key Words: Wire Drawing, Carding

Item: 093

Event Year: 1775

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 39-42

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: Oliver Evans grew up during the revolutionary war and as a boy he became one of the first to draw wire in America. He describes the process of the time period on pages 39 - 42.

Technologically:

People Associated: Oliver Evans

Key Words: Wire Drawing, Carding

Item: 094

Event Year: 1789

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 32

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: Letter dated 1789 to Pliny Earle of Leicester Massachusetts from a textile manufacturer, asking for a quote on re-covering the drums of their carding machine. They say "We are not desirous of beating thee down in thy price, or thou should do it below what thou could reasonably afford, but …"(Lewis, 33).

Technologically:

People Associated: Pliny Earle

Key Words: Wire Drawing, Carding

Item: 095

Event Year: 1820

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 44

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: In 1820 Elliot Prouty returned to from New York after a brief abstinence from wire drawing to join his brother Russell Prouty and resume wire making in Spencer.

Technologically:

People Associated: Elliot Prouty, Russell Prouty

Key Words: Wire Drawing, Carding

Item: 096

Event Year: 1820

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 45

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: Although records are hazy it appears as though Foster and his brother Rosell Bisco took over the Watson and Windsor mill in Spencer in about 1820.

Technologically:

People Associated: Foster Bisco, Rosell Bisco,

Key Words: Wire Drawing, Carding

Item: 097

Event Year: 1822

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 44

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: In 1822 Russell Prouty was granted a U.S. patent for "an improvement in the art of wire drawing." Lewis attempted to locate information on this patent, however the U.S. Patent Office apparently destroyed its records pertaining to this.

Technologically:

People Associated: Russell Prouty

Key Words: Wire Drawing, Carding

Item: 098

Event Year: 1876

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 45-47

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: As time passed the demand for wire increased as did its applications and specifications. Wire production was no longer primarily for textile cards. Telegraph wire, hoop skirts, wire fence, and wire nails required wire of increased length, and of larger diameter. Furthermore wrought iron which had previously been used was becoming obsolete, in favor of Bessemer steel, which offered higher tensile strength, a and greater product consistency. With the establishment of technical institutions such as the nearby Worcester Polytechnic Institute, the use of chemistry, metallurgy, and pyrometry was becoming more common. The Wire Village soon found itself behind the curve and unable to meet the modern day industrial demands.

Technologically:

People Associated:

Key Words: Wire Drawing, Carding

Item: 099

Event Year: 1812

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 35

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: When Lewis used to visit the American Antiquarian Society in his home town of Worcester Massachusetts, the current librarian, Clarence Brigham used to tell him that: "If anything was ever written about wiredrawing it must have been by Oliver Evans, for he was in and out of more technologies than any man since Leonardo da Vinci, and whatever he knew he always found occasion to write." The piece Clarence was referring to was Oliver Evans' February 14, 1812 article in the Philadelphia Aurora which urged Americans to revive the U.S. textile industry by going into the manufacture of card wire.

Technologically:

People Associated: Oliver Evans

Key Words: Wire Drawing, Carding, Oliver Evans

Item: 100

Event Year: 1812

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 43

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: The first re-emergence of the wire drawing industry since the Revolutionary War occurred about the same time as Oliver Evans article appeared in 1812. One of the first and most significant wire mills of this time period was the Spencer Wire Co. which was founded by Jacob Watson, who started drawing wire in his kitchen. He and Windsor Hatch later set up a formal mill on the outskirts of town where Turkey Hill Brook meets the Seven Mile River. Concurrently, Elliot Prouty another local wire maker from nearby Cherry Valley set up a wire mill just downstream from Watson and Windsor's. Records of these early ventures are vague, and it appears that due to economic conditions they did a combination of farming and wire drawing off and on.

Technologically:

People Associated: Jacob Watson, Windsor Hatch

Key Words: Wire Drawing, Carding, Oliver Evans

Item: 101

Event Year: 1812

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 46

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: Although exact sources of the early iron are unknown, it was believed to be refined locally. Jonathan and Nicholas Jenks operated a forge on the Five Mile River which refined Iron Ore that was left in bog deposits in and around Lakes Quabog and Wickabog.

Technologically:

People Associated: Jacob Watson, Windsor Hatch

Key Words: Wire Drawing, Carding, Oliver Evans

Item: 102

Event Year: 1847

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 45

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: By 1847 it is apparent that the Bisco brothers had gained formal ownership of both the Watson and Winsor mill and the Prouty mill.

Technologically:

People Associated: Bisco

Key Words: Wire Drawing, Carding,Bisco

Item: 103

Event Year: 1926

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 244

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: In 1926 the Carboloy Company developed a new insert die system which out lasted the traditional tool steel dies that were in use at the time.
By 1934 practically all wire dies were equipped with carbide inserts.

Technologically:

People Associated:

Key Words: Wire Drawing, Dies, Carboloy

Item: 104

Event Year: 1876

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 47

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: In 1876 Richard Sugden, an English immigrant who had owned a card making business in Leicester bought out the Bisco brothers mills and formed the Spencer Wire Corporation. The share holders of this new found corporation were Richard Sugden himself, Jonas and Joel Prouty, Charles Denny, J.H. Goddard, Alex Milne, Phillip Moen and Charles Washburn.

Technologically:

People Associated: Richard Sugden, Jonas Prouty, Joel Prouty, Charles Denny, J.H. Goddard, Alex Milne, Phillip Moen

Key Words: Wire Drawing, Spencer Wire Corporation

Item: 105

Event Year: 1880

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 47

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: In 1880 Harry Goddard started working for Richard Sugden as an office boy and handyman at the Spencer Wire Corporation. Harry was a third generation wire man. His grandfather had started out drawing wire with Ichabod Washburn in Worcester and his father Dorrance Goddard was the superintendent of the South Works. It was at the South Works where Harry cut his teeth in the wire drawing industry working for three years before going to Spencer.

Technologically:

People Associated: Richard Sugden, Harry Goddard

Key Words: Wire Drawing, Spencer Wire Corporation

Item: 106

Event Year: 1895

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 47

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: Richard Sugden died in 1895, and J.H Goddard bought the mill. By this time Harry Goddard had become the President and Treasurer and he continued to operate the Company. Ironically, his father Dorrance worked under him as a superintendent in Spencer during the last few years of his life.

Technologically:

People Associated: Richard Sugden, Harry Goddard

Key Words: Wire Drawing, Spencer Wire Corporation

Item: 107

Event Year: 1899

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 47-48

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: In 1899 Harry Goddard and Richard Sugden's nephew, Bruce Dunn formed a partnership. It became clear that the mill in Spencer ("Wire Village") was becoming outdated. The demand for wire exceeded the local supply of iron, making it necessary to have iron shipped in from elsewhere. Because of Spencer's rural location and rough terrain, it was not economically feasible to have materials shipped in. The partners decided to set up a new mill in Worcester which retained Spencer Wire Company name. This mill operated from 1899 until about 1919.

Technologically:

People Associated: Harry Goddard, Bruce Dunn

Key Words: Wire Drawing, Spencer Wire Corporation, Spencer Wire Company

Item: 108

Event Year: 1930

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 49

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: Although wire drawing had been greatly reduced at the Spencer Wire Village mill the company kept it going until it was dismantled in 1930.

Technologically:

People Associated:

Key Words: Wire Drawing, Spencer Wire Corporation, Spencer Wire Company

Item: 109

Event Year: 1920

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 48

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: Around 1920 the Spencer Wire Company was bought by the Wickwire company, and became the Wickwire-Spencer Steel Corporation.

Technologically:

People Associated:

Key Words: Wire Drawing, Spencer Wire Corporation, Spencer Wire Company, Wickwire-Spencer Steel Corporation

Item: 110

Event Year: 1788

Bibliographic Data: *Fifty Years of Wire Drawing*
Henry M. Smith

Page: 2

Publication Data: 1884

Item Location: Baker Library Case 7

Why Worcester:

Importance of Item

Historically: A substantial wire mill was built in Dedham Massachusetts for the manufacture of iron wire for the production of cards and fish-hooks

Technologically:

People Associated:

Key Words: Wire Drawing, Wire Cards, and Fish Hooks

Item: 111

Event Year: 1900

Bibliographic Data: *Wright Wire Company*

Page:

Publication Data:

Item Location: Worcester Historical Museum

Why Worcester:

Importance of Item

Historically: Photo Album for the Wright & Colton Wire Cloth Company which appears to have made primarily wire fencing and mesh (chicken wire) during the late 1800's to early 1900's.

Technologically:

People Associated:

Key Words: Wire Fence

Item: 112

Event Year: 1745

Bibliographic Data: *The Wire Gauge*
Arthur Warren

Page: 2

Publication Data:

Item Location: Baker Library Case 2

Why Worcester:

Importance of Item

Historically: The first reference to a wire gauge, or other means of measuring the thickness of wire did not appear until 1745. This reference appears on pg 53 of Lewis's "Philosophical Commerce of Art" published in 1745. After describing the typical wire drawing process in detail, he mentions that the wire drawer uses a "size" made of a piece of brass with notches in it to monitor the progress of the process.

Technologically:

People Associated:

Key Words: Wire Gage, Wire Standards

Item: 113

Event Year: 1912

Bibliographic Data: *Wire Gages, Progress to Uniform Standards*
C.L. Miller

Page: 1

Publication Data:

Item Location: Baker Library Case 2

Why Worcester:

Importance of Item

Historically: The American Steel & Wire gage (A.S.& W.) gage is the same as the Washburn & Moen gage. It is also noted that this was the most commonly used steel wire standard during this time period.

Technologically:

People Associated: A.G Warren

Key Words: Wire Gage, Wire Standards

Item: 114

Event Year: 1851

Bibliographic Data: James F. Newcomb

Page: 1

Publication Data:

Item Location: Baker Library Case 7

Why Worcester:

Importance of Item

Historically: This is a correspondence between James F. Newcomb (Owner of a Penn. advertising firm) and Arthur G. Warren, manager of the industrial museum dated March 20, 1928. In this letter Newcomb refers to the first wire nail machine used in America, built in 1851 which was on display at the Worcester industrial museum.

Technologically:

People Associated: James F. Newcomb, Arthur G. Warren

Key Words: Wire Nails

Item: 115

Event Year: 1920

Bibliographic Data: *Steel Wire in America*
Kenneth Burnham Lewis

Page: 48

Publication Data: The Wire Association, Stamford Conn.
1952

Item Location: Gordon Library

Why Worcester: Carding, Nearby Textile Industries

Importance of Item

Historically: During the 1920's numerous wire men from both former Spencer and Washburn wire employees began staring their own businesses. While Washburn & Moen was concerned with making common wire products, many people saw money to be made in specialized lower volume products such as flat wire, high carbon steel wire, etc.

Technologically:

People Associated:

Key Words: Wire Products, Diversification

Item: 116

Event Year: 1868

Bibliographic Data: *Morgan Milestones*
Erskine Margaret

Page: 5

Publication Data: Morgan Construction Company
1988

Item Location: Gordon Library

Why Worcester:

Importance of Item

Historically: Following the end of the Civil War, Washburn donated a building to WPI which opened on November 10, 1868. The building was symbolic of a new era in New England, there was a movement from rural farm life to an industrialized society. According to Erskine the wire mill was the "keystone" of this growth.

Technologically:

People Associated:

Key Words: Wire, Industrial Revolution