INDUSTRIAL WORCESTER

by

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To the MECHANICS
and MANUFACTURERS
PAST *and* PRESENT
of WORCESTER

CONTENTS

INTRODUCTION

I wrote that part of the History of Worcester County, published in 1889, that dealt with the Manufacturing Industries of the City of Worcester. In order that it might be more available for reference, I have for a long time intended to republish it in book form with such additions as I might be able to make, and with an adequate index. A work of this sort is never completed. It is like a painting which to the eye of the artist is never finished. But if we were unwilling to turn out any but a perfect product, little would be produced. I know that there is a lack of proportion in what I have written, due in part to the fact that I have, as far as possible, adhered to the form in which the material was originally published and in part to the fact that all the information I desired was not accessible.

There must be many mistakes, omissions and inaccuracies in what I have written. I shall be very grateful to anyone who will call my attention to them to the end that at some future time an adequate history of Industrial Worcester may be written.

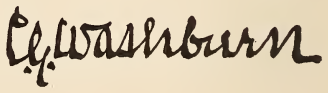
There is nothing which adds so much to the stability of a community as the presence of those who have contributed largely to its growth, whose lives have become a part of it, who have placed the stamp of their originality upon it. This is particularly true where the life of the individual spans that of the community.

Such instances, unknown of course in the older countries and now in the earlier settled portions of the United States, are the rule rather than the exception in many parts of the West. Within the past thirty years have died many men who could have told us the story of Worcester's industrial growth from their personal knowledge of events and the account books of some of them would afford a pretty accurate tracing of the progress of American manufactures.

It is much to be regretted that the story of Worcester's growth has not been more completely told by those who witnessed it from day to day and that such rich stores of experience and anecdote, available only during the life of the individual, have not been more largely drawn upon. One by one those who laid the foundation of Worcester's great prosperity have passed away until there are none left whose business life covers the whole space of our great industrial development.

Many of them were men of very simple character who began life in a small way and made slow progress. They were reticent, modest, industrious, shrewd, enterprising and a large proportion of them very public spirited. They accumulated property not always because of great gains, but more often because of frugal living and large savings. The same horse which took the family to church on Sunday did the transportation for the shop or mill on the other days of the week.

It is not, after all, the policies of great nations which interest us most deeply, or great historical events and places, but rather the every day affairs of the neighborhood and particularly the habits and customs of by gone days. A suit of clothes worn by Washington would now be regarded with as much interest as the reading of his farewell address is listened to with reverence, and I venture to say that a view of Main Street as it was one hundred years ago will now command a wider interest in this community than a photograph of the Roman Forum. If some magician could bring it about, who would not like to spend an afternoon sitting by the stove in Daniel Waldo's hardware store in Lincoln Square listening to the gossip of the village? The days in which our pioneer mechanics and manufacturers lived were those of small things, but the seed then planted is now yielding a most abundant harvest.



May, 1917.

CHAPTER I

Early Encouragement of Manufactures—Saw and Grist-Mill—The Silver-Mine—Potash—Timothy Bigelow—Early Manufacture of Cloth—Paper-Mills—Character of Business prior to 1820—Trades-people Discontented with the Heavy Taxes—Public Men appear in Home-made Cloth—Worcester Honorable Society—The First Exhibition of the Worcester Agricultural Society.

After the first settlement of Worcester had been broken up by the Indians in King Philip's War, a meeting of those interested was held at Cambridge, March 14, 1679, N. S., for the purpose of considering the expediency of again settling the town.[1]

As a result of this meeting, it was resolved "to settle the said plantation some time the next summer come twelve months, which shall be in the year of our Lord 1680."

The town was to be built to attain six ends, which were enumerated, chief among them "the better convenity of attending God's worship," and the "better education of their children"; but provision was also to be made "for the better accommodation of trades-people."

Nothing of a practical kind was done looking toward the settlement until the General Court threatened to forfeit the grant unless the settlement were made; accordingly, an agreement was entered into April 24, 1684, with that end in view. It was voted that the plantation be divided into four hundred and eighty lots, three of these to be set apart for the maintenance of a saw-mill, and three for a grist-mill. To the builders and maintainers of works promoting useful trades, and for a fulling-mill, when the place is capable thereof, six lots.

[1] Lincoln, p. 33.

The histories appear to agree that Captain John Wing built the first mills in Worcester, some time in 1685, perhaps in the month of March; he probably had both a saw and grist-mill located on the north of Lincoln Square, on Mill Brook, about where the Nashua freight depot is now situated.

Captain Wing appears to have been a man of considerable consequence. He was a resident of Boston, one of the founders of the Old South Church, an officer in the artillery company and kept the Castle Tavern. He was a member of the committee having charge of the plantation of Quinsigamond, and became a large landholder there, conducting his mill in Worcester and his tavern in Boston at the same time. He died in 1702.[1]

From 1686 until the fall of 1713 no records appear of the transactions which took place in the settlement, and during a great part of that time the country was exposed to the ravages of the Indians, and, in consequence, the town was almost entirely deserted.

The third attempt to effect a permanent settlement was made in October, 1713; the old saw-mill of Wing appears under the ownership of Thomas Palmer, Cornelius Waldo, of Boston, and John Oulton, of Marblehead.

The next mill to be built was that of Obadiah Ward, which he devised to his son in his will dated December 16, 1717. It was near the upper canal-lock, present site of Crompton's Loom Works[2] on Green St.

Elijah Chase built the first corn-mill, near where the Quinsigamond Paper-Mills were afterwards erected on the Blackstone River. The water privilege, with thirty acres of land at Quinsigamond, was granted by the town to Captain Nathaniel Jones, September 12, 1717, upon

[1] "Early Settlement of Worcester," by Francis E. Blake.
[2] Lincoln.

condition that he should complete and maintain a grist-mill for twelve years. He built a dam and saw-mill in 1726, but both were probably swept away in the flood of 1728-29, and in 1732 the town took steps to recover the land by reason of the failure of Jones to comply with his contract.[1] The mills in Worcester at this early period were few in number and simple in character. Saw and grist-mills, with an occasional fulling-mill and trip-hammer shop, were to be found; certainly the demands of two hundred people could not have been very great.

In 1754, according to a description found in Lincoln's History, "a vein of metal, which was supposed to be silver, was discovered near the head of the valley, about a mile north of the town. A company for exploring the spot was formed by some of the most substantial inhabitants, furnaces and smelting-houses were erected and a cunning German employed as superintendent. Under his direction a shaft was sunk eighty feet perpendicularly, and a horizontal gallery extended about as far through the rock, which was to be intersected by another shaft, commenced about six rods north of the first opening.

"Among the masses which were, within a few years, laid around the scene of operations were specimens of the ores containing minute portions of silver, specks of copper and lead, much iron and an extraordinary quantity of arsenic; when struck against steel a profusion of vivid sparks were thrown out, and a peculiarly disagreeable odor of the latter mineral emitted. On the application of heat this perfume increased to an overpowering extent. The company expended great sums in blasting the rocks, raising its fragments and erecting buildings and machinery. While the pile of stone increased, the money of the

[1] "Early Paper-Mills in Massachusetts," E. B. Crane, Proceedings Worcester Society of Antiquity for 1886.

partners diminished. The furnaces in full blast produced nothing but suffocating vapors, curling over the flames in those beautiful coronets of smoke which still attend the attempt to melt the ore.

"The shrewd foreigner, in whose promises his associates seem to have placed that confidence which honest men often repose in the declarations of knaves, became satisfied that the crisis was approaching when it would be ascertained that the funds were exhausted and that stone and iron could not be transmuted to gold. Some papers which exist indicate that he pretended to knowledge in the occult sciences as well as skill in the art of deception; however this may be, he assured the company that the great enemy of man had been busy in defeating their exertions, making his presence redolent in the perfume of sulphur and arsenic. He obtained the sum of $100 and made a journey to Philadelphia to consult with a person experienced in mines and their demons, for the purpose of exorcising the unsavory spirit of the crucible. He departed with a barrel full of the productions of the mine, but never returned to state the results of his conference.

"The proprietors abandoned the work when they were awaked by the reality of the loss from the dream of fortune, and afterwards destroyed the records of their credulity."[1]

"The spot is easily found. Follow the Nashua Railroad north on foot from its crossing on Mill Brook till you pass the two-mile post. The deserted shaft is about twenty rods to the northeast of this spot. It is readily found, as a pile of slate and stones still lie where they were thrown out by the miners on a slight eminence in the meadow."[2]

[1] Lincoln, p. 294.

[2] "The Heart of the Commonwealth," Henry J. Howland, 1856.

And yet the German superintendent may have been more superstitious than knavish. The mineral which baffled him, whose arsenical fumes almost suffocated his miners and confirmed his belief in the supernatural, was cobalt, a name derived from Greek *Kobalos*, German *Kobold*, a little devil. German folk-lore is full of the diabolical pranks of the Kobold, and of pity for the unfortunate beings who suffered from the tortures which he inflicted to prevent incursions upon his subterranean dwelling.

In 1760 the manufacture of potash appears to have been carried on quite extensively in and about Worcester; indeed, it was a thriving industry throughout the country. By reason of its scarcity in England, Parliament remitted the duties in 1751, and encouraged its importation from the colonies, where wood was plentiful. Numerous pamphlets upon the desirability of this branch of manufacture to the colonies, and upon the best methods of making potash, were at this time published.

Its manufacture was urged on the ground of affording the colonies an article of export with which to pay for the manufactures imported from Great Britain, and the North American plantations were thought to be well adapted to the manufacture of potash by reason of the abundance of wood suitable for the purpose. A writer upon this subject, in 1767, makes the following recommendations:

> It is supposed that each set of works for carrying on the manufacture of potash will have a range of ten miles round for its supply, less than which would not be sufficient; and I would here, by the way, caution such who may undertake to erect works for this purpose, that the place they fix upon be at least twenty miles distant from any other works of the like kind, lest they only injure their enterprise by thus cutting off the prospect of a sufficient supply of ashes.
>
> Each set of works under such advantages of obtaining stock will, I presume, at the least, annually produce twenty tons of good potash, which, at the lowest rate it has ever been sold for, namely, £25, would

amount to £500 sterling, and if twenty of these works were to be erected within the limits of the province of Massachusetts (which I think a moderate number), there might be annually exported out of the province alone 400 tons of potash, which, at the before-mentioned low rate, would amount to £10,000 sterling.[1]

The process of manufacture was simple, and consisted in treating wood-ashes with water until the potash contained in them was exhausted, and from the lye thus made a salt was obtained by evaporation. The woods chiefly employed in making potash were hickory, oak, beech, birch, elm, walnut, chestnut and maple. Woods like evergreen, or that abound in turpentine, were avoided.

Worcester appears to have been well supplied with wood, and works for the manufacture of potash were established in different parts of the town. Pleasant Street was at one time known as Potash Hill. Lincoln, in his history, says: "Works for making potash were first established in the north part of the town about 1760; buildings for similar purposes were placed on the west side of Lincoln Street, a little above the old Hancock Arms Tavern, by John Nazro, about ten years after; four more were established at much later periods."

Peter Whitney, in his history, published in 1793, says: "The first complete ton of potash was sent to market from the neighboring town of Ashburnham, where it was made at the time of the settlement in 1735." In 1788 there were about two hundred and fifty potash works in Massachusetts. Governor Bowdoin, as a remedy for the distress then prevailing, had recommended in a message to the General Court, 1785, that the farmers in towns where there was an abundance of wood to be cleared away, should devote themselves to the production of potash and pearl-ash, and the ashes should be deposited

[1] John Mascarence's address to His Excellency, Thomas Pownall, Esq., captain-general and Governor-in-chief in and over His Majesty's province of Massachusetts Bay in New England.

with the State agent, who should sell them and use the money to pay the taxes of the men who brought them.

Isaiah Thomas, in 1793, advertised a book on the manufacture of pot and pearl-ash.

It has seemed worth while to dwell at some length upon the manufacture of potash, as it so clearly shows the narrow resources of the provinces at that time, and the lack of any manufacturing interests beyond the simplest kinds designed to meet the wants of a scanty population.

One of the earliest mechanics to attain prominence in Worcester was Timothy Bigelow, who, before the Revolution, had a blacksmith's shop where the Court Mills afterwards stood, near the present junction of Union Street with Lincoln Square. Of him a somewhat romantic story is told.

There then stood on the site of the block of brick houses, opposite the court-house, the residence of the orphan daughter of Samuel Andrews, then the principal heiress in Worcester. To quote from an old newspaper story:[1]

"In the rear of the Andrews home Tim Bigelow had a blacksmith's shop, where he blew the bellows, heated and hammered the iron, and shod the horses and oxen and mended the plows and chains for the farmers of the country about him. Now Tim was as bright as a button, more than six feet high, straight and handsome, and walked upon the earth with a natural air and grace that was quite captivating. Now Tim saw Anna, and Anna saw Tim, and they were well satisfied with each other; but, as he was then 'nothing but Tim Bigelow, the blacksmith,' the lady's friends, whose ward she was, would not give their consent to a marriage. So, watching an

[1] "Carl's Tour in Main Street."

opportunity, the lovers mounted fleet horses and rode a hundred miles, to Hampton, in New Hampshire, which lies on the coast, between Newburyport and Portsmouth, and was at that time the 'Gretna Green' for all young men and maidens for whom true love did not run a smooth course in Massachusetts. They came back to Worcester as Mr. and Mrs. Timothy Bigelow.

"He was a man of decided talent, and well fitted by nature for a popular leader. All the leading men of the town at that time were Tories. He espoused the cause of the people, and soon had a party strong enough to control the town, and, being known as a patriot, he was recognized by Hancock, Samuel Adams, General Warren, James Otis and others of the patriot party throughout the Province. He was sent as a delegate from Worcester to the Provincial Congress, and, as captain of the minute-men, he led his company from Worcester to Cambridge on the 19th of April, 1775, at the summons of a messenger, who rode swiftly into town that day on a large white horse, announcing that war had begun.

"Blacksmith Bigelow soon rose to the rank of major, and, afterwards, to that of colonel of the Fifteenth Massachusetts Regiment, which was composed almost exclusively of Worcester County men. He was at the storming of Quebec, at the taking of Burgoyne, at the terrific scenes of Valley Forge and on almost every other field made memorable by the fierce conflicts of the Revolution.

"When the war was over he returned home, his constitution shattered by hard service for his country, his health ruined, his fortune gone in consequence of the formidable depreciation of the currency, under which forty dollars was scarcely sufficient to pay for a pair of shoes."

In 1789 a few men formed an association for the purpose of manufacturing cloths, that had theretofore been imported from Great Britain, and in the *Spy* of April 30, 1789, the following notice is found:

On Tuesday last the first piece of corduroy made at a manufactory in this town was taken from the loom; and March 25, 1790, the proprietors of the Worcester Cotton Manufactory gave notice that they would not take any more linen yarn for the present, having a sufficient quantity on hand.

May 27, 1790, Samuel Brazer advertises "goods of American manufacture to be sold at wholesale and retail, corduroys, jeans, fustians, federal rib, and cotton, for cash only. The prices are reasonable, the quality of the goods superior to those imported, which will induce all to give preference to the manufactures of their own country." Later, we find:

An Overseer wanted at the Cotton Manufactory at Worcester, also three or four healthy boys as apprentices; two or three journeymen weavers at said manufactory. Apply, for further information, to Saml. Brazer or Daniel Waldo, Worcester.

August 5, 1790, all persons who had demands against the proprietors of the Worcester Cotton Manufactory were requested to present them to Samuel Brazer and Daniel Waldo, Jr., from which we conclude that the enterprise had not prospered, and it is probable that upon the declaration of peace, goods could be obtained more cheaply from England than they could be manufactured here.

This factory, containing crude machinery, stood upon Mill Brook, and was located in School Street, east of the present location of Union Street.

When the manufacture of corduroys and fustians was abandoned, the factory was moved to Main Street, and was thereafter known as the Green store (present site of Parker block). Samuel Brazer was from Charlestown,

where he was a baker, and in 1782 engaged in the same business in Worcester; he appears to have been somewhat jealous of his good name, for in 1784 we find him refuting a slander in regard to the size of his bread. In October, 1785, he dealt in crockery and West India goods at the sign of The Old Maid, in the centre of the town. From this time on Mr. Brazer was engaged in a variety of occupations.

Daniel Waldo, Jr., who was associated with Samuel Brazer in the manufacture of corduroys, was a son of Daniel Waldo, who moved to Worcester from Lancaster in 1782, and engaged in the hardware business near the bridge over Mill Brook at Lincoln Square.

The manufacture of paper took an early and prominent place among the industries of the Colonies.

May 3, 1775, at a convention of delegates from towns in Worcester County, the following vote was passed:

Resolved, That the erection of a Paper-mill in this county would be of great public advantage, and if any person or persons will undertake the erection of such a mill and the manufacture of paper, that it be recommended to the people of the county to encourage the undertaking by generous contributions and subscriptions.

In the *Spy* of July 5, 1775, the following notice is found:

Any person or persons that incline to set up that useful manufacture, the making of paper, may hear of one who will undertake to give directions for building a mill, and will carry on the business in good shape with assistance.

From the pamphlet on "Early Paper Mills in Massachusetts," by E. B. Crane, and part of the Proceedings of the Worcester Society of Antiquity for 1886, we learn that Abijah Burbank, of Sutton, was the first to respond to this resolution.

Paper was evidently very scarce, for want of it but one-half of the *Spy* could be published October 30, 1776.

This was no doubt due to the scarcity of rags, which continued for some time, for on October 30, 1777, the following notice was published:

> The paper-mills and, of consequence, the printing offices in this county must inevitably stop unless the good people are more careful in preserving their rags. The advanced price of 3*d*. per lb. for clean linen rags is now given by the printers, which, together with the invaluable benefit which the public must derive from having a plentiful supply of paper books, cannot fail of the desired effect.

This difficulty seems, however, to have been overcome, for in May, 1778, Mr. Burbank advertised,—"The manufacture of paper in Sutton is now carried on to great perfection."

The business of Isaiah Thomas as printer and publisher in Worcester had become of considerable consequence. The Rev. Peter Whitney stated that no person had added more to the consequence and advantages of the town and county of Worcester than Isaiah Thomas. The publishing of the *Spy* was only a part of his business. After the war, in 1788, he conducted a printing-office in Boston and in Worcester, and carried on a large business as printer, publisher, bookseller and bookbinder.

Mr. Thomas lived on the site of the stone courthouse, just south of which his office was located. He employed in the various departments of his business one hundred and fifty hands.

To provide paper for his needs, Mr. Thomas, to quote from Mr. Crane's pamphlet, "presumably with the intention of erecting a paper-mill, on January 7, 1785, purchased of Ephraim McFarland, for ninety pounds, the southerly half of a dam and water privilege located at what is now known as Quinsigamond village, and on the northerly side of the street, in front of the site now occupied by the South Works of the American Steel & Wire Co.

"Owing, perhaps, partly to the unsettled condition of the affairs of state, and to the impoverished plight of the country, the building of the mill was deferred, and November 9, 1787, he sold the property for eighty-five pounds to Dr. Elijah Dix, from whom he again purchased it January 31, 1793, for one hundred pounds, and soon began the construction of a two-vat mill;" and, to again quote Mr. Crane, "This mill, built by Mr. Thomas, was supplied with two vats of about one hundred and ten lbs. capacity, and they ran usually fifteen hours each day, employing ten men and eleven girls. The main product of this mill was hand-made paper, and from twelve hundred to fourteen hundred lbs. were turned out weekly. As to price of labor: The skilled engineer received about three dollars per week, vat-men and coucher three and a half dollars each without board; ordinary workmen and girls, seventy-five cents per week each; boys, sixty cents each, and they were given board.

"It was here at this mill that Zenas Crane, a native of Dorchester, toiled at the trade of paper-making for several years previous to the summer of 1799, when he set out from Worcester to establish, in company with Henry Wiswell and Daniel Gilbert, a paper-mill in the western portion of Massachusetts, and succeeded so admirably in laying the foundations for a business that, through the careful and skillful management of Mr. Crane and his descendants, has assumed the most flattering proportions, and whose trade-marks, known as 'The Old Berkshire,' 'Old Red Mill,' 'Pioneer Mill' and 'Government Mill,' stand for as good an article of paper as can be found in this country or perhaps any other."

Mr. Thomas sold his paper-mill to Caleb and Elijah Burbank, of Sutton, February 24, 1798. This paper-mill was the second in the county and the eighth in the State.

Another building was erected shortly after 1811, below the Thomas Mill, and used as a sickle-factory by Gardner Burbank, Elijah's son; afterwards it was converted into a paper-mill. This building was located in what is now the scrap-yard of the South Works of the American Steel & Wire Co. On February 24, 1827, the Elijah Burbank mill was burned. The fire was caused by spontaneous combustion of cotton waste. The loss was $500.

In 1778 the principal articles, aside from food and the ruder kinds of cloth, were imported, and mostly from England. The resident of Worcester could find steel, bar iron, choice brandy, New England and West Indian rum, coffee, alum, brimstone, powder and shot at the store of Samuel & Stephen Salisbury, on the north side of Lincoln Square, just east of the Salisbury mansion, where the depot now stands.

Elisha Clark, at this time, followed the business of rope-making about two miles from the meeting-house, on the road to Sutton.

Clock and watch-work was done in a small way, but not of a very fine grade, if we may judge from the following description of a watch supposed to have been stolen: "A large old-fashioned watch with the glass broken in three places and put together with putty."

As a rule, shoemakers in the early days went from house to house, but in 1779 Nathan Heard appears to have established a small shoemaker's shop in Worcester.

Daniel Waldo, to whom reference has been made, opened, in 1782, a store near the bridge over Mill Brook at Lincoln Square, where he offered for sale best Heart and Club German steel, bar iron, 4dy. and 10dy. nails, window-glass, Dutch looking-glasses, iron shovels, spades, saddlers' ware, and in general, an assortment of hardware and West India goods, choice Bohea tea, etc.

The firm of D. Waldo & Son, was dissolved December 31, 1791; Daniel Waldo, Jr., continued.

In 1783, Abel Stowell manufactured clocks and watches in his shop south of the meeting-house, on the west corner of Park and Salem Streets. He made in 1800 the clock formerly in the Old South Church. The business of watch and clock-making appears to have been a considerable industry at this time. Benjamin Willard, of Grafton, who had an office with Isaiah Thomas, had sold two hundred and fifty-three eight-day clocks up to 1784.

The art of hat-making was early practiced in Worcester; John Smith offered one shilling each for catskins in 1782, and in 1789 Nathan Blackburn advertises for an apprentice in the hat-making business.

In 1789 Palmer & Daniel Goulding owned a tanyard. Almost every town had a tan-yard, and leather of sufficiently good quality was made to serve the needs of the shoemakers and saddlers in the immediate vicinity.

Improvements in the simple conveniences for living were made from time to time, and in 1791 the appreciation of the necessity for a cheap and satisfactory artificial light is found in the construction of a new candle machine, price, forty-five dollars,—with which it was claimed a boy could make three hundred and sixty rods of candles per day.

Abraham Lincoln had a trip-hammer and grist-mill a few rods from the court-house, which he offered for sale in 1795. It must have been located on Mill Brook. The works are described as containing two pairs of bellows that go by water, a grindstone and mill all under one roof; "said works and grist-mill are as convenient and as well situated for custom as perhaps any in the Commonwealth."

The desire for communication between the seaboard and Worcester appears to have been felt previous to

March, 1796, when some persons formed an association at Providence for making a canal to Worcester, and they were at that time invited to a conference in Worcester at the tavern of Ephraim Mower. Later on, no doubt as a result of this meeting, a prospectus appeared setting forth the purpose of the Canal Company, which was to issue four thousand shares of stock at one hundred dollars each, which it was estimated would cover the cost of building the canal. Subscriptions were solicited in Worcester; William Paine (at Dr. Lincoln's store), Joseph Allen (at his office), Isaiah Thomas, Thomas Payson, Daniel Waldo, Jr., and Samuel Chandler were appointed to receive them.

In October, 1796, a number of individuals petitioned the General Court for an act of incorporation for the purpose of cutting a canal from Great Pond in Worcester to Boston, but nothing was done at this time either with the Blackstone Canal or with the proposed canal to Boston. In 1822 surveys were made for the Blackstone Canal, which was afterwards put into successful operation, as appears later in the narrative.

In 1798 Daniel Denny had a card-factory on Mechanic Street near Main, opposite Mower's tavern (present site of Walker building); later, he moved to Main Street, opposite the present site of the Bay State House. He, no doubt, bought his wire of Daniel Waldo, who imported it, and who, at this time, announced "Sixteen casks of Wool and Cotton Card wire will be landed in a few days from the brigantine 'Aidar,' just arrived from Amsterdam."

Dutch plows, made in Connecticut, were at this time for sale at Denny's store.

Cornelius Stowell, the clothier, had, in 1785, a shop on the east corner of Park, now Franklin, and Orange

Streets. Abel (the clock-maker), Peter and Ebenezer were his sons. The two latter he took into partnership with him about 1790, when they began to manufacture woolen goods, print calicoes, carpets, dye and dress woolen goods. They had two fulling-mills, and dyed fine scarlet and deep blue colors in the best manner.

In 1804 Peter & Ebenezer Stowell commenced to weave fine carpets, and at one time had six looms of their own invention and construction in operation. They made the first carpets used in the State-house at Boston. July 19, 1809, a patent on wood screws was granted to Abel Stowell, and in January, 1816, he and his son were located on the Common, a few rods southwest of the Baptist meeting-house, where they conducted a miscellaneous business, dealing in stoves of cast and sheet iron, with their funnels, "as cheap as they can be purchased in Boston or any other place." Machinery of all kinds in brass and iron, particularly such as are used in carding and other factories; clocks for meeting-houses and printers' materials in iron and brass. Among his effects offered for sale by his administrators in May, 1819, was an undivided part of what is called the Black Lead Mine, consisting of two acres. This was, no doubt, what was later known as the Worcester Coal Mine. Black lead was procured here and ground into a paint, which was quite generally used.

In January, 1808, Curtis & Goddard were busy making chaises, and at this time appear to have moved from opposite the jail to a building south of the bank. Samuel Newhall had taken the noted stand of John Johnson, where he intended carrying on the soap-making business. Thomas Stevens, cabinet-maker, states that he has purchased the right to make and sell two kinds of churns for several towns in the county.

In May, 1810, John Earle and Erasmus Jones erected a wool-carding machine to pick, break and card wool at the building known as Lincoln's Trip-hammer Shop, fifteen rods east of the court-house.

At this time the number and variety of manufactures in Massachusetts appear to have increased considerably. Some idea of these, in 1810, may be had from a notice issued from the marshal's office in Boston, July 17th, asking for information in regard to the following industries: tanneries, distilleries, sugar refineries, breweries, paper-mills, oil-mills, snuff-mills, chocolate-mills, gunpowder-mills, glass-works, fulling-mills, carding-machines (going by water), hemp and flax spinning-mills, cotton and wool-spinning mills, rope-walks, furnaces, air furnaces, forges, bloomeries, rolling and slitting-mills, cut-nail factories, trip-hammers and steel-furnaces.

The sudden increase in the variety of manufactures may be attributed to the embargo, declared in December, 1807, and to the complications then existing between this country and France and England, which led to an almost complete stoppage of importations, and manufactories of cotton goods, woolen goods, iron, glass, pottery and other articles rapidly sprung into existence.

Previous to the embargo, according to Hildreth,[1] there were in the United States but fifteen cotton-mills with a total of eight thousand spindles. By the end of 1809 eighty-seven mills were built, of which sixty-two were in operation—forty-eight by water and fourteen by horse-power—working thirty-one thousand spindles, and many more were in process of erection. Most of the saws used in Worcester in 1810 doubtless came from the works of Elijah Waters & Co., at Sutton, who kept on hand steel-plate and saw-mill saws of various sizes.

[1] Richard Hildreth's "History of the United States," Vol. III, p. 210.

One of the earliest machine-shops in Worcester was that of Earle & Williams, in 1812, opposite the court-house, where they carried on the business of machine-making, and advertised for sale machinery for spinning cotton and wool, carding-machines, and brass castings. Their shop was destroyed by fire January 5, 1815.

In April, 1813, the attention of shoe and boot-makers is called to a new and useful improvement, secured by patent, for putting shoes and boots together with copper nails, without any sewing. The patentee announces that he will attend at Captain Mower's tavern in Worcester (the site now occupied by Walker building) from the 12th to the 20th instant, for the purpose of selling patent rights, and claims that the invention "has been proved to answer every purpose for beauty, ease and convenience, and vastly more durable, at a saving of about half the work, and remedies all the evils attending iron nails and wooden pegs."

In April, 1815, the Worcester Tannery is offered for sale. It is described as situated in the center of the town, and one of the most extensive and convenient establishments in the State, in perfect repair, and with all the accommodations and necessary tools for carrying on the business.

"Through the middle of the yard runs a large brook, confined by a very handsome stone wall. A few rods from the tan-yard is a building in which bark is ground by water, and in which there is a patent bark-mill, strong and well-constructed."

This is the tannery formerly referred to as owned by Samuel Johnson, and was located east of the present site of Exchange Hotel.

Some reason for the sale of the tannery may be found in the heavy taxes upon leather. The other tanneries in

different parts of the county appear to have suffered, for no less than nine are offered for sale during 1816 and 1817.

The discontent of the workers and makers of leather, and others, finds expression in the following notice, which appeared May 31, 1815:

Shoemakers ahoy! Have you been at the Collector's and given bonds, with two sufficient sureties, to pay duty upon your work?

If you make a single boot or shoe above $5 value without giving bonds to secure the duty to Government, you do it at your peril, and are subject to a penalty of not less than $500!

What is your situation better than that of Virginia negroes? You must account for every pair of boots you make to the Collector. You must tell how much you ask for them, whom you make them for, and how many pair you make; and, to crown the whole, all this must be done under oath. No, that does not crown the whole; one thing more, whenever a customer breaks, or runs away, or cheats you, in addition to the loss of the article itself, and the labor, you must pay the duty upon it to the Government! This is the crowning, the cap-sheaf.

Silversmiths, carpenters, jobbers, hatters, tailors, tobacconists, boat-builders, tin-men, blacksmiths, and ye mechanics and manufacturers of all articles and commodities of whatever name and nature, be ye also ready. A fine of $500 awaits you unless you comply with the provisions of these arbitrary, iniquitous laws passed by Congress the 16th and 27th February, 1815.

In May, 1815, Earle & Williams give notice that in addition to machinery for carding wool, they will have in operation, about the 1st of July, machinery for the spinning of wool, which can be spun at a rate greatly below the price of hand-spun. They also give notice, June 21, that, in connection with Asa Mann, they have in operation, near Stone's tavern, south part of Leicester, machinery for carding wool.

Joshua Hale, at the same time, states that he has put his machines for carding wool and spinning cotton in most excellent order, and attends them himself; also that he has for sale cotton yarn made of cotton selected by himself in Savannah, which he warrants to be the best.

In September, 1815, Thomas & William Stowell advertise that they have improved the building lately occupied for a wire-factory, one and a half miles south of the meeting-house, where they have put their works in the best order for dressing cloth, and are in readiness to meet any demands in their business. It may be interesting to note, in passing, that at this time the postage to Boston, on single letters, was fifteen cents.

John W. Lincoln, in January, 1816, advertises all sizes of nail-plates from the Millbury Rolling-Mill Company. This company was established in the latter part of December, 1815, for the purpose of manufacturing nail-plates and rods.

William Hovey, June, 1816, advertises a double carding-machine in operation for custom work at his factory, one mile south of the meeting-house in Worcester, where merino wool is carded in the best manner.

October 2 he gives notice that he has taken George March into company with him, and that at Hovey's mill they will manufacture wool into cloth; price for spinning wool, three cents per skein.

At this time considerable interest was manifested throughout the country in manufactures, and frequent meetings were held for the purpose of devising means for their encouragement. A committee of the Legislature in New York urged that members of Congress be instructed to attempt to have the duties on woolen and cotton goods increased; urged the public officers to clothe themselves in American cloth, and that manufactures be exempt from taxation, and manufacturers from serving in the militia, and from other public duties.

It appears to have been quite popular at this time for American statesmen to appear in clothes of American manufacture. It is said that Henry Clay, when once in

Millbury, was presented with a roll of blue broadcloth, the product of the mill of Colonel Sheppard, and Mr. Clay remarked that his next suit of clothes would show Congress what American manufacturers could do.

Daniel Webster also had a suit of clothes made for his use in Washington from cloth made by the Goodell Manufacturing Company, at Millbury, woven, very likely, upon looms made by W. H. Howard, of Worcester.

The following notice appears in the *Spy* of October 22, 1817:

The Members of the Worcester Honorable Society, being prisoners for debt on parole, and deprived of the means of supporting themselves in prison, or their families at home, or of paying their debts, and unwilling their time and talents should be lost to themselves or to the public, hereby give information to their creditors and the good people of this vicinity that there are in the society those who can perform the business of farming, shoemaking, masons, clock and watch repairing, card making, mathematical and meteorological instrument making, painting and glazing, engraving, distilling, rope making, etc., and solicit a share of their patronage in the abovenamed kinds of business, which they can perform within the limits; and they engage they will promptly and faithfully attend to all business entrusted to them.

Worcester Gaol, Oct. 22, 1817.

This is interesting, as indicating the variety of small manufactures carried on in and about Worcester at this time, and as illustrating the unfortunate working of the law then in force, which deprived many worthy men of any opportunity of escaping from their misfortunes.

In October, 1819, the Worcester Agricultural Society gave its first exhibition. Among the Worcester exhibits

of domestic manufactures were two pieces of kerseymere and one calf-skin, tanned and curried in two days by Reuben Wheeler. Nine skeins of tow yarn, from thirty-three to thirty-eight skeins to the pound, spun on a great wheel by a lady in Worcester. The judges noted with regret that no hoes, scythes, plows, wool, cotton and machine-cards were exhibited in a county which had long been distinguished for the manufacture of these articles, and, in their opinion, no cotton cloth sufficiently good was offered to be entitled to a premium.

CHAPTER II

Streams and Mill Privileges—Population of Worcester—Blackstone Canal —The Railroads—The First Expresses—The Old Coal Mine—Peat—Stage Lines.

The introduction of steam-power, the opening of the Blackstone Canal and the railroads, have made it possible for a large manufacturing city to grow where otherwise no considerable progress could have been made; for had it been necessary to depend altogether upon water-power, few large factories could have been located upon the small streams which constitute the headwaters of the Blackstone.

These streams, nevertheless, have played a most important part, affording means for starting manufactories which have since so largely developed in size and variety; while the increased demand for power has been met by the introduction of steam-engines, through whose medium the waters which formerly were directly applied to the water-wheels, and whose capacity was consequently limited, are now equal to any demands which may be made upon them. For these reasons the water privileges and streams deserve prominent mention in any account of the manufacturing industries of Worcester.

The Ramshorn stream, so called, rises in Ramshorn Pond, which lies two-thirds in Millbury and one-third in Sutton; it flows in a northerly direction and is joined by Kettle Brook in the northeasterly part of Auburn.

Kettle Brook rises in Paxton, is fed by Lynde and Parsons Brooks, flows in a southerly direction and joins the Ramshorn stream, as above stated; the united streams,

known as French River, flow in a northeasterly direction. At New Worcester, Tatnuck and Beaver or Turkey Brooks unite with French River, and the course becomes a little south of east. At this point the stream is known as Middle River for about a mile; Mill Brook then joins it, and from this point the river is known as the Blackstone.

Ramshorn Pond is owned by the manufacturers on the Blackstone River, who are assessed for all expenses and repairs. The pond and stream have a water-shed of nine thousand two hundred and fifty-five acres. There are five privileges on this stream, previous to its entering the town of Auburn.

The first privilege was, in 1813, conveyed by Solomon Marble to Carter and David Elliot. The Elliots later deeded it to Amos Eddy and gave him a right to draw from the stream by a canal to the Savory Shop pond (the 2d privilege). From 1877 this mill property has remained in the Hoyle family, hosiery and woolen cloth being the product. Charles E. Hoyle, with a partner, ran the mill (on lease) on woolens about a year. After C. E. Hoyle and Edward Ramseyer retired, Edwin Hoyle and Thomas Windle again formed a partnership, which continued one year, for the manufacture of woolen cloth. Then Thomas Windle alone continued the business until January, 1904, when the mill was partly destroyed by fire. The mill was later rebuilt and Edwin Hoyle carried on the manufacture of yarn. The looms in the mill were run by The Arconia Worsted Co. In 1907, the loom department of the mill was leased for a few years to The Millbury Mills, an Uxbridge company, which manufactured worsteds. Edwin Hoyle died in 1910. Charles F. Day, a son-in-law of Mr. Hoyle, continued the manufacture of yarn for a time. Later he

rented the spinning machinery to George F. Geb. Mr. Day soon resumed the business and continued it until 1913 in the interest of the estate of Edwin Hoyle. In the latter year, Mr. Day began the business of Wool-Scouring on a small scale, and the business has increased to such an extent that it is now one of the largest plants of the kind in the country. Water, steam, and electric power have successively been used. In 1915, all the cards and spinning machinery were removed from the mill and in addition to wool-scouring, the business of wool-sorting was conducted on a large scale. Mr. Day has prepared filter-beds for purifying the water of the stream. It may be said in this connection that no acid is used in the preparation of the wool as in some plants where carbonizing is done. The title of the firm is now The Ramshorn Mills, Charles F. Day, Proprietor.

The second privilege on Ramshorn stream was known as Amos Eddy's Scythe and Trip-hammer Shop and then as the Savery privilege. Stephen A. Savery died in 1895, and the privilege was little used for some years, until 1906, when it was bought by Henry W. Glover, manufacturer of tool-handles. He put in a new water-wheel, and made many improvements. This place has since been purchased by him and has been used in connection with his business at the old Blanchard privilege for the manufacture of tool-handles.

The third privilege was occupied by the old shop of Thomas Blanchard where the eccentric lathe was invented by him and is of considerable historic interest. Late in the year 1888, Henry W. Glover bought this privilege of James A. Dike who had used it for many years. The old shop used by Thomas Blanchard was torn down in 1889,[1] and a new shop was built on the site.

[1] I had a photograph taken of the Blanchard Shop in 1888 which is now in the possession of the Society of Antiquity. C. G. W.

This building was destroyed by fire in 1900. A larger building was erected the same year which still exists. This shop is run by water, steam and electric power. Every description of tool-handles are made here and from various kinds of wood. A machine takes a block of wood squared and sawed the proper length and turns out an almost complete handle. A thimble put on, a little polishing, and the operations are completed. A year's stock, or more, is kept on hand in the store-houses connected with both mills. Since the purchase by Mr. Glover, he has bought land adjoining the pond in the rear of the mill and increased the extent of his storage water.

In 1888 the fourth privilege was in possession of Thomas Windle, who was a Wool Dealer and carried on the Wool-Scouring business under the name of Millbury Scouring Co. While Thomas Windle was engaged in wool-scouring a portion of the mill was occupied by his sons, W. W. and A. D. Windle, in the carbonizing of wool. In 1898, the mill was destroyed by fire for the third time. His sons later separated, each occupying a portion of the mill which had been rebuilt. W. W. Windle moved his business to Bramanville in 1904 where it is still carried on by him. The mill which had been rebuilt after the fire of 1898, was burned and a small mill was erected to which additions were later made. In 1912, A. D. Windle became connected with the Manufacturers Wool Stock Co., which was located at Sutton, Mass., their mill having been destroyed by fire a short time before, the business of The Manufacturers Wool Stock Co. was removed to the mill of A. D. Windle at this privilege in West Millbury, where it was carried on until June, 1915, when the company was dissolved. The officers of the Manufacturers Wool Stock Co. were: Arthur D. Windle,

President; Henry O. Sutcliffe, Treasurer. They were also dealers in wool as well as wool-scourers. The business at this location is now carried on by A. D. Windle under the name of The Millbury Scouring Company. The latest improved machinery is used in the business, and electricity is the motor power used. Several millions of pounds of wool annually are treated here. Thomas Windle, the pioneer in the Wool-Scouring business at this location, died at his home in West Millbury, December 24, 1906.

The fifth privilege is occupied by John S. Rich in the making of shoddy. This is the last privilege on the Ramshorn stream in Millbury, before it enters Auburn at Larned's Village, or Pondville. There was a saw mill here at the sixth privilege as early as 1794; later a mill was built for the manufacture of woolen goods, which has since been used for worsteds. Pond & Larned formerly owned this privilege. In 1887 this property was in possession of L. J. Knowles & Bro., and was operated by Kirk, Hutchins & Stoddard. Later it was owned by the heirs of F. B. Knowles. It was owned for several years by Wilkenson Crossley of Maynard, and later of Brookline. Since 1901 the mill has been run by The Pondville Woolen Co. The goods made here are shirtings and ladies' dress goods. Steam power is used. The company makes electricity for its lights. The employees are Poles, Lithuanians, French Canadians, and Irish. When running at full capacity, the Company employs one hundred hands. The office from which their goods are sold is in New York. The mill has up-to-date fire equipment and a pump connection which can pump seven hundred fifty gallons of water a minute. During all the years since 1888, various kinds of woolen goods and other material have been made at this mill.

The seventh privilege has long been known as Dunn's Mills; here saw, grist and shingle-mills have been located at different times; plow handles, probably for Ruggles, Nourse & Mason, were at one time made here. The old mills were burned some time prior to 1888 and the privilege was bought by James Hilton, an Englishman, who built a new mill for making shoddy. Since Mr. Hilton's death, in 1915, the mill, the property of his heirs, remained closed until recently, when the manufacture of shoddy has been resumed.[1]

A mile beyond, Kettle Brook and Ramshorn stream unite, not far from the French meadows, on the left of the Norwich and Worcester Railroad coming from Auburn to Worcester. Kettle Brook flows from a reservoir in Paxton, which was built and is owned by the mill-owners along the stream. I have heard the statement that this name was suggested by the deep basin near Parsons' privilege, which somewhat resembles a kettle. The first privilege was occupied by an old saw-mill, but little used and somewhat dilapidated, owned by the town of Leicester and originally known as Arnold's Mill. The pond is now used as a reservoir.

The second privilege was formerly known as Mulberry Grove, and later, in 1889, Mannville, where satinets were manufactured by the Mann Brothers. All manufacturing at this place has ceased and the privilege is now a part of the water system of Worcester.

George Mann, one of the oldest and most widely known manufacturers in this section of Massachusetts, died in October, 1915, at his home near Mannville at the age of eighty-one. He had lived in Leicester practically all of his life. He was a member many years ago of the

[1] This property of thirty-one acres and the water privilege was acquired in January, 1917, by the American Steel & Wire Company to ensure an additional water supply.

firm of George Mann & Bro., proprietors of a mill in which narrow cotton warp fabrics were made. When Worcester took over Kettle Brook Water System, about fifteen years ago, the business was moved to East Brookfield, and conducted under the name of Mann & Stevens of which Mr. Mann was President.

The third privilege is what was known as Kent's, built by the father of P. G. Kent, formerly of Jamesville, who first built a saw-mill, then changed it to a shoddy-mill, then into a satinet-mill, which was run by P. G. Kent & Brother for some years. The privilege has since become part of the water system of the City of Worcester.

At the fourth privilege is located Bottomly's brick mill, built by him, and known as his third mill. It was at one time owned and operated by the late E. D. Thayer, and used for the manufacture of satinets.

The fifth privilege was known as the Chapel Mill, built by L. G. Dickinson, and used for the manufacture of satinets. It was destroyed by fire in 1886 and later rebuilt. In 1897, Albert E. Smith and Channing Smith organized the Chapel Mill Corporation with a capital of $23,000. H. J. Brouard was President, Albert E. Smith was Secretary, and Channing Smith, Treasurer. In 1898 the capacity of the mill was doubled. In 1903, they purchased the old Bottomly Brick Mill—still called by many the Brick City—property. The mill then standing was modernized and the capacity doubled at an expense of $80,000. This and the mill below are to-day known as The Chapel Mills Corporation. In 1905, the capital of the corporation was increased to $200,000. In 1910 it was again increased to $300,000. Dress goods and shirting flannels are made here. At these mills are twelve sets of cards and one hundred

ninety-six narrow looms. The number of employees is about four hundred persons of many nationalities. Channing Smith is President and Treasurer.

The sixth privilege known as the Eli Collier Mill was also built by L. G. Dickinson, and was run on satinets, and for many years was run by Mr. Collier, L. B. Butler and John Shepard. It is now owned and operated by Channing Smith. Dress goods and shirting flannels are made here. About eighteen hands are employed.

The seventh privilege was the Watson Mill, used for the manufacture of broadcloth. It was burned many years ago, and has never been rebuilt.

The eighth privilege is the old mill built by Thomas Bottomly, an Englishman. This was one of the first mills built in this region, and is said to have been built before any of the mills on the stream. Mr. Bottomly was one of the pioneers in the broadcloth business, which he conducted at this mill for many years. It has been remodeled, and was run by Mr. Hodges who was succeeded by George W. Olney. The mill was subsequently run under the name of George W. Olney, Woolen Mill; established, 1874; incorporated, 1899. About one hundred hands were employed in the manufacture of white flannels. November 22, 1916, the entire property was sold at auction. The purchasers were B. F. Northridge Co. and C. A. Brosnan.

The ninth privilege, known as The Valley Wollen Mill, is one on which a mill was built by Thomas Bottomly for the manufacture of broadcloth, and was known as his second mill.

[1] Lynde Brook empties into Bottomly's Pond, and a

[1] March 30, 1876, Lynde Brook dam was carried away by a freshet. The writer witnessed the catastrophe. Bridges, dams, roads and dwellings were swept away, about 5000 feet of the Boston and Albany R. R. was washed away. The aggregate damages paid by the City including the cost of the new dam were $227,000.

short distance up this stream is the Worcester Reservoir. This mill has passed through several hands, and in 1889 was owned and occupied by Albert E. Smith, who made woolen goods. In 1892, Mr. Smith associated with him as partner his son Channing Smith. The mill is now owned and operated by Channing Smith in the manufacture of Dress Goods and Flannels. The employees, like those in all the mills here, are American, English, Irish, and French, and some other nationalities. The number of employees is one hundred twenty-five. When the partnership was formed in 1892, between Albert E. Smith and his son Channing, they had four sets of cards and forty-eight looms. Now the mill is running ninety-six looms. Many improvements have been made here during the past few years. A. E. & Channing Smith bought the old Eli Collier Mill in 1908. The latter mill, with the Valley Woolen Mill, are the property of and run by Channing Smith, independent of the Chapel Mills Corporation. Albert E. Smith, more familiarly known as "Doc" Smith, died in 1910.

The tenth privilege was occupied by Robert Young for a saw-mill, which was afterwards changed into a satinet-mill. It was washed away in the Lynde Brook disaster. The privilege was then merged in the Ashworth & Jones privilege.

The eleventh privilege was formerly occupied by a grist-mill, built by a Mr. Adams, who sold it to Wadsworth & Fowler. The grist-mill was torn down and replaced by a satinet-mill, which, after some time, was sold to Ashworth & Jones, who erected there a handsome mill, one hundred and seventy by fifty feet, four stories high, which was run on beaver cloth. In 1886 it was purchased by the late E. D. Thayer, Jr., who carried on a large business in the manufacture of woolen

goods until his death in 1907. The business was continued by his estate until 1910 when the property was sold to the George E. Duffy Manufacturing Co. of which George E. Duffy is President and Treasurer. One hundred seventy-five hands are employed in the manufacture of Overcoatings and Cloakings. Since the Duffy Company came into possession, the Mill has been somewhat enlarged. It now has nine sets of cards and one hundred two broad looms in operation. The goods are sold in New York. This mill property is one of the finest on the stream.

The twelfth privilege was originally occupied by a shingle-mill, then by a paper-mill, which was changed into a satinet-mill; it then passed into the possession of Ashworth & Jones, who connected it with the privilege next above.

The thirteenth privilege was known as the Solomon Parsons property. It then passed into the hands of Mr. Darling. Satinets were manufactured here for a long time. The Jamesville Woolen Co. is now operating here.

The fourteenth mill is known as Hunt's. This was also built by Solomon Parsons, and sold to Bellows & Darling. Cotton batting was first made here, and then satinets. L. D. Butler and Eli Collier came here in 1882, and leased the property for three years of the Hunt heirs. In the summer of 1885, they bought the mill privilege. In 1888, Mr. Collier sold out his interest to Mr. Butler and Mr. Pfaffman. In 1899, Mr. Butler sold all his interest to Mr. Pfaffman, who continues the business. Forty hands are here employed, about equally divided between men and women. The nationalities of the employees are like the other mills on the stream—American, English, Irish, Canadian, French.

The fifteenth privilege is that of the Standard Plunger Elevator Co. which employs about fifty hands, composed of Americans, English, Swedes, etc. The officers of the company are: A. B. Bridges, President; L. G. Hagenbuch, Treasurer; E. L. Dunn, Secretary. They are incorporated under the law of Massachusetts. The capital of the company is $750,000.

The sixteenth is the Jamesville privilege, which Benjamin James bought of the heirs of the Burnett estate. It was originally a saw-mill in the woods. Mr. James bought soon after 1850 and built the factory, which he ran on hosiery until about 1860; he then changed to army cloth, and after that to fancy cassimeres. It was run up to the time of Lynde Brook disaster, 1876, when the dam was destroyed, the water plowing twenty feet beneath the dam. The mill was rebuilt and run on cassimeres until about 1880. It passed through several hands, and finally came into the possession of P. G. Kent & Co., who enlarged the mill and made satinets. There is quite a village at this point, a chapel and depot. The Pan-American Match Co. now occupies the mill and privilege.

The seventeenth privilege was in 1889 occupied by the Stoneville Mill. The waters of Kettle Brook come into the Stoneville Pond at the end nearest New Worcester; at the other end a stream comes in which has been known as Young's Brook, and by other names. About a mile up this stream was an old paper-mill, erected about 1834 by Nathaniel S. Clark and Daniel Heywood. Kettle Brook, with this stream, carried the Stoneville Mill, operated by the Stoneville Worsted Company in the manufacture of yarn for the carpet-mill of William J. Hogg, as it was then. In 1834 Jeremy Stone owned

this mill; it then went into the possession of Edward Denny, next of A. L. Ackley, and later was changed from woolen to cotton goods.

John Smith bought the mill about 1858, and it was subsequently run by his sons—C. W. & J. E. Smith—for many years. The Ettrick Mills have occupied this privilege since 1894 in the manufacture of Brussels Carpets and Rugs.

About a mile from this point Mill Brook joins the Ramshorn stream, and thence proceeds through the French Meadows, and is known as the French River.

At the next privilege Mr. Trowbridge, grandfather of the late William T. Merrifield, built, in 1810, a mill for the manufacture of cotton yarns. There had previously been a saw-mill, and possibly a grist-mill at this point. At this time Joshua Hale was carding wool at the privilege once occupied by the late Albert Curtis. The farmers were in the habit of taking their wool to Mr. Hale to have it carded and spun, and bought their yarn at Trowbridgeville, doing the weaving at their own homes.

Tatnuck Brook has a water-shed of eight thousand nine hundred and forty-three acres. Upon an old map, published in 1784, a trip hammer-mill, a corn-mill, and a saw-mill are found upon Tatnuck Brook, within the limits of the town of Worcester. The first mill recollected by those now living is a saw-mill in Holden, owned by a man named Hall; this was prior to 1850. The second privilege was near the outlet of the present reservoir, where there was another saw-mill.

The third privilege was at Tatnuck, where satinets were manufactured. The ruins of this mill stood here for some years. Nothing remains now but an ice house.

On the fourth privilege was the old mill built in 1834 for David T. Brigham, in Tatnuck, near the bridge on

the road to New Worcester. It was built by the late William T. Merrifield in 1834. Prior to 1885, the late E. D. Thayer made satinets here. Frank C. Smith, the present owner and operator of the mill, acquired possession in 1885. He manufacturers woolen goods. The mill has been enlarged and a new dye house built. There are forty-five employees and thirty-six looms are operated.

At the fifth privilege, Patch's saw and grist-mills were located, long since, but within the memory of many now living, abandoned.

The sixth privilege was a small mill, and the seventh, the upper privilege now occupied by Loring Coes & Co., Inc. This and the lower privilege on Leicester Street are more particularly described in that part of this book which treats of the wrench business.

Tatnuck Brook was known at one time as Half-Way River, as the bridge at New Worcester was half-way from Boston to Springfield. On its tributary, Turkey or Beaver Brook, a saw-mill was located in 1784, the remains of which can now be seen.

At the junction of Tatnuck Brook and Ramshorn Brook was the old original dam which was removed by the late Albert Curtis about 1845. The privilege once occupied by factories of Albert Curtis and Curtis & Marble is described elsewhere.

Next to this privilege is the one occupied in 1889 by the Hopeville Manufacturing Company, manufacturers of satinets. This was occupied by Thomas Sutton in 1831, where he put in the first iron water-wheel in the country. Sutton's original mill was burned in 1862. About 1848 there was a cotton-mill here run by S. H. Thayer. This was formerly known as Hornville, so called because, when the first mill was built, there was no bell, and the help were called to work with a horn. The first mill

located here was a grist-mill. Bigelow & Barber bought the privilege in 1853.

Next come the carpet-mills, once the location of White & Boyden's machine-shop, where the late Albert Curtis learned his trade. Hatch and Gunn here commenced the manufacture of broadcloth in 1827; they were the first in Worcester to make woolen goods throughout. Then comes the Wicks Manufacturing Company, who recently commenced the manufacture of worsted suitings.

The next privilege is the one formerly occupied by the Worcester Wire Company, now the Central works of the American Steel & Wire Co., which has been used as a manufacturing site for many years and for many different purposes.

Upon the map previously referred to published in 1784, North Pond is said to cover thirty acres of ground. John Pierce's map, 1795, gives the area of North Pond forty acres, and indicates that in that year there were in Worcester five grist-mills, six saw-mills, one paper-mill. Near where Mill Brook leaves North Pond there were situated, in 1784, two fulling-mills; just southeast of the court-house was a trip-hammer shop. Between the two and just north of Lincoln Square the old mill of Captain Wing was located in 1685. Then a grist-mill, probably on the site of the Crompton Loom-Works, and a saw-mill was located at Quinsigamond, with the statement that "there is soon to be a paper-mill."

Mill Brook has a water-shed of seventy-seven hundred and fifty acres. The first privilege below North Pond Dam was occupied by a cotton-mill built by George T. Rice and Horace Chenery, about 1830.

Below this privilege, on Neponset Street, is now located, since 1912, the plant of the M. K. Smith Company, manufacturers of builders finish of all kinds, employing

sixty operatives, more or less. A part of the building is occupied by the Worcester Felt Shoe Company.

The second was a factory built by Frederick W. Paine for Washburn & Goddard, and occupied by them until 1834; then by Goddard & Parkhurst until 1838, when it was leased for a short time by Ichabod Washburn, and was later occupied by William Crompton until it was burned in February, 1844. A. H. Sears now (1916) living at the age of 93, worked in this mill in 1836 making blunt-pointed screws for Goddard & Parkhurst. The present buildings were erected after the fire of 1844.

The Bay State Tool Handle Co., A. R. Dyke proprietor, has occupied this site since 1908. The buildings and privilege have been owned since 1912 by the American Steel and Wire Co.

The third privilege was the old tannery privilege originally built by Dr. William Paine, father of F. W. Paine, for a grist-mill, which was run by the family for many years.

About 1836, N. Eaton & Co. had a paper-mill here. The Olivers, stove dealers, next used the privilege to grind black lead. In the fall of 1854, Samuel Warren purchased the property of Mrs. Oliver, and ran it as a tannery until 1885. Mr. Warren's ancestors on both sides for three generations were tanners. His main business was to supply the cardmakers with their leather. This water privilege was purchased about 1888 by the late Stephen Salisbury, Senior.

The fourth privilege is Grove Mill, where the late Stephen Salisbury, Sr. built a wire-mill for Ichabod Washburn in 1834, now the location of the North Works of the American Steel & Wire Co.

The fifth, Court Mills privilege. Abraham Lincoln had a triphammer shop here in 1795; Earle & Williams a

machine shop in 1812, and a bark-mill was probably run in connection with the old tannery located just back of Exchange Hotel in 1815.

Before Court Mills was burned there was an old one-story building located here, used in 1828 by William Hovey for the manufacture of shears and straw-cutters. The basement of the new Court Mills was built of the stones which came from the old jail, which stood on the square facing the present depot. Howard & Dinsmore took the first lease of the Court Mills, and were succeeded by Samuel Davis.

The sixth privilege was built by F. W. Paine, at the corner of School and Union Streets. Here was located a small wooden building, thirty by eighteen, two stories high; the basement was occupied by W. H. Howard, lead pipe manufacturer; the second story by Calvin Darby, who ran a carding-machine. Mr. Howard was bought out by Ichabod Washburn in 1822, and January 1, 1823, Mr. Washburn and Benjamin Goddard formed a partnership, and at the same time bought out Calvin Darby. They manufactured woolen machinery here until their removal to Northville, in 1831. March, Hobart & Co. succeeded them. The premises have been occupied by various parties from 1822 in the manufacture of woolen machinery.

The seventh privilege was called Flagg Mills, afterwards known as the Red Mills, and owned by William B. Fox. The Red Mills were occupied by sash and blind and cutlery manufacturers, while from the same privilege was obtained power which ran the woolen-mill of Fox and Rice, on the other side of the street. This privilege was sold, and the site became part of the sewage system in the mayoralty of James B. Blake.

The eighth privilege was occupied by the upper and lower paper-mills at Quinsigamond, later by the South Works of Washburn & Moen Manufacturing Company since acquired by the American Steel & Wire Company.

The ninth and last privilege in Worcester was occupied by the Perry Grist-Mills, which were built in 1831.

Mill Brook has played an important part in the development of the manufacturing interests of Worcester, and three distinct privileges on this stream have been occupied by wire factories, while the first experiments of Ichabod Washburn were conducted at the location of the Lombard Factory, on School Street. The first wire-mill was located at Northville, and later was moved down the stream to the Grove Mill privilege, and later still the Quinsigamond privilege was used for this business. Mill Brook has for many years been condemned to the main sewer shortly after it leaves the works of the American Steel & Wire Company, in Grove Street, from which it emerges into the Blackstone, just below the works at Quinsigamond.

It was not until 1820 that Worcester took first rank among the towns of the county. The census of 1765-76 gave Worcester the fifth place in population, following Sutton, Lancaster, Mendon and Brookfield. In 1790, 1800 and 1810 Worcester stood third in order, Brookfield and Sutton preceding.

In 1820 Worcester took first place, and from that time to the present has shown a constantly increasing percentage of the increase in the population in the county. That percentage amounted to something over eleven per cent for the decade ending 1830, and over fifty per cent for the decade ending 1880; while of the increase (17,142) in the population of the county between 1880 and 1885, 10,098, or nearly fifty-nine per cent, belongs to the city

of Worcester; and of the population of the county, which was 244,039 in 1885, Worcester had 68,389, or a little over twenty-eight per cent. In 1910 the population of the county was 399,657 and of the city 145,986 a little less than thirty-seven per cent. In 1820 the population of the city of Worcester was 2,962, and of the county 73,625.

This brings us to the time of the building of the Blackstone Canal between Worcester and Providence, which marks an important epoch in the progress of Worcester, and too much credit cannot be given its projectors for appreciating the necessity to Worcester of communication with the seaboard. It is true that the canal was never of great practical value, by reason of the better facilities for business afforded by the railroads. It is equally true that without the railroads the canal would have ensured the growth and prosperity of the town.

The plan of making a navigable water-way from Providence to Worcester was first suggested, in 1796, by John Brown, of Providence, and his associates, but the Legislature of Massachusetts, failing to assent to an act of incorporation, it was not then carried into execution.

In May, 1822, "Gentlemen who are friendly to the project of a canal from Worcester to Providence are requested to meet at Colonel Sikes' Coffee-house on Friday evening, at seven o'clock." Another meeting was held on May 24, and a committee appointed, upon which the following gentlemen served: Levi Lincoln, John Davis, John W. Lincoln, William E. Green, John Milton Earle, Edward D. Bangs.

In September, 1822, the surveys of the canal were completed. According to the report of the committee, the length of the canal would be forty-five miles and

the descent from Thomas Street to tide-water in Providence 451½ feet.

The ground was bored every twelve rods for the whole distance, and upon the route selected no rock was found within the depth of excavation. The engineer reported, "I have come to the conclusion that a canal 32 feet wide at the top, 18 feet at the bottom and 3½ feet depth of water, would be the proper size to be formed, and that locks of 70 feet between the gates and 10 feet in width would be sufficiently large for the trade intended."

The estimated expense of the work, including locks, was $323,319.

The excavation in Rhode Island was commenced in 1824, and a meeting of the Blackstone Canal Company was called at the Thomas Coffee-House, Worcester, April 9, 1825, for the purpose of forming a corporation.

Great expectations were formed of the amount of business that would be done, and it was claimed that the canal would more than double the value of real estate within six miles of it. The subscription books for $400,000 of the capital stock, were opened in Providence, April 27; three times the required amount was subscribed for, and the stock sold at a premium.

In May, 1826, the canal was located in the village of Worcester.

Fears were entertained in Boston at this time that the canal would divert trade from Boston to Providence; to counteract this, a plan for a railway between Worcester and Boston was proposed. It is related that a wag, happening to be in town when the account of the sale of canal stock was received, was asked what the Boston folks would do when they heard of that. "Oh," replied he, "they will rail a-way!"

The first canal-boat to arrive in Worcester was the "Lady Carrington," which arrived from Providence October 7, 1828, and moored in the basin in Central Street at head of canal, at eleven o'clock, and was advertised "To take passengers for Millbury to-morrow morning, returning in the evening, and she will remain here during the present week for the accommodation of parties."

The arrival of the "Lady Carrington," according to an account in the *National Ægis*, October 8, 1828, "was greeted on passing the locks by the cheers of the multitudes assembled. On reaching the Front and Central Streets bridges continued cheers hailed its approach. At eleven o'clock the boat arrived in the basin, and the commissioners and the crowd assembled were addressed by Colonel Merrick, chairman of the Board of Selectmen, who expressed the sentiments appropriate to the occasion. On the conclusion of his remarks, enthusiastic cheers, the thunders of cannon and the peal of bells welcomed the visitant to the town. The commissioners and other gentlemen of both States were passengers on the boat, and with the gentlemen of the town partook of a collation at the house of the Governor."

The following notice appears in the *Spy* at this time:

Port of Worcester, October 8, 1828, Arrived yesterday, Canal-boat "Lady Carrington," Captain Dobson, from Providence, with slate and grain for Nathan Heard.

At the end of October "Lady Carrington" arrived in Providence loaded with domestic goods—butter, cheese, coal and paper.

The following extracts, taken from the papers of the day, will give some notion of the amount and character of the goods shipped:

Canal-boat "Providence," Captain Dobson, with 10,000 lbs. lead pipe from T. & J. Sutton, machinery from William Hovey, and iron castings from Sumner Smith.

Departed, boat "Massachusetts" for Providence, with 26 casks of beer and 11 hogsheads from Trumbull & Ward.

Arrived, canal-boat "Worcester," Captain Green, from Providence with 3457 lbs. of iron for Washburn & Goddard, 4169 lbs. of lead to J. & T. Sutton, 13 bales of cotton, 3 tons of logwood and one ton of copperas for William Buffum, Jr.

There were three serious drawbacks to the prosperity and profits of the canal, which soon made it unpopular with most of its stockholders and patrons. Unfortunately, a portion of the canal was located in the Blackstone River, and boats were more or less delayed in high, and also in low water, and in some seasons for weeks were detained with goods which were wanted for immediate use or sale. In some years the canal was, for four or five months, closed with ice. In a season of drought the manufacturers were jealous of the boatmen drawing so much water, and on several occasions in Rhode Island the owners of the mills and of the water-power ordered large loads of stone tipped into the canal-locks to prevent the boats from passing, which almost excited a riot among the boatmen, and some of the mill-owners were afraid their mills would be fired, as they had been threatened.[1]

April 22, 1846, the *Spy* states that the canal company had sold all that portion of the canal in Massachusetts, with all the privileges and franchises, except the reservoirs, for the sum of twenty-two thousand five hundred dollars to the Providence and Worcester Railroad Company, and April 25, 1849, the locks, boats and water-rights were advertised for sale. The last toll was collected November 9, 1848, but meantime more efficient means of communication between the seaboard and Worcester was afforded by the railroads.

[1] "History of the Blackstone Canal," by Colonel I. Plummer.

In March, 1831, subscription books were to be found at the banks, where those who wished could subscribe to the stock for a railroad from Boston to Worcester.

The Boston and Worcester Railroad Company was chartered June 23, 1831, to build a line from Boston to Worcester,—a distance of forty-four miles. A train was run through to Worcester July 4; but it was not until July 6, 1835, that the road was formally opened, although the cars had, for some time previous, been running from Boston to Westboro, and, as early as April 16, 1834, to Newton. The train of July 6 to Worcester consisted of twelve cars drawn by two locomotives, and contained the president, directors, stockholders and invited guests to the number of about three hundred.

The train, which left Boston at a quarter before ten, arrived in Worcester at about one o'clock. It was met by a committee, of which Charles Allen was chairman; a procession was formed under the direction of General Nathan Heard, and proceeded to the Town Hall, where a collation was served and speeches made. At four o'clock the train started on the return trip to Boston.

At the Insane Asylum, when the first locomotive passed, one of the inmates remarked: "Well, that beats the very devil; I never before saw a critter go so fast with such short legs!"

In April, 1836, the business of the Boston and Worcester Railroad Company was said to have been more than double the amount of that of the corresponding time of the year preceding; passenger cars were well patronized, and there was more freight than the company was prepared to care for. During the first five months of 1837 the receipts were twenty-six thousand dollars

more than during the same period in 1836, and continued to show a steady increase.

The Western Railroad Company was chartered February 15, 1833, to construct a line from the terminus of the Boston and Worcester Railroad to Springfield, and thence to the western boundary of the State. A mass-meeting was held in Faneuil Hall, Boston, October 7, 1835, to take measures to ensure the subscription to the capital stock of $2,000,000. This was accomplished and the following winter the Legislature authorized a subscription of $1,000,000 in behalf of the State, making the capital stock $3,000,000. At this meeting Edward Everett made a speech, in which he insisted upon the importance to Massachusetts of "Communication with the West."

Trains commenced their regular trips between Springfield and Worcester October 1, 1839. The time occupied in making the journey was about three hours. A public dinner was given in Springfield in honor of the opening of the road, October 3, 1839, on which occasion Edward Everett said:

> Let us contemplate the entire railroad, with its cars and engines, as one vast machine. What a portent of art! Its fixed portion one hundred miles long; its movable portion flying across the State like a weaver's shuttle. By the seaside in the morning, here at noon; and back in the compass of an autumnal day. And the power which puts all in motion, most wondrous, a few buckets of water! . . . Did we live in a poetic age, we have now reached the region where the genius of steam communication would be personified and embodied. Here we should be taught to behold him a titanic colossus of iron and of brass, instinct with elemental life and power, with a glowing furnace for his lungs and streams of fire and smoke for the breath of his nostrils! With one hand he collects the furs of the artic circle, with the other he smites the forests of Western Pennsylvania. He plants his right foot before the source of the Missouri and his left on the shores of the Gulf of Mexico and gathers in his bosom the overflowing abundance of the fairest and richest valley on which the circling sun looks down.

September 14, 1867, the two Massachusetts corporations were consolidated under the name of the Boston and Albany Railroad Company, and on December 28, 1870, a further consolidation was effected with the New York roads, thus forming the present organization. The Boston and Albany Railroad Company was leased to the New York Central and Hudson River R. R. Co. for a period of ninety-nine years from November 15, 1899.

The Norwich and Worcester Railroad Company was chartered in March, 1833. The first meeting of the company was held at Webster, July 1, 1835. The length of the route surveyed was a little short of sixty miles, and passed through thriving villages, while upon the banks of the adjacent streams there was said to be water-power sufficient to carry one million spindles; the number of cotton-mills was seventy-five and of woolen-mills twenty-seven, exclusive of Worcester and New London. There were said to be one hundred and forty manufacturing establishments between Norwich and Worcester, within five miles of the road. Though fifteen miles longer than the Boston and Worcester Railroad, it was estimated it would cost five hundred thousand dollars less. Regular trips between Worcester and New London commenced March 9, 1840, and the fare to New York by this route was fixed at five dollars.

The Norwich and Worcester R. R. Co. was leased to the New England R. R. Co. for a period of ninety-nine years from February 9, 1869. This lease was later assumed by the New York, New Haven and Hartford R. R. Co.

R. W. Whiting, Nov. 21, 1838, advertises that, having made arrangements with the Boston and Worcester Railroad Co. to occupy a part of a car, to be run with the passenger train to Boston in the morning and back

in the afternoon, commencing on Monday, 26th of November, he will take charge of all packages, bundles, etc., which may be entrusted to his care, and will see them safely delivered the same day, and that he will also transact with promptness any other business commited to his care. He had an order-box at the Temperance Exchange, Railroad Depot and the American Temperance House, where he could be found after seven in the evening and before seven in the morning.

William F. Harnden has always been credited with being the father of the American Express system. His advertisement is found in the *Spy* of June 24, 1840, where he announces that the Worcester, New York, Philadelphia, Baltimore and Boston Baggage Express will commence July 1, 1840, running daily, and that he will forward in his express car daily, packages, bundles, etc., to and from each of the above named places,—to Boston by steamboat-train every morning, and to New York every afternoon at half-past four.

All packages must be marked Harnden's Express, and sent to his office, N. Tead's Hat Store, one door north of the Post-Office, Worcester. Simeon Thompson, agent, Worcester.

WM. F. HARNDEN, *Prop.*,
8 Court Street, Boston.

S. S. Leonard, in the *Spy* of August 12, 1840, advertises an express between Boston and Worcester.

September 2, 1840, Burke & Co. advertise the New York and Boston Baggage Express, *via* Norwich and Worcester, run by the subscribers, P. B. Burke & Alvin Adams. Packages to be left at J. B. Tyler's, Worcester.

The question of a railroad between Providence and Worcester, a distance of forty-three miles, was seriously discussed as early as 1837, but nothing was done for several years. In August, 1845, the enterprise came nearly to a stand-still, although eight hundred thousand

dollars had been subscribed under the Rhode Island charter and one hundred thousand dollars under the Massachusetts charter; but the Rhode Island charter required that the whole capital of one million dollars should be taken up before the company could proceed. The amount was finally raised, and a consolidation was effected November 4, 1845, of the Massachusetts and Rhode Island Companies, each of which was chartered in 1844. The main line was opened in October, 1847, when a train, made up of nine covered cars and twelve or thirteen open cars, drawn by three powerful engines, arrived in Worcester with twelve hundred passengers from Providence and towns on the line.

This road was leased for a period of ninety-nine years from July 1, 1892, to the New York, New Haven and Hartford R. R. Co.

The Worcester and Nashua Railroad Company, organized in November, 1846, was a consolidation of a company of the same name, chartered in Massachusetts, March 5, 1845, and the Groton and Nashua Railroad Company, chartered in New Hampshire, December 4, 1844. The road was opened from Worcester to Nashua, a distance of forty-six miles, December 18, 1848. The Nashua and Rochester Railroad Company was chartered July 5, 1867, and opened from Rochester to Nashua, a distance of forty-eight miles, November 24, 1874. William A. Wheeler was one of the principal promoters of the Nashua Railroad, and was the superintendent of construction.

December 1, 1883, the Worcester and Nashua and Rochester railroads were consolidated under the name of the Worcester, Nashua & Rochester Railroad Company, which company was leased to the Boston & Maine Rail-

road Company October 30, 1885, for fifty years from January 1, 1886, and subsequently purchased by it.

The Boston, Barre & Gardner Railroad Company, running from Worcester to Winchendon, a distance of thirty-six miles, was chartered April 24, 1847, as the Barre & Worcester Railroad Company, and April 24, 1857, as the Boston, Barre & Gardner Railroad Company. It was opened to Gardner, September 4, 1871, and to Winchendon, January 4, 1874. It was taken possession of by the Fitchburg Railroad Company March 7, 1885, and merged in the latter company as a branch, July 1, 1885, and later with the parent system passed into the control of the Boston & Maine R. R. Co.

It will thus be seen that from an early day Worcester had the advantages of the best railroad facilities, and to this, and to the introduction of steam-power, is to be most largely attributed her rapid growth as a manufacturing city. In 1889 there was not only direct communication with all points north and south, but there were five outlets and thirteen different lines, more or less, affording direct communication with the West. Edward Everett's wish, so strongly expressed in his speech in Faneuil Hall prior to the opening of the Western Railroad, was most abundantly fulfilled.

In 1823 attention was called to the advantages possessed by Worcester which should make it a large manufacturing center. Encouragement was found in the fact that towns in the interior of England, with no greater local advantages, have contained from 10,000 to 15,000 inhabitants, and since the introduction of steam-power, a population of from 80,000 to 100,000 has been reached. It was stated that Worcester would soon be at the head of canal navigation, and in addition, her "inexhaustible store of an-

thracite coal, well calculated for steam-engines," was referred to as being of the greatest value. Considerable attention was given in 1823 to the examination of the anthracite coal deposits, which were located northeast of the city, west of Plantation Street, and near its junction with Lincoln Street, now known as the Old Coal Mine.

The coal was said to be of the same variety as the Rhode Island, Schuylkill and Lehigh coal, and was found, according to statements then made, to ignite easier than any of them and to burn longer. Careful comparisons were made of the relative value of these different varieties and the result, with a given quantity of each, showed as follows:

Worcester coal lasted five hours; Lehigh, four hours twenty-five minutes; Rhode Island, three hours thirty-six minutes. The thermometer was raised by the Worcester coal to one hundred and seventy-nine degrees; by the Lehigh, to one hundred and sixty; by the Rhode Island, to one hundred and thirty-four.

The Worcester coal burned brighter than the others, and with more flame. It was confidently asserted that when the Blackstone Canal should be completed Worcester coal would be the cheapest fuel for Providence; it was estimated, however, that the Worcester coal was more impure than the Lehigh, containing a considerable portion of earthy matter that remained in the form of ashes after burning; but, in spite of this, it was thought that it would answer a valuable purpose. Tests were made at the Worcester Brewery, which appear to have been satisfactory, for in February, 1824, application was made to the General Court for the incorporation of the Massachusetts Coal Company, to ascertain the quality and quantity of the coal, and expense of mining and conveying it to market.

For the next two years it appears to have been used as the principal fuel in the brewery of Trumbull & Ward, and was also used in Col. Gardner Burbank's paper-mill. It was found there, that about half of the bulk of the coal remained after the fire subsided, but upon replenishing with new coal it was mostly consumed in the second burning, and Colonel Burbank found the expense of keeping a fire with this coal to be less than the expense of cutting wood and tending fire, if the wood were delivered at the door free of expense.

In December, 1827, the proprietors of the brewery burned coal taken from the land of William E. Green, which was a little distance from the mine, but appeared to be of a somewhat better quality.

Work at the coal mine must have been prosecuted with some vigor, for in February, 1828, fifteen or twenty young men and a blacksmith were wanted to work there. In November, 1828, an opening twelve feet wide and eight feet high had been carried into the hill about sixty feet, at a descent of about twenty-five degrees, and a railway was laid, on which the coal was carried from the mine to the place of deposit, in loads of fifteen hundred pounds.

In February, 1829, the Worcester Coal Company was incorporated, and in March, 1829, the Worcester Railway Company, with a capital of fifty thousand dollars, with authority to build a railway from the mine to Lake Quinsigamond and to the Blackstone Canal, but the enterprise appears to have been abandoned shortly afterwards. The coal was found to be too impure for economical use. It was somewhat humorously said that there was a d—— sight more coal after burning than there was before.

Peat also was found in the meadows about Worcester. In 1856 it was burned in the Wire Factory as a substitute for wood and coal; in three years nearly two thousand

cords were used in this way, and it was found that a cord of well-seasoned peat would produce as much heat as a cord of dry oak wood; and a cord and a half of peat would generate as much steam as a ton of anthracite coal.

It was estimated that peat could be used to good advantage for manufacturing purposes at a saving of from thirty-three and one-third to fifty per cent over any other kind of fuel. It had the remarkable quality of keeping fire a long time, even burning for a week after the fire had gone down. In April, 1856, the Worcester Peat Company was formed, but no business of consequence appears to have been done by it. It was no doubt found that coal was the cheaper fuel.

In June, 1827, Worcester is spoken of as containing "the large paper-mills belonging to Elijah Burbank, five machine shops, at which great quantities of machinery of various kinds are made, one small Cotton factory, a Lead aqueduct factory and other works of minor note."

Prior to 1813 there was no stage or mail route between Worcester and Providence; in that year, or 1814, it was attempted to run a stage, but the business was only sufficient to support a cheap carriage and two or three horses, and the proprietors abandoned it. Until 1819 the mail was carried once a week in a one-horse wagon; an attempt was then made to run a two-horse stage twice each week, but this did not pay, and was abandoned. In 1823 a line of stages was started and well patronized. For a long time the only stages from Worcester were six times each week to Boston, and six times each week to New York. In 1827 there were eighteen different lines of stages running from Worcester, and the passengers averaged one hundred daily.

CHAPTER III

Textile Fabrics and Machinery for Making Them—Early Manufacture of Cloth—Condition of Woolen Manufacture—John Goulding—Manufacture of Cotton and Woolen Machinery—Card Clothing—Looms—Carpets —Thread.

We have already noticed that Samuel Brazer in 1790 advertised to sell "corduroys, jeans, fustians, federal rib and cotton," and that at the same time he and Daniel Waldo were proprietors of the Worcester Cotton Manufactory. There was then scarcely any machinery for the manufacture of cloth in America; it had been introduced into England, but there were severe laws against its exportation to the colonies.

The process of making cloth, as early conducted, was entirely by hand-power. Hand-cards were used for straightening the fibre of the wool or cotton, which was spun by a single spindle driven by a wheel kept in motion by the hand of the operator. The yarn was woven upon hand-looms, and the cloth thus made was sent to the fulling-mill, which was the first branch of the business not conducted in the household. Fulling-mills were scattered all over the country for the purpose of finishing the cloth made in the farm-houses.

John Earle and Erasmus Jones in 1810 "erected wool-carding machines to pick, break and card wool at the building known as Lincoln's Trip-hammer shop, fifteen rods east of the Court-house."

In 1811 William Hovey, an ingenious mechanic, advertised a new shearing-machine, called the "Ontario Machine," and warned all persons against making or using a machine embodying the principle on which this was

constructed, "which covers a spiral revolving shear working against a straight blade or cutter." One of the advantages claimed for this machine was that it could be carried anywhere in a one-horse wagon, and could be operated either by hand or water-power. It was claimed that this machine would facilitate that laborious branch of the business ten-fold. Hovey constructed another machine in 1812, in which the shears moved across the cloth on the same principle as hand-shears, and he claimed that with this machine he could shear about two hundred yards of broadcloth a day as well as by hand.

In 1814 Jonathan Winslow engaged in the manufacture of flyers of a superior quality for spinning cotton.

Comb-plates for wool-carding machines were offered for sale in 1814 by Daniel Waldo at his store and by Earle & Williams at their shop. At the same time Merrifield & Trowbridge were engaged in making cotton and woolen machinery at the Trowbridgeville privilege.

The prices generally adopted for wool-carding at this time, in Worcester County, were seven cents per pound for common wool, with an addition of three cents when oil was found by the carders; twelve and a half cents per pound for carding half-blooded merino, with the like addition for oil; twenty-five cents per pound for carding full-blooded merino, with the like addition.

An improvement over the ordinary single spindle spinning-wheel is offered by the proprietor, located at Sikes' Tavern, who offers for sale "The Farmer's Spinner," which carries from eight to twelve spindles attached to a single spinning-wheel.

As an indication of the improvements being made in the construction of machinery, attention is called in 1822 to the fact that William Hovey is constructing cylinders

for carding-machines entirely of iron, being cast in four parallel pieces.

Stephen R. Tenney is engaged in building wool-carding, matting, shearing and brushing-machines, in the building formerly occupied by Trowbridge & Merrifield as a cotton factory.

In 1822 Ichabod Washburn manufactured machinery for carding and spinning wool at his shop near Sikes' Inn. January 1, 1823, Mr. Washburn took into partnership Benjamin Goddard (2d), and continued in the same business, to which they added that of carding wool, having purchased the machines lately owned by Calvin Darby.

In June, 1824, Brewster & Fox advertised the best carding-machines and workmen at their establishment, one mile south of Worcester Village,—the South Worcester privilege—carding, six cents; oiling and carding, seven cents.

The machine-shops, so called, at this time were almost exclusively engaged in the manufacture of cotton and woolen machinery.

William B. Fox, who seems at this time to have separated from his former partner, Mr. Brewster, dresses "Handsome wear" at his cloth-dressing factory, one mile south of Worcester, at twenty cents per yard, "common at sixteen cents."

Sarah Hale, widow of Joshua Hale, offered for sale, March 1, 1826, the factory at New Worcester, consisting of the building "occupied for many years past for the purposes of manufacturing cotton and carding custom wool"; but not finding a customer, she had the machines put in good order and resumed business.

Simmons & Wilder carded wool and dressed cloth about two miles south of Worcester Street.

September 13, 1826, William B. Fox moved his wool-carding and cloth-dressing business to the new building erected on the privilege formerly owned by Samuel Flagg, a few rods south of Worcester Village.

The woolen business at this time was in a most depressed condition, and was said to be done at a loss, even with the most prudent management. It was feared that the probable stoppage of the mills would be severely felt in the community. A meeting was held about this time in Boston, and it was decided that it would be advisable to apply to Congress for an increase of duties on imported woolens, or a reduction of the duty upon wool.

The cotton fabrics made in this country at this time were of excellent quality, and the business was in a much better condition than the woolen business.

A meeting was called in Worcester for Friday, December 1, 1826, at Stockwell's, to consider the depressed state of the woolen manufacturers. At that meeting a memorial to Congress was prepared, signed by Emory Washburn, James Woolcott and Maj. John Brown.

One of the most valuable contributions to the woolen machinery of the world was the endless rolling, or American card, invented in 1826, by John Goulding, a native of Massachusetts, and for many years a mechanic in Worcester. Previous to the development of this machine the rolls, or rolling issuing from the carding-machine, were limited to the breadth of the card, and the ends of the separate rolls had to be spliced together by hand process, by a machine called a "billy." Goulding dispensed with the "billy," and, by an ingenious combination of devices, obtained an endless roll, and so perfected his machinery that he could use it successfully from the moment the rolling left the dull end of the first picker until it was converted into yarn fit to be manufactured

into cloth. This device has been styled the most important advance in the card-wool industry of that early period.[1]

Some knowledge of the equipment of a woolen-factory at this time may be had from a notice of a sale in June, 1827, at the woolen-factory then lately occupied by A. & D. Aldrich, and about one mile south of New Worcester, at which were to be offered for sale ten satinet-looms, one double carding-machine, one billy, one shearing-machine, one roping-machine, one press, one copper-kettle, one potash-kettle, press-plates.

In February, 1828, William Hovey stated that he is about to stop his manufacture of satinet shearing-machines, but will continue to make broad and cassimere shearing-machines with vibrating or revolving-shears, and also metallic grinding-machines for keeping the machines in order.

In March, 1830, it was proposed to erect in Worcester a patent hemp and flax-machine, and the Worcester Hemp Company offered to furnish seed to the farmers on the following conditions:

The company would furnish seed at the market price for cash, or in payment would take good notes on interest payable in hemp stem at eighteen dollars per ton, gross weight, when the crop was harvested and delivered at the machine, or would furnish the seed and sow on shares. The company offered to pay eighteen dollars per ton gross weight for good hemp stem delivered at the machine cut, or fifteen dollars without.

In March, 1831, Lewis Thayer and George Willey commenced the manufacture of loom-pickers at New Worcester. Lewis Thayer "carded wool at three and a half cents per pound and waited one year for his pay."

[1] *Boston Advertiser*, November 3, 1888.

In August, 1831, Washburn & Goddard sold their business of manufacturing woolen machinery to March, Hobart & Company, composed of Andrew March, George Hobart, Henry Goulding and B. F. Smith. This firm was dissolved in 1832, and was succeeded by Hobart, Goulding & Company, who dissolved March 25, 1832. They manufactured pickers, carding-machines, condensers, jacks, etc., also comb-plates, and were succeeded by Goulding & Smith.

February 24, 1836, Goulding & Smith dissolved, D. T. Brigham having retired from the firm in 1834, and Henry Goulding continued the business alone. A copartnership was formed, April, 1837, under the title of Henry Goulding & Company, consisting of Henry Goulding, John Gates (2d), and Luke Witherby. They were burned out in August, 1838; the building, which was of brick, was valued at three thousand five hundred dollars, and was owned by Frederick W. Paine; the tools and machinery, valued at eight thousand dollars, were destroyed. This concern built at that time about sixty thousand dollars' worth annually of woolen machinery.

November 15, 1844, Goulding & Davis, who had succeeded, dissolved, and Henry Goulding continued. April 1, 1851, Willard, Williams & Company, bought out Henry Goulding; the firm was composed of Fitzroy Willard, Warren Williams, N. A. Lombard, Charles A. Whittemore and H. W. Conklin; this firm was succeeded April 2, 1855, by F. Willard & Company, composed of Fitzroy Willard, Charles Whittemore, N. A. Lombard and H. W. Conklin. This firm was succeeded April 1, 1861, by Bickford & Lombard, who were succeeded by N. A. Lombard, the proprietor in 1889 who had been connected with the business since 1851. The location of the business was at the southeast corner of School and Union Streets.

From 1823 this business had been confined to the manufacture of woolen machinery of different kinds, including carding and spinning machinery, spinning jacks, pickers, dusters, willowers, etc.

W. M. Bickford succeeded William Stowell, August 31, 1831, and built woolen machinery, condensing, picking, napping and brushing-machines, also spinning jacks, at the Stowell shop in New Worcester; he was succeeded by Abel Kimball, who continued the business at the same place.

Horatio Phelps manufactured looms of all kinds in the shop formerly occupied by William Howard, at South Worcester, from whom Mr. Phelps had purchased the right to make his patent broad looms. The firm of Phelps & Bickford, composed of Horatio Phelps and William M. Bickford, continued to manufacture here, after the formation of their copartnership, all kinds of woolen looms. In October, 1834, they removed from South Worcester to Court Mills, then a new building erected by Stephen Salisbury for the accommodation of parties desiring to lease factory room. Phelps & Bickford afterwards occupied part of the wire factory in Grove Street. Later, Mr. Bickford continued the business alone, and in 1859 he employed twenty-three hands in building looms in the west wing of the Grove Street mill. December 28, 1860, he moved to Merrifield's building, in Exchange Street, where he was prepared to build all kinds of Crompton looms and other fancy looms, broad and narrow; also walking, dressing and spooling machinery, with steam cylinders or pipes for drying; also all kinds of machinery and tools for making wire.

August 17, 1831, John Simmons & Co., announced that they would supply at their new shop in New Worcester the following machinery: Broad and narrow shearing

machines, pressing-machines, napping-machines. This copartnership was composed of John Simmons, Abel Kimball and Albert Curtis, and was dissolved February 21, 1832. Mr. Curtis in 1831 took a lease of Lewis Thayer, the then owner of a part of the water privilege which was originally owned by Joshua Hale. Here he erected a machine shop. The old Hale building was a wooden factory, two stories and a basement, and stood where the middle building of the Curtis & Marble factories stood in 1889.

Albert Curtis was born in Worcester, 1807. At the age of seventeen he was apprenticed to White & Boyden, who manufactured woolen machinery at South Worcester, near the present location of the carpet-mills. After learning his trade he worked here for three years as a journeyman, at one dollar and twenty-five cents per day. In December, 1829, he went to Pittsburgh, but returned in January, 1831, and again entered the employment of White & Boyden. While learning his trade he became acquainted with his fellow-workmen, Kimball and Simmons, and they conceived the idea of going to New Worcester and starting for themselves. The firm of John Simmons & Co. was succeeded by Simmons & Curtis, who continued to make shearing and other machinery. In 1833 Mr. Curtis purchased Mr. Simmons' interest, and continued alone until 1834, when William Henshaw became a partner and so continued until 1839, the firm-name being Curtis & Henshaw. They had not room enough at New Worcester for their business, and for a time leased room of Ichabod Washburn, in the wire-mill in Grove Street. This copartnership was dissolved January 8, 1839.

In 1835 Capron & Parkhurst occupied the old Hale building, which was owned by Clarendon Wheelock.

About 1840 Mr. Curtis purchased of him the Ramshorn water privilege, building and satinet machinery, consisting of two full sets. He had previously bought the Lewis Thayer water privilege, where the old dam stood on Tatnuck Brook, to run his machine-shop. Mr. Curtis leased the old building to John Metcalf and William C. Barber, who ran it until 1842, when it was burned, together with the machine-shop of Mr. Curtis, which was a wooden building with a basement. The original dam on the privilege stood one hundred feet from the bridge toward the location of the present dam, and was about sixty feet long and four feet high.

After the fire of 1842, Mr. Curtis immediately rebuilt the machine shop (52 x 30 feet), three stories high. In 1842 he built a factory on the site of the old Hale mill, a portion of which he leased to Sumner Pratt, to make cotton sewing thread. Mr. Curtis afterwards had an equal interest with Mr. Pratt, and bought him out in 1844. The basement of the building was rented to L. & A. G. Coes, who manufactured wrenches. While Sumner Pratt was here in the thread business, L. J. Knowles and a Mr. Hapgood purchased his product and spooled it in another room of the same building, and put it on the market. After Mr. Curtis bought out Mr. Pratt, he put in looms for making cotton sheetings. The mill was continued as a cotton-mill for several years, when it was converted into a satinet-mill. In 1845 the South Mill was built and used for the manufacture of cotton sheetings and drillings. In 1870 the South Mill was changed to woolen goods, blankets, shawls and dress goods.

At the north end of Curtis bridge was the old wheelwright shop of E. Graves. Mr. Curtis bought out Graves in 1837, and continued the wheelwright business until about 1840.

In 1852 Mr. Curtis bought the Trowbridgeville factory and commenced here the manufacture of cotton sheetings. In 1860 the mill was burned and partially rebuilt and filled with machinery for making woolen goods. He changed the 1845 mill to woolen goods in 1871, and later put in additional machinery for the manufacture of horse blankets. The mill built in 1842 was changed to satinets in 1857. In April, 1863, Mr. Curtis took Edwin T. Marble into partnership in his business for manufacturing woolen machinery for finishing woolen, silk and cotton goods. This Company has made a specialty of shearing machinery, the improvements in which have been greater than in any other machinery used in the manufacture of woolen goods. Mr. Curtis built the first machines for shearing or trimming cotton cloth built in this country; they were used to remove the fuzz. In old times this was accomplished by singeing or burning.

A shearing machine made in France was sent from Pawtucket to Mr. Curtis to be repaired. He examined it and thought it could be improved and then began building the machines. Up to that time the French machines had been used in this country. They had one set of shears; the Curtis machine had from two to five sets and one of his machines would do as much as twelve did in 1830.

Edwin T. Marble was born in Sutton, August 18, 1827. He came to Worcester in 1841. At the age of eighteen he went to work in the machine shop of Albert Curtis and served an apprenticeship of three years. He worked at his trade as journeyman, foreman and superintendent in various machine shops in Worcester and for a time for Alexander and Sewall Thayer as A. & S. Thayer. For several years he was foreman for Thayer, Houghton & Co., Manufacturers of Machinists' Tools. Later he was

superintendent for E. C. Cleveland & Co., Manufacturers of Woolen Machinery.

In the spring of 1850, Mr. Marble worked for a time in Shelburne Falls. He began business for himself as a manufacturer in April, 1863, with Albert Curtis, as has been noted above, under the name of Curtis & Marble. They began business in the same small shop at New Worcester where Mr. Marble learned his trade and employed twenty men, most of them Americans, a few French Canadians. The site is now occupied by the plant of the Worcester Electric Light Company.

In April, 1895, Mr. Marble bought the interest of Mr. Curtis in the business and became sole proprietor. The Curtis & Marble Machine Company was incorporated December 31, 1895. The capital stock was $75,000. E. T. Marble was President and Treasurer until his death, July 3, 1910, when nearly eighty-three years of age, at which time his Company was manufacturing a larger variety of textile finishing machinery than any in the world, covering practically every textile fabric excepting silk. The factory built in 1895 is at 72 Cambridge Street. Several extensive additions have been made to it. Its product now consists of wool burring, packing and mixing machinery and cloth finishing machinery for cotton, woolen, worsted and felt goods, velvets, plushes, corduroys, carpets, rugs and mats. The present officers of the Company are Edwin H. Marble, President; William C. Marble, Vice-President and Secretary; Charles F. Marble, Treasurer; Albert C. Marble, Superintendent. The Company has succeeded to the business of the Atlas Mfg. Co. of New Jersey, The Miller Press and Machine Co. of Woonsocket, R. I., and the shearing department of the Woonsocket Napping Machinery Co. At the present time the corporation

employs one hundred thirty-five men of various nationalities, most of them skilled mechanics.

December 10, 1833, William H. Howard and Silas Dinsmore made cotton and woolen machinery at their machine shop near the Court-House, and continued in business until September 30, 1834, when they dissolved. In November, 1834, Silas Dinsmore commenced the manufacture of power-looms at the same place and April 13, 1835, formed a copartnership with Fitzroy Willard, continuing in the same business. In 1838 Fitzroy Willard was located at Court Mills, where he manufactured broad power, satinet and cassimere looms, and in 1840 Silas Dinsmore manufactured reeds at Court Mills.

The card-clothing industry has been a most important one, and was naturally among the earliest in which the colonists engaged, for the reason that it is essential to the manufacture of textile fabrics. The use to which carding is put is to separate the fibres of the material being worked, and to lay them parallel. The process consists in the reciprocal motion of two surfaces covered with short pointed teeth, between which the stock is placed. Formerly this was done by hand, and was conducted in the household.

"It is probable that either cards proper, or tools closely resembling them, were used as far back as the dawn of civilization, when the art of the manufacture of textiles was in its very infancy. To within a comparatively recent period the processes were very rude, depending mainly on hand labor, and thus the cards employed differed somewhat in their shape from those used at the present day.

"To produce them, a sheet of leather was taken about eighteen or twenty inches by about four inches in width. This was ruled by lines into cross sections as a guide for

the workman, who used a pricker with two blades, piercing two holes at a time at the point where the lines intersected until the whole sheet was pierced. This accomplished, the wire was taken, each pin or shaft being separately bent into a staple by hand. The prongs of the staples formed the card teeth, which were inserted also by hand, one staple at a time, into the perforated leather sheet above described.

"The sheet, with its wire teeth, was now nailed upon a board, and called a card. With this appliance, or rather with a pair of them, the operator carded. He placed tufts of cotton, wool or other fibre between them, and drew the one over the other for several strokes until both were equally filled, and then, by a reverse stroke, he cleaned out the fibre in the form of a roll, called a carding, which was used by the spinsters for making their yarn."

Tacks were first used in making hand-cards, and they were for a time manufactured in this country by cutting them out of sheet-iron with a pair of shears. The tack was held in a vise and headed by a single blow. About six hundred and fifty tacks were required for nailing each dozen pairs of hand-cards to the boards on which they were used. All the tacks used for this purpose for many years were made by hand in the manner described above, until Thomas Blanchard, of Sutton, invented an automatic machine for making the tacks from strips of sheet-iron.

Daniel Denny, whose card-factory has been noticed, probably followed the practice of giving the teeth out to women and children, who would set them in the leather at their homes.

Card-setting by hand was done as late as 1828. Earle & Chase, whose store was at the corner of Thomas and Main Streets, state in August, 1826, that persons who wish

for cards to be set can be accommodated at their store. In 1829 the average price paid for setting cards by hand was forty-two cents per square foot. A good setter would put in about twenty thousand teeth in a day. The best machines in 1889 would set three hundred teeth per minute, and at the present time from three hundred and fifty to four hundred. Wages paid card-setters in 1829 $1.33 per day, in 1889, $3.50 to $4.50 per day. The cost of setting cards is now something less than one-eighth the amount paid sixty years ago, and the wages paid average at least three times as large.

Amos Whittemore, of Cambridge, had patented a card-setting machine in 1797, but it could not be used by others, and the cards made by hand at Leicester were of better quality.

In 1785 the manufacture of cards was begun in Leicester, and to this industry the growth and prosperity of the town is largely indebted. In 1789 Pliny Earle, who had manufactured hand-cards since 1786, made for Almy & Brown, of Providence, R. I., the first machine card-clothing in America, as appears from the following interesting letter:

Respected Friend, Providence, 11th M. 4th, 1789.

Pliny Earl.—We having pretty much concluded to alter and to cover our Carding Machine, and Joseph Congdon informing us that he expected to go to Leicester soon, we thought we would inclose & send thee the Number & diameter of our Cylinders and propose thy covering them with Cards. We have confered with our Card Makers in Town about doing the Jobb, who appear desirous to do it, and are willing to take their pay, all excepting the cost of the wire in our way, but, it being our object to have it well done, and thinking we could rely upon thy performance, have prefered thy doing it.

We have also had it in contemplation to write to Boston, but, being desirous of having it done soon, and that being likely to protract the time of having it done, have waved that also.

We are not desirous of beating thee down in thy price, or that thou should do it below what thou could reasonable afford, but we have thought,

considering thou hast thy machinery now prepared, which was not when thou did that for the company at Worcester, that if we gave thee the same for covering ours as thou had for theirs, tho' a little larger, it would be equivalent to what thou charged them, considering the preparations aforesaid, which the first employers, or rather those on whose account it is especially made, in all such cases must expect to pay, as we have had abundant experience. If that price will answer, we should be glad thou would take the pains to go and view the machine at Worcester, and if there can be any improvement made upon the manner of covering, that, should like thou would make it, either in the Length of the Teeth, or in any other particular. Stowel, who superintends the business there, will chearfully give thee any information respecting the working of theirs, no doubt, upon thy own account and upon ours also, as we are upon friendly terms with him, having divers times been mutually helpful to each other.

We are much in want of ours being done, and should be glad to have it soon; propose, therefore, if thou undertakes the business, that thou would set a time when thou thinks thou could bring the cards down to put on, and we will endeavor to have the machine in readiness to receive them. Inclosed is the dimensions of the Cyllinders,that is, their diameters; the second Cyllinder in circumference, thou knows, has the cards placed at some distance from each other, in order that the rake may take the rolls off distinctly; ours are about 2½ inches apart.

We are of the opinion that the bind of the teeth ought to be in proportion to the circumference of the Cyllinder on which they are placed. We propose having the Cards the same size as those on the Worcester machine, viz.: 16 Inches and all Cotton Cards of equal quality excepting the feeder, and the Cyllinder that takes it off of it, and we need not add of the best quality of the number suitable for the machine, of which, we suppose, the machine at Worcester must be considered as a sample. We should be glad to supply thee with any kind of live Stock, if thou should want, at Cost price, or any kind of produce, cloths included, for the whole or part of the amount; if not, we will pay thee the cash. We think that in four weeks from this time we shall be glad of the Cards. A line from thee by Joseph respecting what we may depend on will be agreeable, as we mean to prosecute the accomplishment of the business as fast as may be.

From thy Friend, Almy & Brown.

P. S.—The diameters of our Cylinders are here subjoined.

The great Cylinder	36	Inches.
the next	26	"
the next	10½	"
1 ditto	10	"
4 "	6	
6 "	3	

One of which, the feeder, to be covered with wool Cards.

It has often been said that the first machine card-clothing was made for Samuel Slater in 1790. Mr. Slater landed in New York November 11, 1789. December 2, 1789, he wrote to Almy & Brown, and December 10 received a reply, making an engagement with him. December 14, Pliny Earle set out for Providence to put cards on Almy & Brown's machine. There is no doubt that Mr. Slater had much to do with perfecting the carding engine and making it a success after he went into the employ of Almy & Brown.[1]

The leather first used in making machine-cards was calfskin, and then cowhide tanned for the purpose. Sheepskin was generally used for hand-cards.

In 1791 Mr. Earle's brothers—Jonah and Silas—became associated in business with Pliny, and in 1806 Silas commenced to manufacture on his own account. At his death his son, Timothy, sold his father's machinery to his cousin, Timothy K. Earle, and Reuben Randall. Mr. Randall's interest, after some transfers, came into the hands of Edward Earle.

Timothy Keese Earle, founder of the T. K. Earle Manufacturing Company, was born in Leicester in 1823. In December, 1843, Timothy K. Earle & Co., consisting of Timothy and his brother, Edward Earle, moved from Leicester to Worcester, and occupied room over Pratt & Earle's iron store, in Washington Square, where they continued the manufacture of all kinds of machine-cards of the best quality. Their machines were built by William B. Earle, between 1843 and 1849.

In 1857 T. K. Earle & Co. built on Grafton Street the factory later occupied by their successors for the manufacture of card-clothing, cotton gin-clothing and belting.

[1]I am indebted to the late Thomas A. Dickinson, of the Worcester Society of Antiquity, for this information and copy of above letter.

This was for many years the largest card-clothing factory in America. Edward Earle retired from the business in 1869, and was succeeded by his brother Thomas, who died in 1871. In 1872 Edwin Brown became a partner, and subsequently, in 1880, the agent and treasurer of the T. K. Earle Manufacturing Company of which T. K. Earle was the president.

The T. K. Earle Manufacturing Company owned a number of patents on their improvements in the method of producing card-clothing. Pliny Earle made one kind of card-clothing, viz.: iron wire teeth set by hand in leather. The T. K. Earle Manufacturing Company made all kinds of leather card-clothing, using both hemlock and oak tanned leather, over ten varieties of cloth card-clothing, and used eighteen or more sizes of soft steel wire, eleven or more sizes of hardened and tempered steel wire, besides tinned wire and brass wire of various shapes and sizes. They curried their own leather, manufactured card-cloths and rubber-faced card-cloths for themselves and for other card-makers. They built almost all their card-setting machines in their own machine-shop and made many improvements in the quality and the methods of card-clothing. They manufactured double and single cover cloth for foundation for card-clothing, having special and improved machinery for the purpose, and in 1883 built a factory on their premises for the manufacture of all kinds of card-cloth, including vulcanized rubber facings, with the very best American and English machinery, and the most improved process of vulcanizing rubber for this purpose.

In 1866 Joseph B. and Edward Sargent, sons of Joseph B. Sargent, the manufacturer of card-clothing in Leicester, organized the Sargent Card-Clothing Company, and built a factory in Worcester on Southbridge Street, now occu-

pied by Queensbury Mills, yarn manufacturers, and Terry Manufacturing Company, manufacturers of woolen goods, with Edward Sargent as manager. April 15, 1879, the business was sold to James Smith & Company, of Philadelphia.

Howard Bros. Manufacturing Company, originally in Washington Square, manufactured machine card-clothing, machine wire heddles, hand stripping cattle and curry cards. The business was established in 1866, by C. A. Howard, the late A. H. Howard, President, Treasurer and General Manager of the company until his death, April 12, 1916, and John P. Howard, and was continued as a copartnership until 1888, when the company was incorporated as the Howard Bros. Manufacturing Company, with a capital of forty-five thousand dollars.

They started with four hands and had a lumber-mill at Keyes, N. H., where they made the backs of their cards. Their machinery is all of their own construction, and much of it special machinery of their own design, notably the card-setting machines, employed for setting teeth, in the cards of which there are from forty thousand to eighty thousand in each square foot of card-clothing. One feature of this business has been the manufacture of diamond-pointed card-clothing and hand stripping cattle and curry cards of every description in wood and leather for cotton, wool and flax. Their trade extends throughout the United States and Canada. They built a new factory on the corner of Franklin and Vine Streets in 1892, the present location. During this year they purchased in England machinery for making their cloth foundations. Their factory has been added to from time to time and in 1913 the capital was increased to $300,000. They employ between sixty and seventy operatives. The present officers are: Herbert Midgley, President

and Superintendent; Harry C. Coley, Secretary and Treasurer.

Charles F. Kent started the business of manufacturing card-clothing in January, 1880.

In 1890 the T. K. Earle Manufacturing Company and the Sargent Card Clothing Company sold out to the American Card Clothing Company, a corporation which purchased all the card clothing factories in the United States with the exception of Howard Bros. Manufacturing Company and Charles F. Kent. About 1902 the American Card Clothing Company bought out Charles F. Kent. The main offices of the American Card Clothing Company, a West Virginia corporation, were in the Knowles building on Main Street, until 1905, when the Company went into liquidation and sold its property to various interests, the Worcester business to a new company, The American Card Clothing Company of Massachusetts, which is now manufacturing card clothing in the old T. K. Earle factory on Grafton Street and also in Philadelphia. The stock of the Company is owned in Providence, R. I.

There appear to have been a number of small manufacturers of cards in Worcester at different times. Daniel Denny and Earle & Chase have already been mentioned. In 1834, William B. Earle had room in Howard & Dinsmore's shop, near the Court-House, for the manufacture of cards. In 1848, William E. Eames, 43 Front Street, manufactured cards; he was succeeded by Earle Warner. In 1849, N. Ainsworth occupied the third story of Goddard & Rice's shop in the manufacture of card-setting machinery. The business was purchased by F. G. Ruggles in 1851.

David McFarland at this time manufactured card-setting machinery, and made the best machines then

made in the country. All the machines at one time running in the Sargent Card-Clothing Company factory, excepting a few English machines, were the McFarland pattern.[1]

"Weaving is the art by which threads or yarns of any substance are interlaced so as to form a continuous web. It is perhaps the most ancient of the manufacturing arts, for clothing was always a first necessity of mankind.

"The simplest form of weaving is that employed in making the mats of uncivilized nations; these consist of single untwisted fibres, usually vegetable, arranged side by side to the width required, and of the length of the fibres themselves, which are tied at each end to the stick which is so fixed as to keep the fibres straight and on the same plane; then the weaver lifts up every other of these longitudinal threads, and passes under it a transverse one, which he first attaches by tying or twisting to the outermost fibre of the side he commences with; and afterward, in the same way, to that on the other side, when it is passed through the whole series. The accession to the art of spinning threads of any length enables more advanced nations to give great length to the warp, or series of threads which are first arranged and to pass the weft, or transverse thread, backward and forward by means of a shuttle without the necessity of fixing at the sides. That kind of weaving which consists of passing the weft alternately over and under each thread of the warp is called plain weaving; but if the weaver takes up first one and then two threads alternately of the warp series, and passes the weft under them for the first shoot of his shuttle, and raised those which were left down

[1] Much of the material used in the article on card-clothing is taken from a book called "A Century Old," published by the T. K. Earle Mfg. Co., and written by H. G. Kittredge and A. C. Gould.

before for the second shoot, he produces a cloth with a very different appearance, called twill.

"There are few arts which require more patience than weaving; as many as from one to two thousand threads often constitute the warp, and these threads may be so varied in quality as to produce many varieties of fabric. From that cause alone there are almost infinite variations; many may be produced by the order in which the threads are lifted for the passage of the weft; that of itself can also be varied as much or more in its quality and other circumstances, so that the inventive genius of the weaver finds incessant opportunities for its display, and nice arithmetical calculations are required in estimating and allotting the numerous threads to the endless variety of patterns which are constantly passing through the loom.[1]

The first practical power-loom was devised in 1785 by Dr. Edmund Cartwright, of Derbyshire, England, a minister of the Gospel, and ignorant of mechanics. He is said to have had his attention turned to the subject by the remark that when Arkwright's patents for spinning yarn by power should have expired, so many persons would go into the spinning business that no hands would be found to weave the cotton. He spent thirty thousand pounds in endeavoring to perfect his loom, and in 1808 received a grant from Parliament of ten thousand pounds for his services. Steam-power was applied to his looms in 1807. Improvements were rapidly made upon the Cartwright loom by other inventors, and it was soon brought into general use for both cotton and woolen goods.

Ichabod Washburn speaks in his Autobiography of seeing a power-loom in the winter of 1813-14, which was so crude that all the cog-wheels were made of wood, and

[1] People's Encyclopœdia.

expresses the opinion that it was probably the first power-loom in the United States. Whether this be true or not, it is certain the power-loom had not, at that time, been long in operation in this country.

In the fall of 1823, Wm. H. Howard and William Hovey were in business together, and after building various kinds of machinery, commenced building broad power looms, and finally settled on the common Scotch looms as the best, and put them in operation at the factory of the Goodell Manufacturing Co., Millbury, at the Pameacha factory in Middletown, Conn., at the Torrington and Litchfield factories, and elsewhere.

This partnership was dissolved, and early in 1825 each manufactured these looms on his own account, William H. Howard building broad power cassimere and kerseymere looms, carding and shearing-machines at his shop, one mile south of the Main Street in Worcester,—South Worcester privilege. For satisfactory proof of the superiority of his looms, he referred to the Goodell Manufacturing Co. in Millbury; to Wolcottville Manufacturing Co. in Torrington, Conn.; and to Zachariah Allen, Providence, R. I. These looms were sold for one hundred and twenty-five dollars each, delivered at the shop in Worcester, including the expense of putting them in operation.

In 1828 Rice & Miller advertised for sale satinet power-looms, and in 1830 Wheelock & Prentice took the shop theretofore occupied by William H. Howard, at South Worcester, and purchased of him the right to build his improved looms, upon which he had a patent for an improvement in the lay motion, consisting of an irregular slot in the sword of the lay through which it was moved. There are many looms now in operation with this movement.

In 1832 Horatio Phelps carried on the loom business at the shop formerly occupied by William H. Howard, having purchased the right to make and sell the Howard Improved Patent Broad-loom. The business was conducted at the same place in 1833, by Phelps & Bickford, who advertised that they were prepared to build to order all kinds of woolen looms of the most improved plan. In addition to the business of making the broad satinet cassimere power-looms, they manufactured to order reeds of any description.

Prescott Wheelock was building looms at his shop in New Worcester in 1833, of any description that the public might want, and in 1835 Silas Dinsmore and Fitzroy Willard formed a copartnership to manufacture power-looms; they dissolved in November, 1835, Fitzroy Willard continuing the business at the same place in Court Mills, where he manufactured broad power satinet and cassimere looms. He built fifty broad power looms in Worcester for W. & D. D. Farnum, and the late Samuel Porter helped set them up in the mill at Blackstone, in 1835. Most of the machinery for that mill was built in Worcester. Henry Goulding constructed the carding and spinning-machines.

All the looms which have been spoken of up to this time were plain looms, so-called, the fancy loom being an invention of later date. The plain loom is one in which a few harnesses, operated by cams, are used. The goods woven on this loom are like cotton or twilled fabrics.

The modern fancy loom varies in range from two to forty harnesses. The movement of these harnesses is controlled by a pattern-chain, made up to correspond with the different make of goods, and for different colors of filling in the goods, drop-boxes, or movable boxes are required, which are also controlled by chain, according

to the pre-determined pattern. With these boxes from one to seven colors can be used. In the trade at the present time the cam-loom, with a single box, whether of two or eight harness capacity, is usually spoken of as a plain loom, and any loom whose mechanism is controlled by chain made up according to a pre-determined pattern, is usually spoken of as a fancy loom.

Up to 1836 the harnesses of all power-looms were operated by cams; consequently the changes of weave of which the looms were capable were very limited, and goods for which an intricate figure or design was required were necessarily woven, as formerly, in a hand-loom.

In 1836 William Crompton, then thirty years old, a native of Lancashire, England, a practical weaver both by hand and power, came to Taunton, Mass., and entered the service of Messrs. Crocker & Richmond.

Here, having been requested to weave a certain pattern of goods, which the looms in use were not fitted to produce, he invented and made a loom of extremely novel design, in that it was the first loom in which the figure or pattern to be produced could be made up on what is known as a chain. This chain is a series of bars or lags, held together by links, so as to form a chain of bars, hence the name. On these bars or lags are rollers or pins, placed in such position that as the chain revolves it lifts, at certain predetermined intervals, levers, which in turn cause the harnesses to be raised in such order that the desired design or pattern is produced upon the loom.

The loom invented by William Crompton overcame two great disadvantages in the cam loom—the limitation of harness capacity and the necessity of changing the cams in order to change the pattern, because its construction made it possible in a very limited space to control and operate a great number of harnesses, and made it

extremely easy to change from one pattern to another. Finally, by William Crompton's invention, any harness could be raised or lowered at any time, and exceedingly complicated patterns could, for the first time, be woven by power. Another innovation in this loom was that the warp was made to move up and down, this double motion giving more room for the shuttle to fly from side to side. For this invention Mr. Crompton received a patent numbered 491 and dated November 23, 1837. Owing, however, to the general depression of the textile industry in this country, he went to England and obtained letters patent, and his looms were later put into operation in that country.

In 1839 he returned to this country, with his wife and family, including his son George, and settled in Taunton. About this time the Middlesex Mills, of Lowell, wishing to manufacture a cloth similar to a piece which had been made by hand in France, requested Mr. Crompton to come to Lowell. He accepted this invitation and applied his patented fancy harness motion to the looms in the mill, and demonstrated that with this motion the desired pattern could be woven. *Thus, in 1840, at the Middlesex Mills in Lowell, fancy woolens were, for the first time, woven by power.*

In a letter written in 1877 to the late George Crompton, by James Cook, agent of the Middlesex Mills in 1840, the following interesting statement is made:

The writer, now in his eighty-third year, in looking over a lot of old samples, came across a piece of fancy woven cloth, the very first woven in this country by power; and the idea crossed his mind that it might be interesting to you to learn the beginning of this great revolution in the fabric now in use very generally in this country to the extinction of the plain fabrics formerly used to a great extent.

Your father came to the Middlesex Mills in this city from Taunton, and represented to the writer and Mr. Edward Winslow, now deceased, a machinist in the employ of the Middlesex Company, that he had a

loom at Taunton for weaving fancy cottons which he thought might be applied to woolen fabrics. The cotton loom was sent for by the Middlesex Company. Mr. Winslow and myself altered one cassimere loom with the assistance of your father, who was a good mechanic, by putting on Crompton's patent. The experiment was an entire success; the alteration was extended very soon to all the cassimere looms and then to the broad looms, so that the whole of the weaving power of the mills was in that direction.

The late Samuel Davis once said that, soon after this, happening to be in Boston, he accidentally met Mr. Crompton at an hotel there, who told him about his loom. Mr. Davis was then building carding and spinning-machines in the old Court Mills, and Mr. Crompton stated to him that he wished to get some one to build his loom, that he had been to Lowell and Lawrence, also to Dedham, but thought that he should close the contract at Lowell. Mr. Davis said he was not building looms, but that Worcester would be a good place to have the looms built, and that Phelps & Bickford would be good parties to undertake their manufacture.

Mr. Crompton came to Worcester and was introduced to Phelps & Bickford, who were then building plain looms. Phelps & Bickford made an arrangement with Mr. Crompton to build his looms upon a royalty, and continued doing so until the expiration of the patent.

In February, 1844, the mill at Northville, owned by Ichabod Washburn, F. W. Paine, G. A. Trumbull, and occupied by William Crompton, was totally destroyed by fire.

In 1848 William Crompton lived in Millbury, where he was engaged in the manufacture of woolen and cotton goods, and where he also had a machine-shop. April 12, 1848, he advertised to sell various kinds of tools used by him in the manufacture of machinery, as he had determined to confine himself to the manufacture of cotton and

woolen goods. Mr. Crompton later removed to Connecticut, where his son, George, worked in Colt's factory. William Crompton died in Windsor, Connecticut, May 1, 1891. The Crompton patent, meantime, had expired; but it was renewed for seven years, and George Crompton came to Worcester, and in 1851 at the age of twenty-two associated himself with Merrill E. Furbush for the manufacture of looms, first locating in Merrifield's building, where they remained until the fire of 1854.

After occupying for a short time quarters in the wire-mill in Grove Street, they hired the Red Mill, near the foot of Green Street, employing about fifty hands in the manufacture of the Crompton loom. At this time William M. Bickford, the successor of Phelps & Bickford, employed twenty-three hands in the west wing of the Grove Street mill in building looms.

August 1, 1859, Furbush & Crompton dissolved. Mr. Crompton continued the business, buying the Red Mill property, and in 1860 erected a new building, which was a substantial brick structure, one hundred and ten feet long by fifty feet deep, three stories high, besides the attic, exclusive of an ell for an engine-house. Mr. Crompton at that time employed sixty hands, which number he expected to increase to eighty as soon as buildings could be erected.

The successive improvements in the Crompton loom can best be given by a quotation from an interesting pamphlet on that subject, published by the Crompton Loom Works in 1881: "Furbush & Crompton made narrow looms from 1851 to 1857, when they brought out a fast-operating, broad fancy loom, with improvements in box-motion. Broad looms, up to this period, operated at about forty-five picks; the new 1857 broad looms, with twenty-four harnesses and three boxes at each end, reached

a speed of eighty-five picks per minute. This was a great stride in production; no advance has been so great since then. The narrow fancy cassimere loom, with three boxes at one end, up to this time had not obtained the speed of eighty-five picks per minute; but with important improvements in the reverse motion, the simplification of devices for operating the lays by means of the ordinary cranks, the use of the ordinary narrow shuttle and the reduction of the size of the shed made a fast economical broad power-loom of eighty-five picks a possibility. One weaver could attend one broad loom as readily as one narrow; therefore "broads" at once came into favor and use, and the comparative exclusion of narrow looms was foreseen.

"Furbush & Crompton built looms until 1859, when the partnership was dissolved. The patents granted to and owned by the firm were in part for improvements in double reverse motion, E. W. Brown's invention, of which they were the sole owners; said patents were by mutual agreement territorially divided—the New England States and the State of New York to Crompton, and the remainder of the country to Furbush, and by said agreement Furbush was debarred from making looms of any kind whatever in Crompton's territory."

In December, 1860, William M. Bickford moved his factory to Exchange Street, in Merrifield's building, where he was prepared to build all kinds of Crompton looms and other fancy looms, broad and narrow. This led to a lawsuit which resulted in Bickford's being found to be an infringer of the Crompton patents. On his death, in 1863, the business went out of existence, the patterns being sold to the Crompton Loom Works.

During 1861-65 Mr. Crompton added to his business of manufacturing looms that of making tools for the manu-

facture of gun stocks, which were sold to gun makers, but at the end of the Civil War the entire resources of the works were again directed to the construction of weaving machinery. He took out over one hundred patents for improvements on looms and for devices outside of his own business, likewise securing numerous patents in Europe. He exhibited his loom at the Philadelphia Centennial Exposition, where he obtained a medal, and at the Paris Exposition in 1867, where all the leading manufacturers of Europe were represented, he received a gold medal.

Mr. Crompton in the late seventies introduced the Keighley dobby into this country. With Horace Wyman, who was associated with him, he improved the harness motion considerably, simplifying it and altering its position (which on English looms had always been in the center of the arch) to the end of the arch, where it could be repaired or fixed more easily, and also avoiding the annoyance of having the oil drop on the warp in the loom. With Mr. Wyman he invented and improved the Crompton gingham loom.

George Crompton died, December 29, 1886, and the business was incorporated January, 1888, with the following officers: M. C. Crompton, his widow, president; Horace Wyman, vice-president and manager; Justin A. Ware, secretary and treasurer.

L. J. Knowles was born in Hardwick, July 2, 1819, and was, in 1836, clerk in a store in Shrewsbury.

In June, 1842, we find the following notice:

"We were shown some miniatures taken by Mr. Knowles at his room in Brinley Row, which we think for beauty, boldness and distinctness, exceed anything we have seen."

In February, 1843, L. J. Knowles & Co., in connection with their daguerreotype business, advertised to do electro-gilding and silver plating.

In 1844 Sumner Pratt leased a portion of one of Mr. Curtis' buildings, at New Worcester, for the manufacture of cotton sewing-thread. Mr. Knowles and a Mr. Hapgood had quarters in the same building, and purchased thread of Mr. Pratt, which they spooled and put on the market.

In 1847 Mr. Knowles commenced the manufacture of cotton warp at Spencer, and in 1849 removed to Warren. During the years 1855 to 1858 he was engaged in the manufacture of satinets in Warren, and made some improvements on the looms he was then running, for two of which he took out patents in 1856—one for a close shed cam-jack for harness motion, and the other for separate picker for each cell in the drop-shuttle box. In 1857 he constructed a drop-box mechanism, for operating drop-boxes by means of cranks set at the opposite extremes of their throw, under the direction of a pattern-chain, or its equivalent. This was the germ of the mechanism of the fancy loom, which has developed by successive stages into the loom as built by the Knowles Loom Works at the present day.

L. J. Knowles and his brother (F. B. Knowles) began the manufacture of looms for sale under the firm-name of L. J. Knowles & Brother, at Warren, Mass., in 1862,[1] and the first looms were made for hoop-skirt tapes, with woven pocket for the wires, and for bindings, tapes, etc. The loom was patented in 1863. This branch of the business continued until the fall of 1866, when the company removed to Worcester, Mass., occupying Dr. Sar-

[1] L. J. Knowles invented and manufactured a steam pump in Warren in 1862. The business was sold to the George F. Blake Mfg. Co. in 1879.

gent's Block—Allen Court, now Federal Street. During 1866 the company began the manufacture of cam-looms for satinets, doeskins and other plain goods, and patented a cam harness motion for this loom in November, 1866.

In 1868 they began to make these looms with drop-boxes at each end, so as to use different colors of filling for checks, plaids, etc. In 1871 they began to make the drop-box looms, with chain or fancy harness motion, so as to extend the range of looms according to the requirements of the patterns. Out of this grew the fancy woolen loom of the present style, the first one of which was built in 1872, and sold to the Jamesville Mills, of this city.

In the spring of 1873 the first broad loom of this style was made from new and heavy patterns, and from that time many thousands have been built for the woolen-mills of the country. This loom was patented in 1873. Meantime, the loom business had grown so that in 1876 from seventy-five to one hundred men were employed. The loom was shown at the Centennial Exhibition at Philadelphia, and as a result won for itself a wide reputation. A forty-harness loom was made in 1876, and the first one was shown at this exhibition, and a number of them were sold. In 1879 the business had grown to such proportions that it was necessary to have more room, and the company, in October of that year, moved to what was known as the Junction shop on Jackson Street.

In 1884 L. J. Knowles died very suddenly, in Washington, and the business was conducted by the surviving brother, F. B. Knowles, until the first of January, 1885, when a corporation was formed under the name of the Knowles Loom Works, with F. B. Knowles as president, which continued the business under the same general management. In 1885 the company brought out a very heavy loom of thirty harness capacity for weaving worsted

goods, which has been very largely introduced. Of this loom they built and delivered the largest single order for heavy woolen looms ever given in this country up to that time, namely—two hundred and four looms for the Riverside and Oswego Mills, of Providence, R. I.

The old hoop-skirt loom has gradually developed into a loom for silk ribbons, suspenders, bindings and all kinds of narrow goods, with great success. The company has perfected, and put upon the market, looms for weaving flannels, dress-goods, fancy cottons, etc., and large numbers of them have been put into the best mills. They have also brought out various looms designed for grosgrains, satins and the various kinds of silk goods, plain or fancy; also coverings for upholstery work, portieres, draperies, etc., for silk velvets, mohairs and silk plushes; and have probably made the widest looms for fly shuttles ever made, having a reed space of two hundred and thirty-six inches. They also introduced a power-loom for ingrain carpets, many of which are now running in the best carpet-mills in the country, and are giving perfect satisfaction.

All the Knowles looms are built on the open shed principle, which is their distinctive feature. The value of the Knowles loom has also been recognized in Europe, and elsewhere, where it has been largely introduced by Messrs. Hutchinson, Hollingsworth & Co., of Dobcross, England, who have built them in large numbers and have several thousands of them in successful operation.

In 1890, on the death of F. B. Knowles, the business was incorporated with the following officers: Charles H. Hutchins, President and Treasurer; George F. Hutchins, General Manager; H. H. Merriam, Secretary; John M. Russell, Cashier. In 1890 the Knowles Co. built new and much larger works on Grand Street and abandoned the

Jackson Street plant. The George W. Stafford Co. of Providence, R. I., was acquired in 1893, and in 1897 the Knowles and the Crompton works were consolidated under the name of Crompton & Knowles Loom Works.

The officers of the new Company were: President, Charles H. Hutchins; Vice-Presidents, Charles Crompton, Frank B. Knowles; Superintendents, George F. Hutchins, Horace Wyman; Assistant Superintendents, Randolph Crompton, A. Bowman Wood; Treasurer, George Crompton; Secretary, H. H. Merriam.

In 1900, the Crompton interest in the Company was acquired by the Knowles interest. In 1899 the plant of the Gilbert Loom Works was purchased. In 1902 the Crompton-Knowles Co. purchased the M. A. Furbush & Son Machine Co. of Philadelphia, and in 1903 established branch works in Philadelphia, especially for the manufacture of carpet looms. In 1905 the business of A. H. Steele & Brother of Worcester was purchased.

In 1903 Edward D. Thayer, William B. Scofield, George Crompton and Randolph Crompton entered into a partnership for the purpose of manufacturing and selling looms. They made a specialty first of worsted, woolen and silk looms, but afterwards made a number of fancy cotton looms.

In 1904 Edward D. Thayer applied for a patent on what has since been called a semi-automatic loom, one in which the filling could be changed while the loom was in operation but could only be so changed by the weaver. In other words, it did not automatically make a change of filling but the filling could be changed without stopping the loom.

In 1907 the Crompton-Thayer Loom Co. was sold to the Crompton & Knowles Loom Works, Edward D.

Thayer, George Crompton and Randolph Crompton continuing with the Crompton & Knowles Loom Works.

During the past few years the principal changes in the fancy loom business have been in the application of warp stop motions to a large number of looms and the development of the automatic and semi-automatic fancy looms.

A large number of patents on automatic looms and their accessories, now the property of the Crompton & Knowles Loom Works, have been granted to Horace Wyman, G. F. Hutchins, Randolph Crompton and Harry W. Smith. Because of the demand for such a variety of complicated looms, this company has had the foresight to employ a very efficient corps of inventors and experts who have continually made improvements in methods not only of handling raw material and the finished product, but in the introduction of special machines made by their own men for special work.

The volume of business is very large, running into the millions of dollars. Looms of every variety are made, among which the most important are those for woolens, silks, carpets, dress goods, cottons, tire fabrics, ribbons, tapes, etc., these varying in price from $50 each to $7,000 each. The capacity of the works is better than one finished loom every ten minutes of working time. The officers of the Corporation are Charles H. Hutchins, President; George F. Hutchins, General Superintendent; Lucius J. Knowles, Treasurer. The number of employees is about two thousand.

The Gilbert Loom Co., Charles W. Gilbert, proprietor, was established in 1866, and in 1889 was located at 186 Union and 33 North Foster Streets, Worcester. The Company employed about fifty hands, using steam-power from a ninety horse-power engine, and built the following varieties of looms and machinery:

Looms for the weaving of tapestry, Brussels and velvet carpets, mohair and cotton plushes, fancy woolen (twenty-four harness, four drop boxes) for woolen and worsted goods. Fancy cotton looms, gingham looms, coach lace looms, satinet flannel, blanket, jean and cassimere looms, gunny cloth and pine fibre looms, tape and narrow wire looms for No. 20 and finer wire, cam looms for chairs and car-seats, heavy looms for cotton duck and belting, needle looms for wipers and sugar strainers; and, in addition to looms, they also built yarn-printing drums and belting frames for tapestry and velvet carpets, cop winders for jute, wool, linens and cotton, yarn spoolers, mill shafting, gear cutters and harness frames; they were also designers and builders of looms for new and special purposes. In 1899 this business was sold to the Crompton-Knowles Loom Works.

Clinton Alvord, W. P. I., Class of 1886, was General Manager of the Gilbert Loom Works, successor to the Gilbert Loom Co. In 1902 Mr. Alvord began at No. 7 Summer St. to manufacture pile carpet looms and textile machinery. The business was incorporated in 1904 as the Worcester Loom Co. which in turn, in the spring of 1916, became the Worcester Loom Works. Mr. Alvord greatly improved the machines or drums for printing the pile yarn for tapestry and velvet carpets and also brought to working conditions the wide Jacquard Axminster loom which is built nine, twelve and fifteen feet in width—about fifty hands are employed.

In 1854 Rodney A. N. Johnson & Co., composed of Mr. Johnson and Daniel Tainter, manufactured spinning machinery for wool carding machines, pickers, twisters, spools, bobbins, boring machines, card clothing, etc., at Merrifield's Steam Mill.

In 1859 Fox & Rice manufactured fancy cassimeres on the stream at the junction of Green and Water Streets, employing two hundred hands and manufacturing fifty thousand yards of cloth monthly. Daniel Tainter, at the same time, employed thirty hands in Union Street in the manufacture of wool-carding machines and jacks.

The business once conducted by the Cleveland Machine Works Co., the well-known builders of woolen machinery, located at 54 Jackson Street, was established in January, 1860, by E. C. Cleveland, who commenced the manufacture of woolen machinery in Central Street in what was then known as Armsby's building. He manufactured cloth dryers, hydro-extractors, cloth-brushing machines, jacks, presses, fulling-mills and wash-mills, and continued in this business until early in 1863, when, in addition to the above-named machines, he built the first set of the well-known Cleveland cards, which were used for converting wool into roving previous to spinning. These cards were sold to Messrs. Howe & Jefferson, of Jeffersonville, where they ran in the mill of the Jefferson Manufacturing Co. for many years.

About this time the late John C. Mason and J. M. Bassett were admitted to the firm. They, after several years, withdrew, and Mr. Cleveland continued the business until his death, on April 28, 1871. Since the building of the first set of cards hundreds of sets, with improvements from time to time, have been built, and put in successful operation in first-class mills. After the death of Mr. Cleveland the firm was managed by S. W. Goddard, who introduced many new machines and many improvements in the machines made previously, in all about fifty machines for different uses in woolen mills, and all kinds of cards for wool, worsted, felt and shoddy; also twisting, roving, spooling, picking, drying

and cloth finishing machinery. The product was sold throughout the United States, Canada and Mexico.

This business was subsequently bought by James H. Whittle, and moved to Harlow Street, to a plant which he built, and which is now owned and occupied by the Rockwood Sprinkler Co. About 1910 the Johnson & Bassett Co. bought all of the patterns of this full line of machinery. It does not build any new machines but furnishes repairs on existing machines.

In February, 1863, the late Hon. Isaac Davis sold the lower Junction shop, built by Eli Thayer in 1854 for gun work, and used in 1861 for soldiers' barracks, with twelve acres of land, to Jordan, Marsh & Co., of Boston, who intended to convert it into a woolen-mill, with sixteen sets of machinery, making it one of the largest woolen-mills in the State. This shop was first known as the South Junction shop; later, as the Pistol Shop Barracks and Adriatic Mills. Jordan, Marsh & Co., made extensive improvements. The main building was four hundred feet long, forty feet wide and two stories high. The second floor was devoted to carding and spinning, and was arranged for twelve sets of cards and twenty packs of four thousand eight hundred spindles. The first floor was for finishing and weaving; the weaving all to be done by looms made by George Crompton, of Worcester. The main belt was one hundred and fourteen feet long, and thirty inches wide, double throughout, and made at the shop of Graton & Knight then in Front Street. Particular attention was called to this, as showing that the equipment of a woolen mill could be procured in Worcester; the cards, jacks, dryers, dressers, extractors, hydraulic presses, etc., were furnished by the Cleveland Co.

This mill was subsequently owned by the Worcester Woolen Co., incorporated in 1881. The building was

five hundred and eighty-two feet long, forty-two wide, two wings—one seventy-two by sixty, the other ninety by fifty-six. The number of hands, at the beginning two hundred, subsequently increased to two hundred and thirty. They had thirteen sets of cards, fifty-eight broad and two narrow looms, and twenty Bancroft operators. They made fine woolens, cassimeres and suitings, and produced from five thousand to eight thousand yards per week, the annual sales amounting to six hundred thousand dollars. The Messrs. Legg came from Rhode Island in March, 1881, James Legg, Jr., became the owner of the mill, and it was run under the name of James Legg, Jr. & Co., until July, 1881, when the firm of James & John Legg, succeeded. They operated the mill until 1890 when a Corporation was formed under Massachusetts laws, by Edward D. Thayer, Jr., as President, John Legg, Superintendent, Charles J. Little, Treasurer, and Winthrop B. Fay. Mr. Little resigned after one year and was succeeded by Edward D. Thayer as Treasurer.

Mr. Thayer died in 1907, and Mr. Fay died in 1909. January 1, 1911 the Thayer interest was purchased by John Legg, his son, J. Francis Legg, and George C. Bryant. The Fay interest was purchased by Frank S. Fay, a nephew of W. B. Fay, who had been connected with the mill since 1885. The new organization was: John Legg, President and General Manager; Frank S. Fay, Treasurer; J. Francis Legg, Vice President and Superintendent.

In 1916 a large Preparation Plant was built. The plant is now a fourteen Set Mill with twenty mules and seventy-two broad looms, equipped and organized to produce anything from a cheap cloaking to the finest uniform cloths, of which many have been accepted as U. S. standard.

The Alma Woolen Mills, in Green Street, employed in 1889 two hundred hands in the manufacture of fancy

cassimeres and suitings, running fifty-nine looms and eight sets of cards with attendant machinery.

In 1868-69 experiments looking towards making the jacks self-operating were going on in several parts of the country, and were being conducted in the shop of Cleveland & Bassett, in Worcester, by Edward Wright.

The failure of Cleveland & Bassett in the fall of 1869 brought Mr. Wright's experiments in their works to an end, but he arranged to go on with Johnson & Co., jack builders, and July 1, 1870, the copartnership was formed between Johnson & Bassett. The first self-operating attachment for jacks of their make was put at work in the mill of John Chase & Sons, at Webster, in 1870, after which time Johnson & Bassett built up an extensive business in the manufacture and sale of self-operating heads for application to hand-jacks, self-operating jacks complete with heads, and self-operating mules. The business was located in the Merrifield Buildings, 180 Union Street, until October 1, 1886, when it was removed to Mr. Bassett's building, corner of Foster and Bridge Streets, where it is now operated by George M. Bassett.

The manufacture of wool spinning machinery is not a growing but, on the other hand, a decadent industry. There are several reasons for this. In 1880, when the United States had a population of approximately half what it has now, there were about fifty per cent more mills in the country using wool spinning mules than at present. The chief reason for this enormous reduction in wool spinning machinery is the tremendous growth of the manufacture of worsteds. In 1880 there were practically no worsted mills in this country. In the manufacture of worsteds, wool spinning machinery is not required; then, too, twenty-five or thirty years ago most people wore woolen underwear and woolen hosiery. This

practice has almost entirely ceased and the result has been the passing out of the woolen knitting industry. There used to be three or four hundred knitting mills using woolen mules, most of which have disappeared. In 1880 there were eight builders of wool spinning machinery in this country. Today there are only two, this company and one other. The other six have all failed or gone out of business. This company alone can make all of the mules that are required in this country and Canada.

The Crompton Carpet Co. was organized in 1870 by George Crompton, who, with the superintendent, Horace Wyman, invented and patented a loom for weaving Brussels carpets by power, there being at that time no power loom for that purpose, except the Bigelow loom and two makes of English looms, the right to use which in this country could not be obtained. The manufacture of Brussels carpets, therefore, was confined to the Bigelow Co. at Clinton, and the greater part of the carpets used in the United States were imported from England, and a high price was consequently maintained. Mr. Crompton associated with himself in the enterprise Dr. Joseph Sargent, William Cross, Horace Wyman, W. W. Rice, William H. Jourdan, and Calvin Foster—George Crompton being president of the company; William Cross, treasurer; Joseph Sargent, Jr., agent and M. J. Whittall, superintendent. After the death of Mr. Cross, the late Joseph Sargent, Jr., was elected treasurer.

They commenced operations with sixteen looms of Crompton make. The factory was located in South Worcester and was a two-story building, French roof, 115 x 60, run by water-power, the amount being estimated at one hundred horse-power. In 1871 a dye-house was added to the mill (which stood near the site of the old White & Boyden mill, burned August, 1863, and re-

ferred to previously). This enterprise was the beginning of the general manufacture of Brussels carpets in this country. Other companies were soon formed, the restrictions were removed from the sale of the English-made looms, and, in consequence, the price of carpets rapidly declined from three dollars per yard in 1870 to one dollar per yard in 1879. The company started with one hundred and fifty thousand dollars capital, and, before their operations ceased, had increased the number of their looms from sixteen to thirty-six, and continued until 1879, when the machinery was sold to W. J. Hogg, Sr., of Philadelphia, and later the building containing the carpet machinery was leased to Mr. Hogg.

In 1884 Mr. Hogg built a yarn-mill on part of the land he had purchased of Mr. Crompton, on the site of the first Packachoag Spinning-Mill. This building was one hundred by sixty feet. Mr. Hogg employed about three hundred and twenty hands.

The Packachoag Worsted and Yarn-Mill was built and owned by George Crompton. This mill was near the Crompton Carpet Company, and was managed by Joseph Sargent, Jr. In the yarn-mill they started with twenty-four spinning frames and accompanying machinery; later, Mr. Crompton built another yarn-mill adjoining the first. The first Packachoag Mill was burned in 1884; loss, one hundred and eighty-one thousand dollars. After the fire Mr. Crompton sold the land and the ruins of the Packachoag Mill in part to M. J. Whittall and in part to William James Hogg, Jr.

Mr. Whittall, who was superintendent of the Crompton Carpet-Mill from the commencement of the business, was from Stourport, England, where he was manager of the Severn Valley Carpet Works of Fawcett & Spurway. In 1879 Mr. Whittall returned to England, and while there

purchased eight Crossley Carpet Looms. He brought these to this country, and began to operate them in a building leased of the Wicks Manufacturing Company. In 1882 another story was added, and Mr. Whittall added eight more carpet-looms; but business increasing, more room was needed, and he determined to erect a building for himself. In 1883 he bought of Mr. Crompton a piece of land facing Mr. Crompton's original carpet-mill, and erected a building one hundred and seventy-five by sixty feet, two stories in height. This mill was finished during that year, and the machinery from the Wicks building, together with fourteen new carpet-looms, was put into operation. In 1884 an extension was added, together with twelve looms, making forty-two in all.

It will be recollected that Mr. Whittall had purchased part of the land and all of the buildings that remained of the Packachoag Mill property, and on this spot he erected another carpet-mill, and also repaired the old yarn-mill, engine-house, etc. In this new mill he had seventeen new looms, making fifty-nine carpet-looms in use in his business. He manufactured six-frame and five-frame Wilton and body Brussels carpets, and employed about three hundred and twenty hands in 1889, when he built what is known as the Whittall Mill No. 2, a two-story brick building, 250 x 60, thus increasing his spinning and weaving capacity. At the same time, another story was added to the spinning mill making it three stories high. It was named The Edgeworth Mill.

Mr. Whittall formed a copartnership in the spinning department with Alfred Thomas, who came from England in 1880. This copartnership still exists and Mr. Thomas is in charge of the Edgeworth Mills.

In 1891, Whittall Mill No. 3, a two-story brick building was added to the plant. The same year, the mill of the

Palmer Carpet Co. at Palmer, Mass., with twenty-four looms and employing about one hundred hands, was purchased. In 1897, Mr. Whittall's son, Matthew P. Whittall, became associated with him in business.

In 1901, the plant of William J. Hogg was purchased. This consisted of the yarn mill built on the land purchased from Mr. Crompton, the site of the first Packachoag Spinning Mill which was burned in 1884, and the Hogg Carpet Mills, which consisted of the original Crompton Mill and a mill erected by Mr. Hogg. This brought to Mr. Whittall the ownership of the mills in which twenty years previously he was the Superintendent.

In 1902, an addition of one story was made to Whittall Mill No. 2, while the mills purchased from Mr. Hogg were improved, the water power developed, and two new turbine wheels added.

In 1903, the old Crompton Mills were extended, doubling their capacity. In 1904, what is probably one of the finest dye-houses in the country was built, which contains the most modern washers, dyers, and drying machines. It is a brick building 235 x 75, the upper story of which is devoted to the storage of worsted yarns.

A new problem was now confronted. There were three power plants which were neither economical nor adequate. A central station was therefore constructed to distribute power to the entire works. There were installed boilers of 2250 H. P. and a large engine driving an electric generator.

In 1905, a six-story wool warehouse was built at the Edgeworth Mill, which has about three million pounds capacity. This storehouse is used for the storing of raw wools. This same year a third story and tower were added to Mill No. 3. In 1906, Worcester Carpet Mill No. 3, consisting of a four-story mill 145 x 60, was added

to the plant, also a brick building to be used for supply rooms, and a piping and blacksmith shop.

In 1906, the business had grown to such a size that the Whittall Associates were organized, of which M. J. Whittall is President and Treasurer, and M. P. Whittall, Assistant Treasurer.

In 1907, Mr. Whittall purchased the machinery of the Percy Rug Company, an Axminster plant for the manufacture of rugs which found a market throughout the United States and in foreign countries.

In 1910 there was added a four-story brick building, 60 x 266 feet, on the fourth floor of which are located commodious, well-lighted offices. A coal pocket of ten thousand tons capacity has also been added. The total floor space of the plant is five hundred thousand square feet, and there are three hundred and fifty looms in operation. The salesrooms are located in New York, San Francisco, and St. Paul, Minn.

A new carpet has recently been added to the products of the Mills called Chenille, or Scotch Axminster. It is a heavy, high-piled fabric in which the rows of tufts are set by hand. The looms weave rugs as wide as fifteen feet, seamless, and of any length.

An advertising department which conducts a general campaign of national advertising has been recently organized.

At present about fifteen hundred hands are employed, mostly English and Americans, ninety per cent of whom are skilled labor.

The plant is equipped with automatic sprinklers and other fire apparatus to conform to Massachusetts laws.

The operatives do not belong to any federation of labor or labor union, but have what is called a "Shop Club," with which the administration of the Whittall Associates

confers at regular intervals. There is also a mutual aid society which pays employees a stated sum per week in case of disability. In case of death the family receives a benefit. In case of injury, the operatives have the services of a physician without cost.

Early in 1916 the plant of the Cochrane Mfg. Co. at East Dedham, Mass., was purchased. This consisted of seven buildings with power house and office building and employed seven hundred and fifty men. It has produced Velvet and Axminster carpets. It is the purpose of the purchaser to manufacture here the better quality of less expensive fabrics.

The manufacture of thread has been conducted in Worcester for many years. This is a most favorable place for this industry, because of the excellent shipping facilities, and the fact that the Worcester Bleach & Dye Works—one of the best dye-houses in the country—is located here. Thread was first manufactured in Worcester in 1865. The business was discontinued from 1879 until 1881 when it became a rapidly-growing industry. The Glasgo Thread Company, so called by reason of the fact that the company controlled a spinning-mill at Glasgo, Conn., was incorporated in March, 1883, and for a time the business was conducted in Foster Street, in the building of Charles Baker. In 1885 the company removed to Beacon Street. The average daily production was four thousand dozen of two hundred yards.

The process of manufacture is most interesting, and consists in carding cotton until the fibres lie parallel to each other; the loose rolls are then taken to the drawing-machine, which consists of a series of rolls, each set revolving faster than the preceding, which reduces the strand to the required degree of fineness. The strands are repeatedly united and reduced. This process is

called "doubling," and ensures a uniform, strong and perfect product. The united threads, which are called "slivers," are then spun into a single thread on a mule. After being dyed the skeins are subjected to the operation of drying, and are then put upon spools for finishing by saturating with sizing, and passing over rapidly revolving brushes.

Important improvements have been made in thread machinery since the introduction of its manufacture in this city; the most important is the automatic winder, with which the operator can wind from two to four times as much, and with less exertion, than he could formerly do by hand. The automatic machine is set to wind any number of yards the operator may desire.

The Glasgo Thread Co. was the first to introduce fine Sea Island thread upon pound spools. Previously only the small spools were used, but later almost any size might be found, from two hundred to thirty thousand yards, which led to a considerable saving to the consumer. The greater part of the thread used by the manufacturing trade was put up on large spools holding from six thousand to thirty thousand yards. This company is no longer in existence.

The Ruddy Thread Co., manufacturers of all grades of cotton thread—principally for the manufacturing trade, sewing-machines, corset-works and shoe manufactories, was established in 1887, and located at 75 Central Street, under the management of Robert Ruddy.

The Worcester Thread Company, originally Smith, Barr & Co. (Morrison Smith and Thomas N. Barr), was located in its River Mill at Clinton where it began business in 1893. Early in 1894, the late Edward D. Thayer, Jr. and William B. Scofield acquired an interest in it. They incorporated the Company as The Worcester Thread

Company and moved the plant to Worcester in one of the Estabrook buildings on Hermon Street. The capital stock was $35,000. The Company manufactured linen (flax) threads and yarns for the shoe, harness and carpet trades. The business was finally sold to the Linen Thread Company of America in the early part of 1902.

The Wachusett Thread Co. was formed in January, 1889, by Peter Wood, James Montgomery and Charles Dolan. They were previously connected for many years with the Ruddy Thread Co. which sold out to the American Thread Co. in 1898. They started business in April, 1899, renting two stories in the building at No. 116 Gold Street. They soon found it necessary to occupy the entire building. Later they built the two-story building on Middle River Road to do part of the work, which could not be done in their Gold Street mill.

After a few years they purchased a tract of land on Middle River Road with the intention of erecting a new factory, which was built in 1911, where they could have all their machinery under one roof.

The officers of the Corporation are Peter Wood, President; James Montgomery, Secretary and Treasurer; Charles Dolan, Superintendent.

The Cranska Thread Co., Floyd Cranska, Treasurer, is located at 70 Beacon Street.

C. H. Hutchins & Co., 2 Allen Court, now 15 Federal Street, established in 1876, manufactured in 1889 elastic and non-elastic webs for suspenders and stocking-supporters, also spool tapes, used by cotton and woolen manufacturers to tie up their goods. The material used was cotton and rubber, the rubber being woven in process of manufacture. The looms were the Knowles fancy loom, one of which would weave twenty-five hundred yards per day. This became the Hutchins Narrow Fabric Co. and was

sold in 1900 to Ephraim Bond who after a short time moved the business to Springfield, Mass.

The L. D. Thayer Mfg. Co. was located in 1889 in the building formerly occupied by Ethan Allen. The Company was organized in 1878, and manufactured tapes, bindings, galloons and webbings.

A. G. Hildreth, in Stevens' Block, manufactured overalls, pants, shirts, butchers' frocks, etc., and employed forty-five hands, using sixteen sewing-machines. In 1887 three hundred and twenty-five thousand yards of cloth were cut up, and in 1888 five hundred thousand yards. The business is now located at 25 Hermon Street.

The Holland Hosiery Co. was established in Hallowell, Me., in 1883, moved to Worcester in 1886, and manufactured seamless half hose.

The Worcester Felting Co., in Foster Street, in 1889, did a large business in the manufacture of linings, upholstery, saddlery felts, petershams, rubber-boot and shoe linings and trimming felts.

George L. Brownell manufactured improved twisting machinery of his own invention for laying hard and soft twines, lines and cordage.

In 1889, he was located at No. 16 Union Street, one of the buildings now owned by The Wire Goods Co., occupying one floor and basement and employing fifteen hands, which were divided as to nationality about evenly among Americans, Irish, and French Canadians. The above premises were occupied until 1895 when, because of a steadily increasing business, Mr. Brownell moved to the present location, 49-51 Union Street, a factory built in 1882 for The Worcester Barb Fence Co. by the late Stephen Salisbury, Sr. He occupied the first floor and basement until 1909 when the business occupied the entire building. At the present time, under normal conditions,

Mr. Brownell employs between one hundred and one hundred twenty-five hands, the nationalities now including Americans, Irish, Swedish, Lithuanians, Poles, French Canadians, and Greeks.

He specializes on twisting machinery and makes machines for working almost any substance known to the textile trade varying in size from machines adapted to make a fine silk line to machinery for making rope up to three-quarters inch diameter, and including improved twisting and spinning machinery for making hard and soft twines, lines and cordage, wet or dry twist, from cotton, linen, hemp, manila, sisal, paper, silk, jute, hair, wool, etc. C. L. Brownell is associated with his father in the business.

In 1889 the Carroll Machine and Spindle Works manufactured machinery for twisting yarns.

Among the smaller manufactures connected with textile fabrics, but none the less important, was that of improved loom-reeds, manufactured by M. Place & Co., whose business was originally established by Silas Dinsmore in 1840.

In 1889 William H. Brown, 81 Mechanic Street, manufactured a number of ingenious tools for the use of carders. This business was established in 1855.

In 1876 B. S. Roy, located, in 1889, at 75 Beacon Street, began the manufacture of card-grinders, for grinding card-clothing, all his machines being of his own invention. Mr. Roy was formerly superintendent in a cotton-mill, and, recognizing the necessity of a better method for grinding the card-clothing, engaged in this business. The old method of grinding cards was by spreading emery on a board, which was rubbed back and forth over the ends of the wires, thus sharpening the teeth. This process was called by the English "strapping" or "strickling" the

cards. The next improvement was the construction of a machine, with a cylinder covered with emery, but with no traverse wheel. This method of grinding teeth made them uneven. In Mr. Roy's improvement, the traverse wheel runs with an endless chain back and forth on the cylinder over the teeth of the card with a rotary motion. These machines were sold in this country, South America, Mexico, Canada, England and Ireland. This business is now located at 775 Southbridge Street, under the name of B. S. Roy and Son.

J. H. Whittle, established in 1880, manufactured tin spindles for mules, spinning-frames, drawing-cans, filling-boxes, condenser-rolls, slasher-cylinders, drying-cans, etc., rubber-rolls for woolen-cards, and immersion-rolls of copper.

CHAPTER IV

Foundries—Machine Tools—Agricultural Implements—Wrenches.

William A. Wheeler was one of the oldest iron founders in the State, having begun in 1812; he moved from Hardwick to Brookfield, and from the latter place came to Worcester in 1823 and established a blacksmith's business at the corner of Thomas and Union Streets. Among other pieces of work he made the doors of the old Court-House in Worcester. This blacksmith's shop was on the site of the foundry. In 1825 Mr. Wheeler, in company with George T. Rice, H. W. Miller and A. D. Foster, under the name of William A. Wheeler & Co., made all kinds of castings, fire-proof book-cases and doors. To run a fan for his cupola-furnace, Mr. Wheeler had the first steam-engine, or one of the first ever operated in Worcester. In 1826 the business passed under the control of the Worcester & Brookfield Iron Foundry, which had furnaces in both places.

Daniel Heywood & Co. furnished at this time all kinds of castings. The demand appears to have been considerable, for in 1827 Washburn & Goddard received orders for machine castings made at Stafford, Conn.

In 1828 Sumner Smith (Worcester Iron Foundry) put a furnace in blast near the paper-mill of Elijah Burbank, at Quinsigamond, and had for sale every description of iron castings, cast-iron plows, stoves, cauldron kettles, hollow-ware, oven frames, Darby's patent wheel-boxes. In 1833 the Worcester Iron Foundry removed from Quinsigamond to the first mill privilege north of Main Street, one mile from the Court-House, on the Worcester road leading to West Boylston.

In 1831 or 1832 Mr. Wheeler returned to Worcester and reorganized his shop, abandoned the steam-engine which he had previously put in, and substituted horse-power. He continued to do a constantly increasing business until the foundry was enlarged, about 1840, when another steam-engine was added and a machine shop attached. The castings were made for the iron-workers and tool-makers in the city, and comprised castings for heavy gearing, besides a variety of other work, including heavy sheet-iron work, fire-proof safes, mill-irons, water-wheel irons, cages, coupling-boxes, plow-castings, patent ovens, ash-holes, boiler-doors and pipe-boxes; factory shafting was also turned. About the time his machine-shop was started Mr. Wheeler procured an iron planer, to be run by hand. This was the first iron planer in Worcester, or in the State. It weighed about one hundred and fifty pounds, and was three and one-half feet high. The bed was four feet long and twenty inches wide. Mr. Wheeler designed the first boring-machine in Worcester, and in 1838 got out patterns for cook-stoves, and box-stoves for heating, which he manufactured. In 1842 he invented a furnace for heating buildings with wood or coal.

In 1838 he started the manufacture of brass castings for general use. When Mr. Wheeler commenced business he made five hundred or six hundred pounds of castings per day, and increased until his daily production was ten tons. He began with three or four men, and in the height of his prosperity employed two hundred. In 1852 Mr. Wheeler's son (Charles) became interested in the business at Thomas Street, and when William A. Wheeler died, in 1873, it passed into the hands of William F. Wheeler, and finally to the Wheeler Foundry Company, which remained at the old location for a time, and then moved to 138

Mechanic Street, where the business employed about ninety men. In 1914 the company was obliged to abandon this location and under the name of the Wheeler Foundry Company has acquired a building site at 174 Prescott Street.

In 1843 the Washington Square Iron and Brass Foundry, built by A. A. Trask, was operated by S. Trask & Co. in the manufacture of cauldron-kettles, stoves, oven-doors, ash-pits, etc., and in 1843 a new foundry was built near the Boston and Worcester Railroad by Henry P. Howe, and was occupied by George Goodnow in the manufacture of iron, copper, brass and composition castings.

In 1847 Oliver K. Earle built a foundry on the corner of Canal and Foundry Streets. He sold out to A. B. Chaffee in 1848, who took Jason Chapin into company the same year. They started in business to supply Howe & Goddard with their brass castings. In 1852 Chapin purchased Chaffee's interest, and in 1853 built a shop in Manchester Street, where he continued until 1859, when he built the shop in Summer Street, where he continued until 1887, when he sold out to L. H. Wells.

In 1849 Fitch & Jones made castings in iron and brass, and were succeeded in 1850 by E. & D. H. Fitch & Co.

In August, 1850, McFarland & Bisco, of Leicester, started in the malleable iron business, which was continued in 1851 by Wood, McFarland & Co. They occupied the building known as the Arcade, formerly as "The Old Brewery," near the "Western depot." Here, with one air furnace and two small annealing furnaces, they commenced the making of malleable castings for guns, carriages, harness buckles, wrenches and parts of cotton and woolen machinery, previously made of wrought iron. At this time there was but one other malleable iron foundry in the State, which was located at Easton. The

process of malleable iron founding is different from that of ordinary casting. The purpose to which the product is applied requires a greater degree of tensile strength and tenacity in the materials and a closer attention to all the details. Instead of placing the coal and pig-iron in the furnace together, the pig-iron is thrown into what is called the air furnace by itself and subjected to an intense heat; it is then drawn out and poured into moulds, in which state the metal is very hard and brittle; it is then packed in an annealing furnace and subjected to strong heat for about nine days and nights, when the furnaces are opened and the pots cooled; the iron is then unpacked and cleaned ready for delivery, when it has both fineness of grain and great toughness.

The old firm of Wood, McFarland & Co. remained in business but a short time; their interest was taken by Warren McFarland, who continued with a silent partner until 1877, when he became the sole owner. From one air furnace and two annealing furnaces the plant was increased until it had two air furnaces and six annealing furnaces.

In 1880 George B. Buckingham, who had been connected with Mr. McFarland since 1873, took charge of the works, Mr. McFarland remaining connected with it until his death, in 1884. In December, 1886, Mr. Buckingham purchased the property of the Worcester Malleable Iron Foundry, that being the second known by this name, which had been run about three years, and was thereafter run as the Worcester Malleable Iron Works. The line of goods made included different parts of agricultural implements, guns, pistols, sewing-machines, cotton and woolen machinery, in fact, all parts of machines or tools where strength and lightness are combined. The use of malleable iron and steel castings, made by the

above works, was largely owing to the reasonable price in comparison with forgings, as odd shapes can be more easily produced than by the forge.

The second malleable iron foundry, known as the Worcester Malleable Iron Foundry, was started in Manchester Street, by Waite, Chadsey & Co., in 1852. The Arcade Malleable Iron Co. moved to the present location at Albany Corner Muskeego Street in 1907. It was incorporated in 1906 and employs over one hundred men of various nationalities. The officers are: H. Paul Buckingham, president; Thomas T. Booth, vice-president; Alonzo G. Davis, treasurer.

In 1857 Oliver K. Earle, who had previously been in the lumber business, was admitted into partnership with Fitch & Jones, who continued business at the Union Street Foundry and also at the Junction Foundry in Southbridge Street. After Mr. Earle's death, Willard Jones, Wood & Light, Richardson, Merriam & Co. succeeded; it was then taken by Otis Warren. The first work done at this foundry was the manufacture of the iron-work for the front of Foster's Block, at the corner of Main and Pearl Streets. C. S. Weeks & Co., Slocum & Stickels, A. B. Davidson and the Junction Foundry Co. did business in succession at this location.

Caleb & J. A. Colvin commenced the foundry business at Danielsonville, Conn., in 1863, where they manufactured stoves and machinery castings. In 1865 Caleb sold his interest to his brother and moved to Worcester, where he bought and built his plant in Gold Street. In 1891 the L. W. Pond Machine and Foundry Co. succeeded to the business. The Company was incorporated in 1902. Thomas O'Leary is president and treasurer. About two hundred men are employed here.

J. A. Colvin subsequently moved to Worcester, and a new partnership was formed, which continued until 1880, when he built the present foundry in Jackson Street. Mr. Colvin died in 1915. The business, now known as the Jackson Street Foundry, is owned and carried on by his estate, J. B. Colvin special administrator and manager.

Heald & Brittan built on Foundry Street, about 1866, and made iron castings. They removed from there to the Thomas Street Foundry, when the Wheeler Foundry Company moved to Mechanic Street. This foundry afterwards came into the possession of the Holyoke Machine Company.

L. H. Wells and Herbert M. Rice began business January 1, 1867, in North Foster Street. Mr. Wells learned his trade of Jason Chapin, and was subsequently foreman of the late George Crompton's foundry, in Green Street. Mr. Wells purchased Mr. Rice's interest in September, 1869, and in 1877 invented his bronze metal, largely and successfully used for bearings. By the use of chemicals the oxidation of the tin, one of the ingredients, was prevented; the metal was ten per cent denser than the ordinary bronze, and of a very firm, tough structure. In 1887 Mr. Wells purchased the Chapin Foundry in Summer Street, to which he removed. Mr. Wells had the largest set of furnaces in the city; his castings were cleaned by power in a large water rumble, a hollow cylinder, which made ninety revolutions per minute. Emery wheels were used for smoothing the castings.

The process of casting consisted of melting the metal in crucibles made of plumbago, and then turning the molten metal into moulds. When taken out the castings were cleaned and finished. This business is now carried on by the Wells Chemical Bronze Works incorporated in 1906.

The officers are C. A. Harrington, President; F. C. Harrington, Treasurer; M. E. Hamilton, Secretary and Manager. The business was moved from Summer Street to the present location, corner Temple and Harding Streets, in 1914. The plant is thoroughly equipped, employs sixteen hands and has a capacity of four tons of metal per day.

Prespey Pero located in Hermon Street in 1877. He manufactured machinery and tool castings, and made a specialty of light castings. His business has grown from employing three or four men until he now employs from forty to fifty. The business is now conducted by the Pero Foundry Co. Prespey Pero, President; Miss Ida Pero, Treasurer; Edward Pero, Vice-president.

The Star Foundry was established in 1880 by George Crompton, and started with forty men. Double that number were employed in 1889 on all kinds of work, including steam-engines, machinists' tools and castings for building purposes, although the principal product was loom castings for the Crompton Loom Works.

Luther Shaw & Son in 1889 did a business in brass castings, and manufactured Babbitt metal and solder, also all kinds of brass composition, zinc, lead and white metal castings. They also made gong-bells, faucets and copper castings. Their product was sold throughout New England, and some of it in New York State, but the bulk of it was used in this city and county. The metals used were principally copper, tin and antimony. The business was for some years carried on by William Oakley, then by Oakley & Taylor. About fifteen years ago the firm name was Kindred & Taylor and for the past five years the business has been conducted by Walter B. Taylor at 29 Jackson Street.

Arnold & Pierce, at the Hammond Street Foundry, established in 1882, began with six men, and in 1889 employed twenty-two. They manufactured castings for the makers of machinists' tools.

The firm of A. Kabley & Co., composed of A. Kabley, Alonzo Whitcomb and F. E. Reed, located at 57 Gold Street, started with fifteen men. They supplied all the castings for the machinists' tools of F. E. Reed and Alonzo Whitcomb & Co., besides doing some general work. The business is now carried on under the patronage of the Whitcomb-Blaisdell Machine Tool Co. The foundry at 25 Southgate Street employs two hundred men.

The Standard Foundry Co. was incorporated in 1899 and has a fine plant at the corner of Gardner and Tainter Streets. This company makes a specialty of light machinery castings. The officers are F. T. Williams, president; C. F. Hutchins, vice president; T. T. Booth, treasurer. One hundred and forty men are employed.

The manufacture of machinists' tools has, for many years, had a most prominent place among the industries of Worcester. To Samuel Flagg, or, as he was more familiarly known, "Uncle Sammy Flagg," belongs the distinction of having first engaged in this business in Worcester, whither he came, from West Boylston, in 1839, to secure better facilities and to save cartage of castings which he used in his machine-shop in West Boylston, where he built tools and cotton machinery from patterns made by William A. Wheeler. He made a turning-lathe, which was the first one Mr. Wheeler had when he started his machine-shop. The ways and frame of his machine were of wood, the head and tail-box of iron.

Mr. Flagg hired room and power of Samuel Davis, the lessee of Court Mills, and there made hand and engine lathes. He had no planer when he commenced. At

that time the planing of iron was looked upon as a remarkable accomplishment. The work was done by hand-chipping and filing, which was of necessity tedious and unsatisfactory. The old Court Mills, located on Mill Brook, at the junction of Lincoln Square and what is now Union Street, was the cradle of the machinists' tools industry in Worcester, as it was of many others. Mr. Flagg started with eight or ten men, and every one thought that he was visionary to expect to keep them occupied in building machinists' tools. He was the first man in Worcester to use a planer in this business. Ruggles, Nourse & Mason, and Thomas Daniels, the inventor of the Daniels planer, were also tenants. Deacon Richard Ball was at this time Mr. Daniels' foreman.

In 1845 Thomson, Skinner & Co. succeeded to Mr. Flagg's business. They moved to Merrifield's building, and, shortly before the fire of 1854, were absorbed by the New Haven Manufacturing Company, and removed from the city. Mr. Flagg continued without a competitor until Pierson Cowie started in the old Red Mill on the Green Street location of the Crompton Loom Works. From there he removed to the then new building of Howe & Goddard, subsequently Rice, Barton & Fales, in Foster Street, and thence into the building where W. T. Merrifield's engine was located in 1889.

In 1845 or 1846 Cowie made six iron-planing machines which were driven with a common log chain passing over a drum at each end of the machine. This arrangement was, in a few years, superseded by a rack and gears. He was succeeded in 1845 or 1846 by Woodburn, Light & Co., who, in 1851, moved to Estabrook's new building at the Junction, built by Charles Wood and Col. James Estabrook. Later the firm became Wood, Light & Co., and, in 1870, built the shop subsequently occupied by

McIver Brothers, where they at one time did a very flourishing business and had the best equipped shop in New England, employing one hundred and seventy-five men. They introduced greatly improved methods for turning shafting, increasing the amount from forty to fifty feet per day to three hundred feet. They also invented and manufactured bolt-cutting machines, the best then known. Wood, Light & Co. and McIver Brothers later went out of business and the building is now part of the plant of the Wright Wire Company.

The building of railroads created an increased demand for machinists' tools, and in 1845, Samuel C. Coombs, a machinist in the employ of Phelps & Bickford, in company with R. R. Shepard and Martin Lathe, a woodworker, in the same shop, formed a copartnership under the style of S. C. Coombs & Co. They started in the Court Mills, then moved to Dr. Heywood's shop. Before they moved C. Wheelock was taken into partnership. From the Heywood shop, in Central Street, subsequently used by the Harrington Brothers as a paint shop, they removed to the Estabrook shop, where they occupied room in the northern end of the building, where their successors, the Lathe & Morse Tool Co., continued until they moved to their own building, in Gold Street, where they were located in 1889. Their business from the start was the manufacture of lathes and planers. They employed on an average about fifty hands, and their product went all over the world. The Lathe & Morse Tool Co. was succeeded by the Draper Machine Tool Co. which was later, in 1905, merged in the Whitcomb-Blaisdell Machine Tool Co. at 134 Gold Street.

The first exhibit of machinists' tools was made by S. C. Coombs & Co., at the Mechanics' Exhibition held in September, 1851. The first exhibition of the Mechanics'

Association was held in the City Hall, Tuesday, September 26, 1848, and the circular announcing it was signed by William B. Fox, William A. Wheeler, Ichabod Washburn, William N. Bickford, Freeman Upham, John Boyden and Samuel Davis.

A. & S. Thayer began at Court Mills in 1845, where they employed ten men in the manufacture of engine lathes. These were an improvement upon the lathes then in use, and attracted much attention among machinists. A. & S. Thayer moved from Court Mills into Allen & Thurber's Pistol Shop, which stood just south of Merrifield's engine-house, and was burned in 1854. They occupied the south-end basement, while Samuel Flagg & Co. occupied the north end. They afterwards moved into the Dr. Heywood building, in Central Street. While there, Sewall Thayer died. Upon his death, A. Thayer associated with him H. H. Houghton and E. C. Cleveland. They moved back into the pistol-shop, and remained in Union Street till the fire, when they removed to Washington Street (the location of the Allen Boiler Works in 1889) and continued in business until 1857, when Mr. Cleveland retired. They continued the business at the Washington Street shop until the breaking out of the war, or a little later, and were employing about one hundred and fifty men, and making some of the finest tools in the country, when the business was bought by the New York Steam-Engine Company, and continued a short time under that name, when it was moved to Passaic, N. J., and finally went out of existence.

The firm of Samuel Flagg & Co. was organized in 1847. Mr. Flagg associated with him Henry Holland and two of his former apprentices, L. W. Pond, and Ephraim H. Bellows. They started in the second floor of Heywood's building, in a room twenty feet by forty. They remained

there for a short time, until Allen & Thurber's building was ready for tenants, when they moved into the north end; they remained there until 1849, when William T. Merrifield put up his first brick building; they then moved into the same location occupied by the Wheelock Steam-Engine Company in 1889. Shortly before the fire they took the whole basement, and were burned out in 1854, when they went into the lower floor of the Goddard & Rice factory in Union Street, where they remained until the Merrifield buildings were rebuilt, to which they returned, remaining until 1861. Prior to this time Mr. Pond had bought out the others in interest. Meantime J. B. Lawrence, in 1854, built the east end of the building later occupied by the Pond Machine Tool Company. In 1861 L. W. Pond purchased this, and built the west end, and continued there until 1875, when the business was continued by the Pond Machine Tool Company, which in 1888 removed to Plainfield, N. J. While in Worcester, they maintained a high reputation for the quality of their work, excelling particularly in the production of large tools. The Pond Company is now incorporated in the Niles-Bement-Pond Co.

The brothers, Carter Whitcomb (who had been in the employ of Howe & Goddard) and Alonzo Whitcomb (who had been in the employ of S. C. Coombs & Co.) formed a copartnership under the name of Carter Whitcomb & Co., and began the manufacture of copying-presses, in 1849, in the Union Street shop of Howe & Goddard. They occupied room in Merrifield's shop prior to the fire of 1854, when they were burned out; they returned soon after the new building was completed, and later went to the Estabrook building, and from there to the location in Gold Street. This was the first successful attempt to establish in this country the busi-

ness of manufacturing copying-presses. George C. Taft had previously begun the manufacture, but continued only a short time, when it fell into the hands of the Messrs. Whitcomb. These presses were sold throughout the country, the sales, in some years, amounting to five thousand presses. From the first this company manufactured iron planers, and later commenced the manufacture of shears and punching-machines. The iron planers first made were very light and poorly constructed; the gears were cast, the cut-gear was unheard of. This company continued to make copying-presses, iron planers and shears for cutting iron plate for boilers, but their principal business was in planers. Alonzo Whitcomb purchased the interest of his brother and the Whitcomb Mfg. Co. was in 1905 merged in the Whitcomb-Blaisdell Machine Tool Co.

In 1856 Samuel Flagg organized a Machinist Tool Company, composed of Samuel Flagg, Pierson Cowie, Dexter Flagg, Lemuel G. Mason and George H. Blanchard. They continued in business only a short time, but made at their shop, in Merrifield's building, the largest lathe, with one exception, up to that time made in the country. It weighed about thirty-five tons; the length of the ways was thirty-five feet and width eight feet. They also engaged in the manufacture of machines for mortising iron, weighing six tons each, some of which were made for the government.

In the fall of 1864 Joseph A. Sawyer had a little shop in the building known as Heywood's Boot Shop, in Main Street, for repair work and the manufacture of sewing and other machines; subsequently he removed to the second floor of the Union Water Meter Shop in Hermon Street, where he manufactured shafting, pulleys and friction pulleys. In the fall of 1877 he built a shop, at 47

Hermon St. one story, forty by seventy-two feet, and in 1881 he built two additional stories to furnish room and power to let. He was the inventor of a machine for pleating cloth up to eighteen inches in width, which was sold to the Elm City Company, of New Haven, and was said to be the only practical pleating-machine ever invented. Mr. Sawyer invented many devices used in boot and shoe factories. After his death, in May, 1888, the business was continued by his son, who manufactured Sawyer's Combined Hand and Power Planer, and who also did a large business in fitting up corset and boot and shoe shops, putting up the stitching-machines and keeping them in repair. Mr. Sawyer made much automatic machinery used in the organ and reed business, and made a specialty of difficult machines for special purposes.

Parritt Blaisdell, who was with Wood, Light & Co. for fifteen years, built a shop in Jackson Street in 1865 and commenced the manufacture of machinists' tools, with four or five men. Afterwards he took into company John P. Jones, and in 1873 S. E. Hildreth. Mr. Blaisdell died in 1874. His widow sold a part of his interest to Enoch Earle. This Company was, in 1905, merged in the Whitcomb-Blaisdell Machine Tool Co. which in 1907 sold the real estate of the old Blaisdell Company to the John H. Parker Co. which later went out of business and the property was sold to the Quinsigamond Pressed Steel Co.

Whitcomb-Blaisdell Machine Tool Co., 134 Gold Street, was incorporated in June, 1905, and brought together the Whitcomb Mfg. Co., The Whitcomb Foundry Co. and P. Blaisdell & Co. and in October of the same year merged the Draper Machine Tool Co. The officers of the new Company were Alonzo W. Whitcomb, President; Charles E. Hildreth, Vice-President and Treasurer; and Ernest

T. Clary, Secretary. In October, 1915, Mr. Whitcomb disposed of his interest and in July, 1916, the following officers and directors were elected: Charles E. Hildreth, President; J. P. Holman, Leominster, Mass., Vice-President; E. T. Clary, Treasurer and Clerk. Directors, the above officers and F. A. Drury, F. C. Smith, Jr., F. G. Schofield, of Worcester, E. F. Pitman, of Boston, Mass. This company manufactures lathes and planers and employs about one hundred and fifty men in the machine shop and one hundred and fifty in the foundry, the former composed largely of Swedes, Irish and Americans and the latter of Finns, Poles and Lithuanians.

W. F. Bancroft & Co., established in 1870 by Kent & Bancroft, made self-operating spinning machinery, lathes, planers and special machinery. Later this business was sold to John Wehinger and was afterwards combined with that of N. A. Lombard & Co., now discontinued.

William H. Eddy, manufacturer of machinists' tools, established 1873, manufactured planers, twist-drills, grinding-machines, stone, bolt and gear cutters; the twist drill-grinders were his own invention; he also devised a clutch friction pulley that prevents noise in the changing of belts. Mr. Eddy was contractor for L. W. Pond for twenty-one years.

In 1872, Vernon F. Prentice, who had been for some time connected with the firm of Wood, Light & Co., with his brother, Albert F. Prentice, began the manufacture of lathes and drills under the name of A. F. Prentice & Company. The firm suffered some financial reverses in the panic of 1873, and it was found that because of the general depressed condition of business throughout the country, following that panic, there was not enough business for the firm to require the time of both brothers, and in consequence Vernon F. Prentice withdrew.

In 1875, F. E. Reed, who, from the beginning had been in charge of the office work of the firm, purchased a one-half interest. In 1877, he purchased the remaining half from Albert F. Prentice and the firm became F. E. Reed & Company.

Albert F. Prentice, with his brother Vernon F. Prentice, then started the firm of Prentice Brothers. These two concerns, the Prentice Brothers and F. E. Reed & Company continued doing business in Worcester, the F. E. Reed & Company being incorporated as the F. E. Reed Company under the laws of Massachusetts in 1894, and Prentice Brothers as Prentice Brothers Company in 1898. The business of both firms grew slowly at first, but beginning about 1890 a large foreign business materially aided both concerns. The F. E. Reed Company devoted its entire attention to the manufacture of lathes and the Reed lathe became known the world over as the Standard lathe. The Prentice Brothers Company, for a long time, confined themselves chiefly to the manufacture of drills. About 1905 they brought out their geared head lathe, which met with immediate success.

The firm of F. E. Reed & Company was originally located in French's building on Hermon Street. In 1883, the firm built a large building on Gold Street. The plant was enlarged in 1888, 1889 and 1890. The firm of Prentice Brothers was originally located in the Estabrook building on the corner of Hermon and Beacon Streets. In 1889, the business was moved to the new Crompton Associates building on Cambridge Street, the Prentice Brothers occupying this building jointly with the Powell Planer Company. In 1895, the Crompton Associates built for the Prentice Brothers the present West (steel) shop. In 1899, the Crompton Associates built another shop at the east of the original shop, and

in the same year, the Powell Planer Company having moved out, the Prentice Brothers Company took the space formerly occupied by this concern. In 1908, the Prentice Brothers Company took space formerly occupied by the Crompton-Thayer Loom Company in the Crompton Associates buildings, near them, on Cambridge Street, and when the R. L. Morgan Company ceased doing business, they took a great part of the space formerly occupied by that concern.

In April 1912, there was effected a consolidation of the F. E. Reed Company and Prentice Brothers Company, whose early history was so closely interwoven. A new corporation, the Reed-Prentice Company, with $1,250,000 of Preferred stock and $1,250,000 Common stock was formed, which took over both the above companies and also the Reed Foundry Company and the Reed & Curtis Machine Screw Company. The shops of the Crompton Associates on Cambridge Street, occupied chiefly by the Prentice Brothers Company, were purchased by the new company. In October, 1912, the Reed & Curtis Machine Screw Department was sold to J. Vernon Critchley, who organized the Critchley Machine Screw Company, which was succeeded by the R. B. Phillips Mfg. Co.

In 1914, the Common stock of the Reed-Prentice company was reduced from $1,250,000 to $750,000, making the total capitalization of the company $2,000,000. During the years 1913 and 1914, a new automatic lathe was developed, and later a milling machine and profiling machine were placed on the market. The present European war has created a great demand for the products of this company, as well as for those of all others engaged in this industry.

In August, 1914, Mr. Fuller resigned as president and at the Annual Meeting in February, 1915, Lucius J.

Knowles was elected President. The officers of the Company then were: President, Lucius J. Knowles; Vice-Presidents, George F. Fuller, Albert E. Newton; Treasurer, George Crompton; Assistant Treasurer, Henry H. Knapp; Clerk, George Crompton.

The Reed-Prentice Company at present employ about eleven hundred men and occupy a floor space of 296,554 square feet. This Company was purchased in November, 1915, by new interests and the following officers were elected: Robert F. Herrick, President; Jeremiah J. Mackin, Treasurer. The following officers were continued: Albert E. Newton, Vice-President; Henry H. Knapp, Assistant Treasurer. The Directors were Robert F. Herrick, Albert E. Newton, Henry P. Kendall, Robert C. Morse, George C. Lee, Frank A. Drury, and Homer Gage. On January 1, 1916, Joseph W. Lund took the office of Treasurer in place of Mr. Mackin, and L. W. Ware succeeded to the office of Assistant Treasurer in place of Mr. Knapp. There were no further changes until Dr. Homer Gage resigned from the directorate, and was succeeded by Malcolm F. Donald; Robert C. Morse was elected a Vice-President.

Under the names of Boynton & Plummer, 50 Lagrange Street, James Kindred, H. S. Brown and Henry Kindred, beginning in 1878, manufactured blacksmith drills, bolt-cutting machines and shaping-machines, and were pioneers in this class of work in the city. Their trade extended throughout the country and to Australia and South America. At the death of Mr. Kindred the business was sold and subsequently discontinued.

In February, 1878, E. H. Wood began to manufacture for Harwood & Quincy, of Boston, the Bramwell Feeder, which was used for feeding the wool into carding-machines. This feeder revolutionized the work of supplying carding-

machines, and was a great factor in the development of the wool-carding business. In 1881 their shop, near the Junction, was completed and the Harwood & Quincy Machine Company was formed. The Bramwell Feeder was invented by W. C. Bramwell, of Terre Haute, Ind.; the patent was owned by Harwood & Quincy, who had the exclusive manufacture of the machine. Edwin H. Wood, the superintendent of the company, was seventeen years the foreman in the shop of Daniel Tainter, formerly a well-known manufacturer of woolen machinery.

In 1879, W. C. Young began with one assistant in Mawhinney's building, No. 19 Church Street, the manufacture of shoe tools and edge planes; at one time he employed twenty hands in the manufacture of engine-lathes, wood-turning and amateur lathes, which he designed himself, exporting a large number.

J. A. Fuller, at No. 3 Cypress Street, made machinists' tools, lathes, planers and speed-lathes, employing seven men; he also manufactured bench-gears and small dynamos. The business is now discontinued.

Currier & Snyder began in 1883 in Central Street, later at 17 Hermon Street, where they manufactured upright drills. At first they employed but one hand, and later fifteen. The ease and rapidity with which their drills could be manipulated won for them a high reputation. Both the partners were for many years employed in the Blaisdell shop. The company is now known as J. E. Snyder & Son, 119 Dewey Street.

The Powell Planer Company, Edward M. Woodward, Albert M. Powell, was incorporated in 1887 for the manufacture of iron planers, shapers and other machinists' tools. It was re-organized in 1899; the capital was increased and the name of the corporation was changed to Woodward & Powell Planer Company, which is located at

99 Webster Street. Starting with thirty-five men, the company now gives employment to about one hundred skilled machinists. Since the organization in 1887 to the present time, the corporation has made a specialty of manufacturing metal planing machines making a larger variety of sizes and types than any other concern in the United States.

The company controls several patents of importance on metal planing machines and has a large trade with railroads and locomotive shops and a foreign trade which extends to Europe and the Orient. The same individuals who organized the Company in 1887, manage and control the corporation of today.

The tools made previous to 1845 were very much lighter than those made today. The beds of the engine lathes were of wood, with strips of iron bolted to them for the ways, and the carriage that held the cutting tool was operated by a chain. Gradually this was superseded by a rack and gears driven by a rod in front of the lathe. Tools have been very much increased in weight and the workmanship is much improved. There has been as great a change in the character of our shops as in their products. Then, a man was expected to begin work as soon as he could see, and to continue until nine o'clock at night, with half an hour for breakfast, an hour for dinner and half an hour for supper. Whale-oil lamps were used; these smoked badly and made the atmosphere almost unendurable. Pay came but once in six months, and then often in the form of a note,—a strong contrast with the short hours of the present day, steam heat, gas or the electric light and weekly wages in cash.

It is said that it took the observation of the farmers and the inventive genius of the mechanics of the country

from 1797 to 1842, to decide upon the best form of a plow. It was a subject that seemed to afford endless opportunity for argument and controversy. Thomas Jefferson was much interested in the subject, and in a letter written to Jonathan Williams, in July, 1796, says that he has discovered "the form of a mould-board of least resistance," that he has reduced it to practice, and that his theory is fully confirmed. He gave this subject careful study, as appears from his correspondence.

The first iron plow in Worcester County was made by William A. Wheeler, in Hardwick, in 1822, but plows of some sort were made in Worcester in 1821 and prior to that time by Oliver Wetherbee, who carried on the business in the blacksmith's shop of Levi Howe, and later at his own shop, a few rods from Captain Thomas' inn. In November, 1823, Mr. Wheeler announces that he will keep on hand all kinds of plows at his shop in Thomas Street.

In November, 1824, the committee, in reporting upon the articles exhibited at the Cattle Show, then lately held, refer to two cast-iron plows exhibited by Oliver Wetherbee, and state that they are fast superseding those of the old construction.

Burt & Merrick, in June, 1828, appear as agents of the Hitchcock plow, claimed to be superior to those previously used, and in 1829 Benjamin Butman & Co. had for sale "Nourse's Cast-Iron Plows." These plows were manufactured by J. & J. Nourse, at Shrewsbury, and were known as the Hartford Cast-Iron Plows.

In April, 1833, C. Howard's cast-iron plows are offered for sale by G. T. Rice & Co., and, at the same time, Mr. Wheeler announces that he has "just received an assortment of plow-points from the various patterns heretofore cast at Brookfield." Meantime, Joel Nourse

appears to have moved from Shrewsbury to Worcester, and to have taken a shop in Thomas Street, for in August, 1833, he there offers for sale plows of the most approved construction and of five different sizes. He also offers for sale in March, 1834, his "side-hill plows." Mr. Nourse seems to have been a successful manufacturer of plows, for in its report, the committee at the Cattle Show, in 1835, compliments him highly, and says that all the plows on the field except three were of his make.

J. Nourse & Co., March, 1836, added the manufacture of cultivators to their business, and in March, 1838, Ruggles, Nourse & Mason, a firm composed of Draper Ruggles, Joel Nourse and J. C. Mason, announce that they have made arrangements for manufacturing on an extensive scale the most improved form of cast-iron plows, and that they have secured Jethro Wood's patent on the same, and add,—"Most of the cast-iron plows are made too short, and are too concave for the mould-board to run easily." Ruggles, Nourse & Mason made plows for turning over green sward, turning over stubble; and also made three sizes of the celebrated side-hill plows; also, improved seed-sowers, improved expanded cultivators, and Coats' patent revolving hay-rake. The first plow made by Nourse and others was a clumsy affair; the mould-board and standard were of iron, the rest of wood. Ruggles, Nourse & Mason were in Thomas Street at first, about opposite the present location of the City Waterworks Shop; afterwards Samuel Davis induced them to move to Court Mills, where increased facilities enabled them to largely extend their business.

The next new implement made by Ruggles, Nourse & Mason was the Wilkes revolving horse-rake. They were constant exhibitors at the Cattle Shows, and in 1851 showed over twenty different kinds of plows. This indus-

try was a most important one. Worcester, at that time, is said to have been more largely engaged in the manufacture of agricultural implements than any other city or town in the United States, and the business had been entirely developed within a comparatively few years; for there were those living who remembered the stub hoes and wooden plows, while the sensation of first seeing the cast-iron plow was fresh in the recollection of many farmers in the county. Ruggles, Nourse & Mason at this time, 1851, occupied the Court Mills, the main building being of brick, two hundred and fifty feet long, seventy-five feet wide and four stories high, and employed about two hundred hands. The motive-power was partly steam and partly water, supplied by Mill Brook. The same turbine wheel was used for power in E. W. Vaill's chair factory as late as 1889.

The white oak timber used was furnished by Oakham, Paxton, Sterling and other towns. The iron castings were made in an adjoining building, and three tons of iron were used daily. The product was sold in Boston, where the salesroom occupied the second story in Quincy Market, and where were displayed upwards of three hundred different patterns of plows alone, to say nothing of other agricultural implements and dairy equipment.

Among the recipients of medals at the Crystal Palace Exhibition in New York, in 1854, was the Worcester Shovel Company, for Kimball's patent shovels with malleable iron sockets; and Ruggles, Nourse & Mason for Armsby's patent corn shovel, for Perry's patent meat-cutter and a vegetable-cutter; also, for double sod and subsoil plow. In 1855 they offer mowing-machines for sale.

April 1, 1856, Ruggles, Nourse & Mason were succeeded by Nourse, Mason & Company, consisting of Joel Nourse, Peter Harvey and Samuel Davis. After a time Nourse,

Mason & Company sold out to Mr. Nourse, who organized a company consisting of Joel Nourse, Peter Harvey and Sampson & Tappan, of Boston, doing business under the name of Nourse, Mason & Company. Meantime, they had started a shop at Groton Junction, where they were increasing their capacity as well as employing all the labor that could be accommodated at the Worcester factory. In 1859 they were employing two hundred and fifty hands; their pay-roll amounted to eight thousand or nine thousand dollars per month, and they had increased their power by putting in a sixty horse-power engine.

In 1860 the works were purchased by Oliver Ames & Sons, and, in 1874, moved to the large brick factory in Prescott Street, where they were in operation in 1889 under the name of the "Ames Plow Co." They manufactured all kinds of agricultural implements, power-machines, meat-cutters, etc. In 1887 they made seven thousand wheelbarrows. They made at one time seven thousand plows yearly and employed one hundred and seventy men. This company moved to South Framingham January 1, 1912, where it had built a new plant.

In 1857, J. T. Adriance & Co., manufactured Manny's improved mowing-machine, and during that year made about six hundred of them. Alzirus Brown, in 1858, also manufactured these machines and Manny's reaper, employing from forty to fifty hands.

In September, 1859, J. M. C. Armsby, who had previously been a partner in Nourse, Mason & Co., completed his building in Central Street, for the manufacture of plows, cultivators, harrows, horse-rakes, hoes, etc. It was one hundred feet long, thirty-five feet wide and four stories high, with two wings extending back—one, seventy-four and the other fifty feet. An engine of twenty-five

horse-power, made by the Putnam Machine Company, was the only piece of machinery in the building not of Worcester manufacture.

A patent was granted, December, 1861, to L. G. Kniffen, of Worcester, on his Union Mower. He formed a company for its manufacture, to be known as the Union Mowing-Machine Company, Alzirus Brown, agent.

About 1861 A. P. Richardson and A. P. Barnard organized the Buckeye Mowing Machine Company to manufacture the Ohio Buckeye Machine. They were licensed to manufacture for New England only. Richardson and Barnard separated after one or two years, the latter going to West Fitchburg. Barnard made machines for Massachusetts, Rhode Island and Connecticut, while Richardson made machines for Maine, New Hampshire and Vermont. Richardson then began making the machines under his own name. In 1865, Whitman and Miles, both from Fitchburg, bought out Richardson. The company was incorporated in 1870, keeping Richardson's name. The Presidents have been A. P. Richardson, Jared Whitman, and E. P. Curtis (who entered the business in 1864).

The Richardson Mfg. Company took over Alzirus Brown's business about 1870 and then made, besides the Buckeye, the Union Mower, which had been manufactured by Brown, the Bullard Hay Tedder and the Whitcomb Horse Rake. The Union Mower was soon abandoned. The company was first located on Central Street, in an old brick building owned by Otis Warren. Richardson & Barnard started here. In 1866, they bought a building across the street belonging to John Heywood. The Company moved to Prescott Street in 1868-70, occupying the present factory which was leased from the late Stephen Salisbury, Sr., and enlarged from

time to time. The market is exclusively in New England. The company employs about one hundred and fifty operatives.

The water privileges at New Worcester, occupied by the two factories of the Coes Wrench Company, are, historically, of considerable interest.

Captain Daniel Gookin, who was one of the commissioners appointed by the General Court, October 11, 1665, to survey the country in the vicinity of Lake Quinsigamond, to determine if there be a "meet place for a plantation, that it may be improved for that end, and not spoiled by granting of farms," was the original owner of this property, and from him the late Loring Coes' great-grandfather had a deed of this water-power and built a saw-mill at the upper dam, where previously there was a beaver dam.

On the site of the Leicester Street mill, wool and carding machinery was built from an early day. This privilege came into the hands of Moses Clements, and from him passed to William Stowell, who also made woolen machinery, carding machinery and jacks. From Stowell the privilege passed to Thomas Harbach, at one time associated with Joseph Converse, then to Edward and Martin Wilder, from whom it was purchased by L. & A. G. Coes, in 1848. At the southwest end of the Leicester Street Works was the old Clements building, of wood, two stories high and fifty or sixty feet long. It was later taken down by the Coes'. The building at the northeast end was erected by William Stowell, about 1835, and was at one time occupied by Kimball & Fuller, in the manufacture of woolen machinery. Loring and A. G. Coes were both born in New Worcester. Loring Coes, born in 1812 was, at the age of fourteen, apprenticed to Anson Braman a carpenter in Worcester. After a service

of three years he entered the employment of Solomon Putnam, a carpenter in Leicester, where he remained until he was twenty-two. After working a short time with Kimball & Fuller he made a contract with Henry Goulding to do all the wood work on the woolen machinery made by him. Aury G. Coes was born in 1817 and also worked for Kimball & Fuller. In 1836 the brothers formed a copartnership and purchased the Kimball & Fuller business, which, meantime, in November, 1835, had been moved from New Worcester to Court Mills. Here they continued until October, 1839, when the Court Mills were destroyed by fire. This loss so far impaired their capital as to prevent their starting again. Their fellow-tenants also burned out were, Samuel Davis, builder of woolen machinery; Ruggles, Nourse & Mason, manufacturers of plows and agricultural implements; H. W. Miller, punching-machines for manufacturing nuts, washers, etc., and Thomas E. Daniels, builder of planing-machines.

After the fire the brothers went to Springfield, Mass., and engaged as pattern-makers in the foundry of Laurin Trask;[1] while there employed they made a model of a new and improved form of the wrench, a tool which they constantly used. There were at that time two styles—one of English invention, and the other known as the Merrick or Springfield wrench. The mechanism of both these wrenches was such that both hands were used to open or close them. This was often inconvenient, as it was important to so adjust the wrench to different openings, by the hand in which it was held, as to leave the other hand free for other demands of the work. It occurred to the Coes Brothers to dispense with the screw on the shaft, as in the Merrick wrench, and affix by the

[1] Van Slyck, "New England Manufacturers and Manufactories."

side of the shaft, a small bar in the form of a screw, which should enter another screw formed in the lower or movable jaw of the wrench; and that the first screw should also have, at its lower end, where it should enter the handle, a rosette always in reach of the thumb of the hand that held the wrench. This rosette, being pressed and turned by the thumb would operate the screw, and the opening and closing of the wrench would easily be effected by one hand. It seemed to them that this adjustment would make the tool much stronger by removing the indentations from the bar or shaft, and that there would be less liability of injury to the wrench from severe or improper use.

In November, 1840, they returned to Worcester, and at once directed their efforts to securing a patent for their invention. The patterns of their spinning machinery had been saved from the fire, and these they sold to Samuel Davis, a manufacturer of woolen machinery, and so obtained the means for securing a patent, which was granted to Loring Coes, April 16, 1841. The brothers now formed a copartnership under the name of L. & A. G. Coes, for the manufacture of wrenches under this patent. They were without capital, and Henry W. Miller, a hardware dealer in Worcester, aided them by fitting up a shop (in the northwest end of Court Mill, in Mr. Miller's shop), with the requisite machinery and tools, of which he retained the ownership, taking and selling all the wrenches manufactured by the Messrs. Coes. The business was so far successful that early in 1843 they were able to purchase the machinery and tools. They were now employing three hands, and made a contract with C. Foster & Co. to sell their goods. The next winter (1843-44) they moved to the shop of Albert Curtis, in New Worcester. They leased a basement in one of Mr. Curtis' buildings

and he built them a blacksmith shop, and put in a trip-hammer for their use.

At the close of their contract with C. Foster & Co., April 1, 1848, they entered into a contract for five years with Ruggles, Nourse & Mason. At this time, also, they bought for fifty-five hundred dollars the old woolen-mill in which they had both worked in their youth—the water privilege, two houses and about four acres of land. They were now employing from twelve to fifteen men, and making from five to six hundred wrenches a month. They repaired and raised the mill and put in a new water-wheel and new machinery.

"Their contract with Ruggles, Nourse & Mason expired, by limitation, April 1, 1853, and they thenceforward sold their own goods. They had, during the twelve years since their first patent was granted, devised, individually or jointly, various improvements in the wrenches and in the special machinery used in their manufacture.

"On July 21, 1853, with Levi Hardy, they purchased from Moses Clement his shop, machinery and business —that of the manufacture of shear-blades and knives for hay-cutting machines. The copartnership continued until May 2, 1864. After the dissolution of their co-partnership, having purchased Mr. Hardy's interest in it, they continued the business, with Charles A. Hardy as the superintendent of the shop, keeping its accounts distinct from those of the wrench business.

"In 1865 they built a dam half a mile above their water privilege, to form a reservoir, and the next year they built a shop at the reservoir, one hundred feet by forty, two stories high, with a basement, devoting it exclusively to the manufacture of shear-blades, hay-cutter knives and similar articles. In 1867 they built a new dam one hundred rods below the reservoir.

"On April 1, 1869, they dissolved their copartnership and divided the business—Loring Coes taking the upper privilege, including the shear-blade business, and A. G. Coes taking the lower privilege, and paying a bonus for the right of choice. At this time they sold monthly from six to nine thousand wrenches.[1]

L. Coes & Company erected the large brick factory at the lower dam, one hundred feet long, fifty feet wide and four stories high, with basement and attic. The building, with the machinery to be used in it, was finished early in 1871.

The Coes Wrench Company is a consolidation of the two companies, which was effected April 1, 1888, with Loring Coes, president; John H. Coes, treasurer, and Frederick L. Coes, secretary—the two latter, sons of A. G Coes. They manufactured wrenches under patents of Loring Coes, dated July 6, 1880, and July 8, 1884. In 1889 they produced fifteen hundred wrenches per day and employed one hundred hands.

At the outlet of the upper pond Loring Coes carried on quite an extensive business in the manufacture of die stock for cutting sole-leather and other purposes. He also made shear-blades, knives for meat, cheese-cutters and lawn-mower knives. He had a trip-hammer in this shop, and the old rolling-mill, used for making plane irons, by William Hovey, on the mill dam in Boston many years ago. A little before the ninetieth anniversary of his birth, Loring Coes bought the interests of his other partners and consolidated his manufacturing enterprises. Mr. Coes died in 1907. The machine knives are now made under the name of Loring Coes & Co. and the wrenches under the name of Coes Wrench Co.

L. Hardy & Co., at New Worcester, conducted by Henry A. Hoyt, manufactured shear-blades, die stock for

[1] Van Slyck, "New England Manufacturers and Manufactories."

cutters, etc., and John Jacques, at New Worcester, manufactured patent shears for book-makers, binders, printers and paper-box makers; also shears for tin-plate workers.

Other manufacturers of wrenches, in a small way, have engaged in the business from time to time. In April, 1852, E. F. Dixie advertises to manufacture "Hewet's celebrated screw-wrench." George C. Taft and John Gleason manufactured wrenches, in connection with copying-presses, at Northville, in 1853. B. F. Joslyn, who seems to have been a most ingenious mechanic, and who made several inventions in fire-arms, made several improvements in wrenches, and on one of these, at least, procured a patent.

Ruggles, Nourse & Mason, who were at one time selling agents for the Coes', manufactured wrenches in 1859, in connection with the business in agricultural implements.

CHAPTER V

Wire—Wire-Workers—Wire Producing Machinery—Copperas.

In the latter half of the eighteenth century the desirability of commencing the manufacture of wire in this country was very generally recognized. But little progress was made for some years, and most, if not all, of the card-wire was imported from England. In fact, at this time there was very little wire made in the world. From a well-authenticated source the assertion is made that in 1810 the entire output of wire in England would not exceed one four-horse load weekly. From the report of Albert Gallatin, then Secretary of the Treasury, made in 1810, it appears that the demand for cards was twice as much in 1809 as in 1808, and was increasing.

The wire is imported, and serious inconvenience would attend the stoppage of the supply, although the manufacture might, and would be immediately established to supply all demands, if the same duty were laid on wire, now free, as on other articles of the same material.

In the early days the hardware dealers of Worcester imported their wire from England or Germany. Wire was drawn in Walpole, soon after the Revolution, by Eleazar Smith, and card-wire was drawn by hand in Leicester as early as 1809. In 1813 mention is made of a wire factory, run by Joseph White, in West Boylston; in April, 1814, of its manufacture in Phillipston, and in the same year a wire factory is advertised for sale at Barre, on the Ware River. Prior to 1815 a building on the old site of the Coes Wrench Factory, on Leicester Street, New Worcester, was occupied as a wire factory. Wire was drawn in Spencer between 1815 and 1820. Its manufacture in Worcester was begun in 1831 by Ichabod

Washburn and Benjamin Goddard, in a wooden factory at Northville. This was on the second privilege south of North Pond dam, and was built by Frederick W. Paine. The factory now standing on this site is the third one built there, the two preceding having been burned.

Ichabod Washburn first engaged in business in Worcester in 1820, with William H. Howard, in the manufacture of woolen machinery and lead pipe. Mr. Howard purchased his half of the business, which he continued. The demand for woolen machinery increasing, Mr. Washburn, in 1822, took as partner Benjamin Goddard, the firm being Washburn & Goddard, and they soon employed thirty men. They made the first condenser and long-roll spinning-jack ever made in Worcester County, and among the first in the country. Any one passing in Main Street, by the head of School Street, in the year 1822, might have seen projecting from one of the large sycamore trees standing there, the following sign:—Wool Carding and Lead Aqueduct Manufactory, with a hand pointing down the street to Washburn & Goddard's shop, on the site later occupied by N. A. Lombard's building, and near the site of the factory for the manufacture of corduroys and fustians, occupied in 1789 by Samuel Brazer.

During the winter of 1830-31 Mr. Washburn, in a small wooden building, back of the brick part of N. A. Lombard's factory, in School Street, experimented in the manufacture of wood-screws. Some time during the year 1831, Mr. Washburn, Mr. Goddard and General Heard visited North Providence, where three brothers—Clement O., Curtis and Henry Read—were making wood-screws under a patent which they owned. An arrangement was made with the Reads, and they moved the screw machinery to the Northville Factory at Worcester. It was brought from Providence on a canal-boat, the journey occupying three days.

Meantime, in August, 1831, Washburn & Goddard sold their business in School Street, and moved to Northville, where the manufacture of wire and wood-screws was begun, the wire being manufactured by Washburn & Goddard, the screws under the name of C. Read & Co., with whom Mr. Washburn had an interest. Washburn & Goddard at the same time manufactured card-wire. Some time between April, 1836, and March, 1837, the screw business was removed to Providence, where it continued for a time under the name of C. Read & Co., but ultimately became the nucleus of the Eagle, now the American Screw Company, which has since acquired a world-wide reputation.

Mr. Washburn states, in his autobiography, that the first wire-machine he ever saw was one of self-acting pincers, drawing the wire through the die about a foot, then passing back and drawing another foot. With this crude machine a man could draw about fifty pounds of wire per day. For this Mr. Washburn substituted the wire-block, which is in use at the present time. The process of wire-drawing consists in taking a coarse wire rod and drawing it through a hole of less diameter than the rod, in an iron or steel plate, and repeating the operation until the rod is reduced to wire of the required size. The reduction is effected by stretching the wire, and not by removing the metal. In 1889 a piece of steel four inches square and three feet long was rolled into a two hundred pound coil of No. 6 rods, measuring about two thousand and forty-six feet. This rod, by the process of drawing from No. 6 to No. 12, was increased in length to 6,848 feet. The diameter of the No. 12 wire was .105, while the billet from which it was made had a sectional area of sixteen square inches.

Mr. Washburn, at this time, happened to be in New York, when Phelps, Dodge & Co., with whom he had business, said to him that they were starting a wire-mill, and expected to make all the wire that would be wanted in the country, and predicted failure for his mill in Worcester.

January 30, 1835, the partnership was dissolved, Mr. Goddard retaining the factory at Northville for the manufacture of woolen machinery, while Mr. Washburn continued the wire business in a factory built for him, by the late Stephen Salisbury, on Mill Brook, which was dammed for the purpose of providing water-power, thus forming what is now known as Salisbury's Pond. The earth removed to make a basin for the pond forms the high ground now found upon the south side and included within the boundaries of Institute Park. The building erected by Mr. Salisbury was eighty feet long and forty feet in width, three stories high in the center, with a sloping roof, two chimneys and surmounted by a cupola containing a bell. In 1835 Charles Washburn, who was graduated from Brown University in the class of 1820, came from Harrison, Me., where he was practicing law, and formed a copartnership with his brother Ichabod, which continued until January 13, 1838. Meantime Benjamin Goddard discontinued the manufacture of woolen machinery, and the Northville mill came into Mr. Washburn's possession. He then made a contract with Mr. Goddard to draw wire for him, and wire machinery was again set up in the Northville factory. About the year 1840 Mr. Washburn bought the water power and property occupied in 1889 by the Worcester Wire Company at South Worcester, now the central works of the American Steel & Wire Co. Mr. Goddard took charge of the mill, and retained that position until

his death, in 1867. All three of his sons worked there—Delano, who afterwards became the accomplished editor of the *Boston Advertiser;* Henry, who later was at the head of an important department at the works of the Washburn & Moen Manufacturing Company; and Dorrance, who for many years was superintendent of the South Works of the corporation. The South Worcester Mill was a one-story building, about fifty feet long and thirty feet wide. Card-wire was here drawn to No. 19 size, and brought to Grove Street to be finished. Coarser wire, for machinery and telegraph purposes, was also drawn at South Worcester.

At the Worcester County Cattle Show, held in October, 1838, Ichabod Washburn exhibited very excellent wire, Nos. 30, 31, 32 and 33, and also iron wire cards.

In 1842 Charles Washburn again became a partner in the business. February 13, 1845, the old wire-mill in Northville, then used as a cotton-factory and occupied by William Crompton, was totally destroyed by fire.

In February, 1847, Prouty & Earle had a wire-factory at Washington Square; subsequently it was purchased by I. & C. Washburn.

At this time the demand for telegraph-wire commenced. From 1847 until 1859 it was mainly of No. 9 size, Stubs' gauge. It was not galvanized at first, but was sometimes painted or boiled in oil, for the purpose of retarding the inevitable process of oxidation. A more complete preservative was later found in zinc, applied by the process known as galvanzing. At first this was somewhat crude, and consisted in dipping the coils of wire in molten zinc, after which the surplus metal was shaken off by violent pounding.

From 1837 until 1847 Ichabod Washburn purchased in Sweden his wire-rod billets, which were bars of iron about

twelve feet long, one and one-eighth inch square in section. These were rolled into wire rods at Fall River, Troy and Windsor Locks, Conn. The inconvenience of having the rolling done at a distance led Ichabod and Charles Washburn, in 1847, to look about for a location for a rolling-mill.

Attracted by the water-power at Quinsigamond, a small part of which was then used by the lower paper-mill remaining at that place, they purchased the whole property of the Lincoln family, thus acquiring what they deemed reliable power, and, at the same time, plenty of room for the location of all the buildings necessary for their purposes. Under their patronage a new firm was organized to carry on the rod-rolling and wire business, under the title of Washburn, Moen & Co., a firm composed of Henry S. Washburn, Charles Washburn and Philip L. Moen. This company was dissolved January 12, 1849, the business being continued by Henry S. Washburn.

January 1, 1849, the copartnership theretofore existing between I. & C. Washburn was dissolved, the manufacture of wire in its various branches being continued at the Grove Street mill by Ichabod Washburn. A division of the property was had, Charles Washburn taking Quinsigamond. February 9, 1849, he offered to rent for a term of years "the building with water-power sufficient for driving machinery for a sash and blind factory, or any other business not requiring a very great water-power." At the same time he offers for sale the entire machinery for the manufacture of paper in the said building. This was the lower of the two paper-mills, which for many years had been run at this point by the Burbanks, and was located in what was known as the scrap-yard of the Washburn & Moen Manufacturing Company, now the

American Steel & Wire Co., about forty feet south of a well, which was in use for a long time and afforded water for the operatives in the paper-mill. The end of the mill was parallel with the railroad, and was only separated from it by the width of the old race-way, and stood at a point about four hundred and sixty feet southeast of the traveled highway, as it crossed the railroad.

April 1, 1850, Philip L. Moen became a partner with Ichabod Washburn, his father-in-law, and was actively engaged in the business from that time.

In July, 1851, a Mr. Adams had a wire-factory opposite the Norwich depot, but no further notice of it is to be found.

January 2, 1853, Henry S. Washburn formed a copartnership with Charles F. Washburn, and they continued at Quinsigamond rolling rods and manufacturing iron and wire under the firm-name of Henry S. Washburn & Co. Meantime, Ichabod Washburn had made considerable progress in the manufacture of wire, particularly of card-wire, introducing new and improved processes. This was made of Swedish bars one and one-quarter inches square, which were rolled at Quinsigamond into wire rods of a little less than one-quarter of an inch in diameter; they were then carried to the wire factories at South Worcester and Grove Street, and drawn to the necessary sizes. The capacity of this rolling mill was about six long tons per day of ten hours.

Early in his experience as a wire-drawer Mr. Washburn adopted an improved process for annealing,—that is, restoring the wire, as it became hard and brittle, by repeated drawing, to its original soft and pliable condition, by heating in cast-iron pots and cooling slowly—this improvement consisted in placing the small coils in double air-tight iron pots.

In 1850, at the suggestion of Mr. Chickering, of Boston, Mr. Washburn devoted his attention to the production of steel wire for piano-fortes, the manufacture of which had been previously monopolized by several English houses. These experiments were successful; and the English wire was discarded for that made in Worcester. From that time on the Washburn & Moen Company was for many years the only manufacturer of music-wire in this country.

In February, 1856, the Quinsigamond Mills consisted of a building one hundred and fifty feet front with two wings extending back one hundred and fifty feet, between which was a hoop building, sixty by thirty feet; these with coal-houses and yards covered more than an acre of ground. Here were manufactured Brazer's screws, rivet rods, bright and annealed market and telegraph, spring, fence, buckle and bail wire; also fine hoops. The daily product was ten tons; eighty-five operatives were employed and one hundred horse-power was supplied by three water-wheels. The annual product of the mill was valued at three hundred thousand dollars.

The first continuous tempering done by Ichabod Washburn was in 1856, in the rear of his Summer Street residence; this was music wire, and the hardening was done in water. Early in 1857 the furnace was removed to the old gymnasium in Orchard Street and oil was substituted for water. This series of experiments led to an important invention in the process of hardening and tempering continuously. Hitherto this had only been done when the steel wire was in the form of a coil by subjecting it first to high heat, and then cooling in oil or water. But the pressure for music wire and for crinoline wire now coming, the old process became too slow and expensive to be endured, and it became necessary to adopt

some more efficient method. This was found in the continuous process of hardening and tempering, which Mr. Washburn patented, and which, without any substantial improvement or change has been universally adopted, rendering possible many results which could not otherwise have been reached.

In 1857 the partnership of Henry S. Washburn and Charles F. Washburn was dissolved, and May 1, of that year, Charles Washburn and Charles F. Washburn formed a copartnership under the name of Charles Washburn & Son, and continued in business at the Quinsigamond Works. Henry S. Washburn remained in the wire business, and occupied as a factory one of the buildings erected by Nathan Washburn near the freight depot of the Western Railroad.

C. Washburn & Son then manufactured most of their common market wire from scrap iron piled on boards eighteen by eight inches, heated to a welding heat, and rolled into billets which were re-heated and rolled into rods. The only appliances in their mills for the production of wire rods were three heating furnaces and a large train of two rolls, in which the pile of heated scrap was rolled to one and one-eighth inch billets of one hundred pounds weight; and a small train of rolls three high, by which these billets were rolled to three and a half by four, Stubs' gauge, wire rods. Experiments in the burning of peat were made by Henry S. Washburn & Co., and by I. Washburn & Co., but it did not prove a satisfactory substitute for coal.

In 1856 the Grove Street mill was known as Worcester Wire Works, Ichabod Washburn & Co.—Ichabod Washburn and Philip L. Moen—Proprietors.

In July 1859, I. Washburn & Company employed one hundred and twenty hands in the Grove Street mill,

and made three tons of iron wire per day. They were erecting a new mill three stories high, eighty feet by forty feet, and were also making large additions to the mill in South Worcester; a new annealing house, fifty feet by thirty feet, two stories high, together with additions to the main building.

The crinoline wire business commenced about 1859 and lasted for ten years. This was made possible by the continuous hardening and tempering process invented by Mr. Washburn, which made it feasible to temper a cheaper grade of cast steel at very little additional cost, and thus substitute it for the more expensive methods before used for increasing the size of women's skirts. This enabled the skirt-makers to put their goods on the market furnished with steel hoops of great toughness and elasticity, and at a price which put them within the reach of the poorest; consequently, this line of business was largely increased until about 1870, when other fashions came into vogue and the consumption of tempered steel in this form steadily decreased. For several years the output of tempered crinoline wire was one thousand five hundred tons annually, making this company the largest consumer of cast steel in the country.

About 1860 Mr. Washburn introduced continuous annealing, cleaning and galvanizing. This was an English invention and a great improvement upon the processes previously used, being of especial value at that time in the manufacture of telegraph wire.

In November, 1862, the iron and wire works of Charles Washburn & Son, Quinsigamond, were totally destroyed by fire.

In 1863 I. Washburn & Moen built a cotton-mill, which was run for about ten years, producing yarn sufficient to cover four tons per day of tempered crinoline

wire. In 1864 I. Washburn & Moen controlled the works at Grove Street and South Worcester, but had no rolling-mill. Their business was confined to iron and cast steel of different grades, Bessemer steel and open-hearth steel being introduced many years later.

January 2, 1865, I. Washburn & Moen changed the copartnership to a corporation under the style of I. Washburn & Moen Wire Works, organized for the purpose of manufacturing wire and wire rods. Capital stock, $500,000. August 4, 1865, the Quinsigamond Iron & Wire Works, which succeeded to the business of Charles Washburn & Son, was organized. November 27, 1866, a petition was filed to form a corporation "for making wire and wire rods, cotton yarn and goods, with a capital larger than at present allowed." The petitioners asked to be incorporated under the title of Washburn & Moen Wire Works, with a capital of $600,000.

July 7, 1867, the mill at South Worcester was burned and the business was conducted at Grove Street until March, 1868, when a new mill at South Worcester was in readiness. About a year and one-half from that time the company commenced the erection of most of the present buildings in Grove Street. Meantime, February 24, 1868, the Quinsigamond Iron & Wire Works and the Washburn & Moen Wire Works were consolidated under the name of the Washburn & Moen Manufacturing Company, with a capital of $1,000,000. Authority to increase this amount to $1,500,000 was granted May 26, 1869.

In the fall of 1869 was built the first rolling-mill, at Grove Street. This was a "Continuous Mill," so called, and was in its essential features an English invention. The adoption of Bessemer steel, which occurred in 1876, created a revolution in the wire business, substituting, as it did, a better and cheaper material for very many pur-

poses. This occurred at the beginning of the barbed wire business. The use of Bessemer steel for this purpose alone, besides furnishing a stronger wire than could be made from Swedish iron, represented a saving of at least four million, five hundred thousand dollars annually to the farmers of the country.

The importance of the fence question to the people of the United States can perhaps be best appreciated by a mere statement of the results contained in the Report of the United States Department of Agriculture for 1871, from which it appears that the cost of fencing in thirty-seven States had amounted to $1,747,549,931, while the annual cost of repairs amounted to $93,963,187.

The cost of fencing per rod, as stated in this report, varies from thirty cents in Alabama to $2.20 in Rhode Island. In addition, a fence occupies and wastes, upon an average, a piece of land half a rod wide, or one acre in every fifty, making a total of not less than 50,000,000 acres in the United States. Not only was the expense of fencing with timber enormous, but apprehension was felt that the supply might be unequal to the demands made upon it. Wire as a fencing material was recommended as early as 1821. Speaking of the wastefulness of the common method of wooden-fencing, the secretary of the New York State Agricultural Society for 1850 stated that the worm-fence took "from every one hundred acres an area of five acres."

The substitution of wire for wood as a fencing material was generally recommended on the ground that it takes up no room, exhausts no soil, shades no vegetation, is proof against high winds, makes no snow-drifts, and is both durable and cheap. As the necessity for a cheap fencing material increased, efforts to supply the need also increased. Up to 1881 twelve hundred and twenty-nine

patents had been issued relating to fencing, and more than two-thirds of that number since 1865. The first patent was in 1801, and up to 1857 about one hundred had been issued, while in 1866, '67 and '68 three hundred and sixty-eight fence patents were issued.

In examining the patents issued it is found that of the twelve hundred and twenty-nine issued up to 1881 forty were to inventors in the New England States; three hundred and seventy-two to the Middle States; one hundred and eight to the Southern States; and six hundred and ninety-six to the Western States; eight to the District of Columbia and five to Canada. Of the States, Ohio had the greatest number, two hundred and forty-one; followed by New York, two hundred and thirty-one; Illinois, one hundred and forty-two; Iowa, ninety-six.

Up to 1873 plain No. 9 round wire was largely used in the West as a fencing material and thousands of tons of it were in use, but it was not satisfactory. It stretched in warm and contracted in cold weather, which was the cause of constant breakages; furthermore, cattle could rub against it with impunity, and this constant pressure loosened the posts and broke the wire.

In the fall of 1873 the manufacture of barbed wire was begun in a small way at De Kalb, Ill., by J. F. Glidden, who was a farmer in that town. He first made a few rods of fencing and put it up on his own farm in November, 1873. The process was very crude when compared with the present method of manufacture. The barbs were first formed by bending around a mandril and then slipped upon one wire of the fence; the second wire was then intertwisted with the first; this locked the barbs in place and prevented lateral as well as rotary motion. The fencing was made in sixteen-foot lengths, and as there was no means for coiling it on spools for transportation, it was

carried to the point where it was to be put up, and then enough of these sixteen-foot lengths were spliced together to give a fence of the desired length. The first piece actually sold for use was in the spring of 1874. Three boys and two men were able to make fifty pounds per day. In June, 1874, it was arranged to do the twisting by horse-power, and this increased the product of three boys and two men to one hundred and fifty pounds per day.

In the latter part of 1874 a rude hand-machine was devised for twisting the barb upon the main wire and spooling the product, which was subsequently unwound and twisted with a second wire and then spooled again. By the use of the latest machinery, one man could produce, in 1889, two thousand pounds, or over five and a half miles, in ten hours.

In the spring of 1876, upon the urgent advice of Charles F. Washburn, an officer of the company who believed that the introduction of barbed wire would solve the fencing problem for the farmers of the west, the Washburn & Moen Mfg. Co. caused automatic machinery to be constructed and patented and in conjunction with Isaac L. Ellwood, of De Kalb, Illinois, acquired control of the underlying barbed-wire patents. These patents were,—one to L. B. Smith, of Ohio (June 25, 1867), in which the barb consists of four radially projecting points from a hub, which is prevented from moving laterally by a bend in the main wire. Patent granted to W. D. Hunt, of New York, in which a single fence wire is armed with spur-wheels which can revolve upon the main wire. Patent to Michael Kelly, of New York, dated February 11, 1868; this is the first patent to show two wires twisted together. The barb was made of a lozenge-shaped piece of sheet metal and was strung upon the main wire, while for strength, a second wire was intertwisted with the

first. This inventor showed a most intelligent conception of the subject matter of his invention, as appears from the following quotation taken from his specifications:

> I can, by this invention, make an efficient fence from unconnected wires, six inches apart, fixing the artificial thorns on the wires four inches apart. This fence takes only one-fourth as much wire as in ordinary wire fences, yet it is more efficient. This fence will weigh about one-eighth as much as ordinary connected wire fence, by which I mean those woven or twisted together. It can be wound on a reel, like telegraph wire, and a farmer can transport as much in a single wagon-load as will serve to build fences for a large farm.

The next patent in point of date, and chief in importance, is the patent to Glidden, dated November 24, 1874, in which is for the first time found a barb made of wire wrapped about a fence wire, and locked in place by a fellow wire intertwisted with the first. Meantime, barbed wire was growing in popularity; at first, strong prejudices had to be overcome. Many hardware dealers would not have it in their stores. The public, too, had to be educated. A length of barbed wire, with two barbs upon it, was shown to two men in Texas; one guessed it was a model of a fence, the barbs being the posts, and another thought it was a bit for a horse. A skeptical farmer said he didn't believe it amounted to much; that he had a bull (Old Jim) who would go through anything, and he guessed he wouldn't stop for barbed wire. His field was fenced; "Old Jim" shook his head, elevated his tail, and went for it. The farmer was converted, and so was "Jim."

Barbed wire, once introduced, grew rapidly in favor. In fact, it became a necessity; strong, durable, cheap, easily transported, and an absolute barrier against man and beast, it became at once the best fencing material known, and the demand for it rapidly increased. Meantime, infringers began to spring up, and litigation fol-

lowed. No stronger or more persistent efforts were ever made to break down a patent property than were directed against the barbed wire patents. Thousands of pages of testimony were taken upon alleged cases of prior use all over the West and in Texas. The greatest interest was taken in the cases involving, as they did, the control of what even then bade fair to be a most important industry.

The defence relied upon establishing the alleged cases of prior use, and also insisted strongly that there was no invention in arming a wire with pricking spurs. The United States Circuit Court for the Northern District of Illinois, in December, 1880, sustained the patents, and this gave the Washburn & Moen Manufacturing Company, and their associate, Isaac L. Ellwood, of De Kalb, Ill., the control of this business. Licenses were issued to most of the parties lately infringing. To protect themselves and their licensees, the Washburn & Moen Manufacturing Company purchased upward of two hundred and fifty patents upon barbed wire and barbed wire machinery.

The amount of barbed wire consumed in this country increased from five tons, in 1874, to a probable output of one hundred and fifty thousand tons, over eight hundred and fifty thousand miles, in 1888. Of this amount, the Washburn & Moen Manufacturing Company made about eighteen thousand tons, over one hundred thousand miles, while the capacity of their works was seventy-five tons per day of ten hours, or four hundred and twenty-six miles. The cost to the consumer during that time was reduced from eighteen cents per pound to less than five cents. This resulted from the reduced price of wire and the introduction of automatic machinery.

About the time that barbed wire began to be manufactured the company became the owners of patents upon

bale ties, a wire substitute for the wood and rope previously used. There were, in 1889, probably ten thousand tons used annually for binding hay in the United States. Each ton of wire would bind three hundred and thirty tons of hay or straw, and the whole ten thousand tons of wire would bind three million three hundred thousand tons of hay and straw.

It formerly cost on an average to press this amount, when bound with rope, two dollars per ton. Wire was applied to the bales with so much greater ease than wood or rope, that a saving of fifty cents per ton, at a low estimate, was effected in pressing hay when wire ties were used. But the greatest saving made to the public by the introduction of wire for binding purposes was in the increased security against loss by fire. When hay, straw or tow are bound with rope or wood, each is easily set on fire, the binding material burns, and thus allows the compressed mass to become loose and add fuel to the flames. This, of course, is not the case when wire is used. For this reason, rope and wood were discarded many years ago in pressing cotton. Altogether, millions of dollars are saved annually to the public by the introduction of wire ties, all of which was effected in the twelve or fourteen years preceding 1889.

After 1884 copper wire took a prominent place among the products of this company, as it was largely substituted for iron, particularly in long-distance telephoning and electric lighting. Copper has always been preferred to iron for electric purposes by reason of its greater conductivity, but previous to the introduction of hard-drawn copper wire it did not possess the requisite strength. By this process a copper wire of sufficient strength could be produced much lighter than iron, and of largely increased conductivity, as is apparent when the fact is

stated that for a given length of wire an equal degree of conductivity will require five times as much weight in a mile of iron as of copper wire.

In January, 1884, there were probably not more than one hundred or two hundred miles of hard-drawn copper wire in use in this country. In 1889 there were at least fifty thousand miles, representing about four thousand two hundred tons of metal, in operation by the various telegraph and telephone companies,[1] the average weight per mile being about one hundred and seventy pounds.[2] The larger sizes of copper wire are used in connection with electric railways.

Among the specialties introduced by the company was wire rope, of which it manufactured: galvanized steel wire cable for suspension bridges; phosphor-bronze and copper wire rope; transmission and standing rope; galvanized wire seizing; hoisting rope; tiller rope; switch rope; copper, iron and tinned sash cord wire; clothes-lines and picture-cords; galvanized iron wire rope for ships' rigging; galvanized crucible cast-steel wire rope for yachts' rigging. The rapid introduction of cable railways about 1889 created another demand for wire rope.

The manufacture of wire nails was another branch of business conducted by the company. The wire nail, as an article of manufacture, was scarcely known in this country in 1879. Since that time it has come into general use, and it is estimated upon good authority that in 1889 more wire nails were used than cut nails. The variety was very large, running from three-sixteenths of an inch,

[1] A memorandum found among the papers of the late Charles F. Washburn states that the first experiments in talking through a telephone wire on the premises of the Washburn-Moen Mfg. Co. were in the month of March, 1876, with a No. 20 bright iron wire laid on the floor of all the rooms in the lower story from the rolling mills into the office of Charles H. Morgan, Superintendent at 94 Grove Street.

[2] "Pocket Hand-Book of Copper and Iron Wire," published by W. & M. Manufacturing Company, 1888.

made from No. 22 iron, to a length of fourteen inches, made from No. 000 wire. It is a little remarkable that the introduction of two articles of manufacture—barbed wire and wire nails—should within the fifteen years preceding 1889 have created a new demand for wire, amounting to at least two hundred and seventy-five thousand tons per annum, which was made possible by the use of Bessemer steel.

While the process of drawing wire is, in principle, the same as practiced eighty years ago, many improvements have been made leading to a largely increased relative product. Great advances have been made in certain of the mechanical processes, particularly in the rolling of wire rods. In 1846 the first rolling mill at Quinsigamond produced about five tons of No. 4 rods in ten hours; in 1889 the output was from forty to fifty tons in the same time and the present output is much greater.

The demand for wire and the purposes for which it was used increased rapidly as indicated by the output of two hundred and forty-five tons daily in 1889 and the manufacture of four hundred and eighteen different kinds of wire. The increase in the business of the corporation was most rapid after the introduction of barbed wire. In 1875 the number of hands employed was seven hundred; in 1880 two thousand one hundred, and in 1889, there were three thousand names on the pay-roll of the company, for the most part heads of families, supporting directly not less than thirteen thousand persons, and indirectly, a much larger number. Of the operatives at that time one thousand were Irish; nine hundred Swedes; five hundred Americans; two hundred and thirty-six Armenians; forty-five Germans; other nationalities, three hundred and nineteen.

The buildings of the corporation at that time covered twenty-five acres of ground, and the machinery was driven by engines of seven thousand two hundred horse-power. The officers of the corporation in 1889 were Philip L. Moen, president and treasurer; Charles F. Washburn, vice-president and secretary; Philip W. Moen, assistant treasurer and general superintendent; Charles G. Washburn, assistant secretary and counsel. The above, with George T. Dewey, Esq., constituted the board of directors.

The capital stock was increased May 27, 1890, to $2,000,000.00, on May 31, 1892, to $2,500,000.00; on Feb. 27, 1898, to $3,000,000.00; on May 29, 1894, to $3,500,000.00; and on May 26, 1896, to $4,000,000.00. The Washburn & Moen Mfg. Co. was bought by the American Steel & Wire Co. on March 11, 1899, and on April 1, 1901, the American Steel & Wire Co. became merged in the United States Steel Corporation. The business is conducted by the American Steel & Wire Company under its own name and with a separate organization.

In 1890 the Company commenced the manufacture of insulated wires in two buildings rented on Union Street, and in order to meet the increasing demand in electrical fields they built, two years later at Quinsigamond, a factory equipped for the manufacture of all kinds of insulated wires for electrical purposes and cables insulated with paper or rubber, lead encased, steel armoured, or protected in any way, for aerial, underground, or submarine service in connection with incandescent lighting or transmission or power.

During the early 90's the Company commenced to manufacture copper rail bonds for bonding the rails of electric railroads and their factory is now the largest and

best equipped in the world. Four styles of rail bonds are now being made, Crown, United States, Multi Terminal and Soldered, all protected by patents. Complete outfits of high grade tools for installing these bonds are also manufactured. These rail bonds have been introduced into every state and territory and in every city in the United States, and have been largely exported to Canada, Europe and other countries. In 1891, the Company erected at Quinsigamond a large factory for the manufacture of springs of every description, fine and heavy, including furniture, agricultural, motor and car springs. On May 19, 1894, the Company leased from Waldo Lincoln the Venetian Red & Copperas Works on Hammond St., and later purchased the machinery, which was moved in 1897 to a building erected for the manufacture of copperas and Venetian red. At the end of the year, 1906, the Company ceased making the Venetian red and now produce only sulphate of iron. The term "copperas" has been discontinued. Owing to the increasing demand for room for specialties manufactured at Worcester, the greater part of the machinery for making barbed wire was removed during 1906 to several of the Pennsylvania Works of the Company.

Under the administration of the American Steel and Wire Company the successive managers of the Worcester District, which at present includes the Company's extensive works at New Haven, Conn., have been,—the late Philip W. Moen, the late Charles Ranlet, Harry G. Stoddard, and Clinton S. Marshall. Mr. Marshall, who has held the office of District Manager since September, 1904, ranks as a veteran in the service, having behind him an active and varied experience of thirty-seven years.

The beginning and growth of the barbed wire business has been alluded to. A few years later, woven wire fencing began to attract attention and grew in favor from its introduction, until at the present time, its annual sales aggregate a very large tonnage. It might be supposed that the sales of barbed wire would diminish proportionately with the increase of the sales of woven wire fencing, but such has not been the case. Without doubt, sales of barbed wire have been far less than if the woven fencing had not been on the market, but barbed wire fencing is in no immediate danger of being abandoned by the farmers and entirely supplanted by the woven wire fence. The following figures apply only to the products of the American Steel & Wire Company. In a period of fifteen years, beginning with 1899, the first and the last years are taken for comparison:

Shipments of	Year 1899	Year 1914
Barbed wire	(net ton) 166,563	193,740 (gain 16.3%)
Woven wire fencing	" " 28,431	293,357 (gain 1031.8%)

The foregoing figures are sufficient to show that barbed wire possesses points of advantage over woven fencing for some purposes.

The steadily increasing demand in the west for various kinds of wire and wire products led The Washburn & Moen Co., in 1890, to the belief that a great commercial advantage would result from establishing a manufacturing plant in the middle west for better service, and to avoid transportation charges on raw material from, and on finished products to the west. As a result, the year 1891 saw in successful operation the large plant located on the shores of Lake Michigan, at Waukegan, Illinois. The erection of this magnificent plant, laid out on the most economical and efficient lines suggested by the experience of half a century, was amply justified by the

subsequent rapid business expansion. Almost totally destroyed by fire in November, 1899, the plant was rebuilt and enlarged by the American Steel & Wire Company, who still consider their Waukegan Works among the most efficient and productive of their many properties.

Meanwhile, the rapid extension of cable street railways had resulted in a large and increasing demand for steel wire rope in long lengths. Andrew S. Hallidie, the inventor of the cable railway, had established the California Wire Works at San Francisco for the manufacture of wire and wire rope. Washburn & Moen Mfg. Co., in the early 90's, purchased the California Wire Works as an adjunct to the development of their far western trade. The use of wire rope for street railways, contrary to expectation, has diminished until it is almost negligible, but other uses for wire and wire rope have increased in inverse proportion to the cable railway demand, so that now the greatly enlarged California properties of the American Steel & Wire Company are required to properly care for and serve the increased Pacific Coast and Oriental Export trade.

The past twenty-five years have witnessed expansion and development in practically every line of wire manufacture carried on in Worcester. In some instances, owing to lack of necessary space, or for purely economical reasons, large departments of the industry have been transferred bodily to western plants, but their places have in all cases been soon filled either by the overflow from previously congested departments, or by the introduction of some branch of wire manufacture, already known to the trade, but not yet established in Worcester, as for example, the making of insulated wires and cables already referred to or by the instituting of

pioneer work in developing an entirely new industry, as for example, the manufacture of copper rail bonds. Thus, little by little, the manufacture of the more common products has been transferred to other districts, and the Worcester plants have long since come to be known as the specialty producing plants of the Company. Notwithstanding the fact that the tonnage of many of these specialties is light when taken separately, it is by no means small when viewed in the aggregate. Some idea of the volume of business in normal times may be obtained from the fact that the maximum output of the Worcester plants in a single year approximates two hundred thousand tons. It is merely referring to a long established fact to mention that in no other city in the world are so many different kinds of wire and wire products manufactured as are produced in Worcester by the American Steel & Wire Company.

A direct cause leading to greater efficiency in manufacture has been the improvement of working conditions, including the wholesale installation of safety devices and insistence upon the observance of "safety first" rules throughout the various plants, better sanitary equipment, better lighting, better ventilation, cleaner mills and mill yards, attractive surroundings, skillful and efficient hospital service and medical and surgical attendance, including district nurses for the benefit of needy employees and their families. The pension system should also be mentioned. The Worcester pension roll numbers about two hundred and twenty. The pensions paid in Worcester to retired employees of the Company for the year 1914 amounted to $39,855.56. These and other precautions and provisions, all of which may be classed under the general heading of "Welfare Work," were unknown twenty years ago in connection

with a manufacturing enterprise. They have developed during recent years as the response of wisely directed organized capital to the demands of an awakened public conscience with respect to co-operative responsibility.

The Worcester pay roll under normal business conditions numbers approximately six thousand, fluctuating above and below that figure. This list of employees includes about three hundred women. The various nationalities represented are distributed as follows. The percentages given are based on the employment list of May, 1915.

	NATIONALITY	PER CENT OF TOTAL NUMBER EMPLOYED
1.	Swedish	21.176
2.	Lithuanian	14.658
3.	Irish	12.655
4.	American	9.698
5.	Finnish	8.458
6.	Polish	8.203
7.	Irish-American	5.628
8.	Armenian	2.893
9.	Italian	2.734
10.	Swedish-American	2.512
11.	Turkish	2.480
12.	English	1.208
13.	French	1.176
14.	French-American	1.176
15.	Danish	.858
16.	Russian	.795
17.	Scotch	.731
18.	French-Canadian	.413
19.	German	.378
20.	English-Canadian	.286
21.	English-American	.254
22.	Albanian	.254
23.	Norwegian	.223
24.	German-American	.191
25.	Greek	.191
26.	Scotch-American	.159
27.	Austrian	.127
28.	Syrian	.095
29.	Afro-American	.064
30.	All others	.326
	Total,	100.000

In 1885 the Company built one twelve-ton stationary furnace for the production of open hearth steel, afterwards increasing to fifteen tons capacity, in 1890 one twenty-ton stationary furnace, in 1895 two twenty-ton stationary furnaces, and in 1899 four fifty-ton rolling furnaces, so that now they have eight furnaces (four acid and four basic), with an annual capacity of one hundred and seventy thousand tons of ingots. At the present time, the four-inch square blooms which are of varying lengths, according to the size bundle desired in finished wire, are rolled to billets usually one and one-eighth inches in diameter, and the billets to rods varying from .162 inches in diameter to as large a size as orders may call for. These rods are then drawn cold to the size wire desired through one or more drafts. At the present time the output of all the rod mills is from two hundred and seventy to two hundred and eighty tons in twelve hours.

Philip L. Moen died April 24, 1891. Charles F. Washburn died July 20, 1893. Philip W. Moen died September 12, 1904.

The Worcester Wire Company, William E. Rice, president and treasurer, was in 1889 located on the Old South Worcester privilege, utilized for manufacturing purposes from the earliest times, now the central works of the American Steel & Wire Co. Here was manufactured a variety of wire, including tedder, rake teeth, wire for hay bales, and barbed fencing, bridge rope and general wire; bottling, baling wire; tinned mattress, tinned broom wire, harvesting wire on spools; wire for the manufacture of screws, bolts, rivets, nails, buckles, staples, rings, hooks and eyes, pin, hair-pin, reed, harness, heddle, bonnet, brush, broom, hat, clock and umbrella wire; also telegraph and telephone wire. This company has been absorbed by the American Steel & Wire Company.

It is interesting to trace the progress of somewhat remote causes to ultimate results. Erastus B. Bigelow was born in West Boylston in 1814; before he was fourteen years old he had invented a hand-loom and a machine for making piping cord. He invented the first power loom for making counterpanes, coach lace, Brussels and Wilton Carpets. This led to the invention of a loom for weaving wire cloth and to the founding of the Clinton Wire Cloth Co. George F. Wright, who died in Worcester May 30, 1903, at the age of seventy-one, was born in Westford and learned the trade of a cabinet-maker. In 1858 he was a member of the firm of Burt, Wright & Co., manufacturers of Horse power machinery at Harvard. The firm name was later changed to A. & G. F. Wright. In 1862, Mr. Wright entered the employment of the Clinton Wire Cloth Co. and was master mechanic for twenty years, during which time he devised many improvements in wire working machinery. He patented the first complete fly shuttle loom, especially designed for weaving wire cloth for fly screens. He originated the method of drying painted wire cloth by running it into a tower and devised the machinery for doing it automatically. This system is in general use by all window screen wire cloth weavers. Mr. Wright probably constructed the first machine in this country for weaving hexagonal mesh netting of which poultry netting is an example. He devised a method for the papering of paper boxes and sold his patent to Dickerman Paper Box Co., of Boston. I am informed that this principle is embodied in machinery now built by the Hobbs Mfg. Co., used by such concerns as the Royal Worcester Corset Co., who make their own boxes. During his early residence in Clinton, Mr. Wright did more or less work as a patent solicitor and was con-

sulted as an expert in patent cases. I well remember when, in 1882, he came into my office, then at the Worcester Barb Fence Co. factory, 49 Union St., and talked over his plan to organize a new company for making wire cloth. He had with him the working drawings of his loom. After spending a few months in Worcester, Mr. Wright organized with his sons the Palmer Wire Goods Co., and located in Palmer, Mass., in the fall of 1883. The business, at first the manufacture of wire cloth and lath, and two years later of poultry netting, was begun with six operatives.

It was reorganized as the Wright Wire Cloth Company in 1885. The company moved to Worcester in December, 1889, and the name was changed to the Wright and Colton (Samuel H. Colton) Wire Cloth Co. The Worcester works (Hammond St.) were started in January, 1890. In 1902 the name of the corporation was changed to Wright Wire Co. Meantime the variety of the products has been greatly increased and now includes wire, wire cloth and window screen cloth, wire rope and cable, wire clothes line and picture cord, poultry netting, wire lathing, staples, conductor strainers, foundry riddles, ornamental iron work and elevator cabs, steel and wire fences.

There are now about nine hundred and fifty employees in the Worcester and Palmer plants, and the company has warehouses in various parts of the country. The capital stock is $650,000, and the yearly amount of business between $3,000,000 and $4,000,000. George F. Wright was president of the Wright Company from 1883 until the time of his death in 1903. The officers are: George M. Wright, president and general manager; Herbert N. Wright, treasurer; John A. Denholm, assistant treasurer; George F. Wright, assistant general

manager, who, with Charles M. Thayer, O. W. Norcross, and Rufus B. Fowler, compose the Board of Directors.

It will be noticed that the founder of this business and Charles H. Morgan, the founder of the Morgan Spring Co. and of the Morgan Construction Co., both received their early training in the Carpet and Wire Cloth Mills established by Erastus B. Bigelow in Clinton.

The Spencer Wire Company, whose headquarters are now in Worcester, was incorporated in Spencer, Massachusetts, in 1876, but had its inception many years before. Experiments in fine wire drawing were made by Windsor Hatch and Charles Watson, about 1812, at the house of Jacob Watson in Spencer. The wire was drawn from two tubs by hand. About the same time Elliot Prouty also began business but it was not until 1820 that wire drawing became an industry, and then only in a small way.

In 1847 Myrick & Sugden succeeded to the business and for almost a half century thereafter Richard Sugden, who later became president of the Spencer Wire Company, gave his undivided attention to the business, until his death in 1895, at the age of eighty. From the beginning the business has shown a steady increase. In 1845 the total product was sixteen tons, valued at $8,000. In 1895 the product was one thousand, three hundred and thirty-two tons, valued at $141,500. The mills at Spencer, consisting of over twenty buildings, are still running to capacity, employing about one hundred and fifty hands and producing about twenty-five hundred tons of finished wire, valued at $300,000 in 1913.

In 1899 it was decided to build a new and larger mill in Worcester on account of its superior shipping facilities

and, in April 1900, the Worcester mill was put in operation. About four acres of land on Webster Street, in New Worcester, the Albert Curtis property, were first purchased. More land, repeated additions and new departments have been necessary each year. The Worcester plant now controls over thirty acres of land. The mill on Webster Street is over three hundred and fifty feet long, four stories in height. On Webster Court five hundred and fifty feet, three stories, and on Jacques Street, five hundred and sixty feet, three stories. These large buildings, with ten smaller ones, give over seven and one-half acres of floor space occupied by the different departments.

In the fourteen years at Worcester, the business has grown to eleven thousand five hundred tons annually, valued at over a million and a quarter dollars. The total business of the Company is over a million and a half dollars annually, an increase of ten hundred per cent in the last twenty years. A very extensive variety of wires and general wire goods are manufactured for trade all over this country and abroad. The range of product covers round wires from three-quarters of an inch diameter to three one-thousandths, and flat wires up to three inches wide. Wire in all shapes, and wire articles from pins to croquet sets, and from watch chains to dish pan handles. Wire rope and cables, from the smallest to six inches circumference, are also an important department, occupying a building built expressly for that purpose. As the works at Worcester are all comparatively new it has been possible to install all modern improvements and electricity plays an important part. The power used is almost exclusively electric, while cranes, elevators, pumps, conveyors, and trucks utilize the same power.

Until within the past ten years very few improvements have been made in drawing wire over the earliest practice, but, in the last decade, radical improvements have been made, particularly in the introduction of continuous drawing machines and of continuous annealing. Because of the length of time this business has been established, the Company has the benefit of experienced workmen who have been employed many years. At the Spencer mills three generations of the same family are working side by side. The oldest employee has worked there over fifty-one years. At the Spencer mills the preponderance of help has always been French Canadians, and continues so today, while at the Worcester mills the majority of the employees are Swedes for the skilled work, and Poles for the heavier work. When running full time about seven hundred people are employed.

Accompanying the material growth of the Company, considerable attention has been paid to the personal side. Mutual Benefit Associations, entirely independent of each other are in successful operation at both the Worcester and Spencer plants. These are managed entirely by the men, and pay both sick and death benefits. A Deposit Account entirely for the use of employees is conducted by the Company. Deposits are placed on interest monthly and may be withdrawn at any time. Only about fifteen per cent of the employees make use of this feature at the present time, but their deposits amount to such a large sum that it shows what could be accomplished by working people if they were disposed to take advantage of their opportunities to save money. Safety appliances are in general use over the plant wherever available and a small premium is paid to members of the Benefit Association who can avoid accidents for certain periods.

The officers of the Company have been long connected with the business. President and Treasurer, H. W. Goddard, since 1881, a grandson of Benjamin Goddard, a partner of Ichabod Washburn in 1831 and a son of Dorrance Goddard; Secretary, E. B. Dunn, since 1892. Superintendent, G. M. Thompson, since 1904; Assistant Superintendent, W. G. Hall, since 1901, and Assistant Treasurer F. Kilmer, since 1900.

Wire-working as an industry in Worcester was contemporaneous with wire-making. In April, 1831, Jabez Bigelow manufactured, in Rutland, "wire sieves, such as meal sieves, sand riddles, etc., also all kinds of safes for meat and provisions." In 1834 he was located at the "Stone building," Front Street, on the canal, where he manufactured "meat, milk, cheese and provision safes, wire sieves, grain, coal, sand, sugar and baker's riddles. Fire fenders, sand screens, hatters' hurls, dusters for paper-mills, cellar and window guards, netting, wire lace, bird cages, plate covers and brass screens." In the following year Mr. Bigelow advertised for two girls who could take a loom to their dwelling.

In 1845, Samuel Ayres began to weave wire for Mr. Bigelow in a shop in Norwich Street. Mr. Bigelow then had three looms—one large and two small ones—and the business employed in all six hands, among whom were Mr. Bigelow's sons. The business of wire-working was subsequently conducted by several firms, and finally consolidated in the National Manufacturing Company, of which Jonah H. Bigelow, a son of Jabez Bigelow, was president. This company has conducted a prosperous business for many years, manufacturing a very large variety of wire goods and is now located at Union Street and Summer Street. In 1916 the business was purchased by the Morgan Spring Co.

The business now conducted by The Wire Goods Company was commenced by Charles G. Washburn in the fall of 1880, on the top floor of the building then occupied by C. H. Hutchins & Company, in Allen Court, now 12 Federal St. The articles manufactured were wire goods for cotton and woolen machinery. September 12, 1882, it was incorporated under the name of The Wire Goods Company, and was continued for a time in Allen Court, but was subsequently moved into the brick factory in Union Street, the present situation. Meantime, the business has very much increased. In 1888 the business of the Ayres Manufacturing Company was purchased and merged in that of The Wire Goods Company.

The Company is still located on Union Street. In 1889 it occupied a floor space of substantially 25,000 sq. ft. This has been increased from time to time until now it occupies approximately 150,000 sq. ft. Arthur W. Parmelee, as President and Treasurer, was in direct control of the business until January, 1900, when he retired from the active management. At that time Reginald Washburn was elected treasurer and Lewis H. Janes, secretary. Mr. Parmelee retained the position of president of the Company until April 24, 1906, when he was succeeded by Reginald Washburn.

The range of merchandise manufactured has increased rapidly since 1889. The Company carries in stock and offers for sale upwards of forty-four hundred different articles made from wire. These articles consist of Wire Hardware, such as bright iron and brass screw eyes, screw hooks, gate hooks and eyes, belt hooks, hitching rings, hand rail screws, hammock hooks, wood screws and garment hangers; Kitchen Ware consisting of such items as strainers, broilers, pot chains, potato mashers,

dish drainers, and kindred articles. In addition the Company produces a wide range of special articles. This is made possible by its exceptionally complete equipment of tools adapted to this class of work.

In addition to the expansion already mentioned, the Company has acquired all of the capital stock of The E. Jenckes Manufacturing Company of Pawtucket, Rhode Island, manufacturers of wire hardware, and the Woods-Sherwood Company of Lowell, the oldest concern in the country manufacturing kitchenware, with an excellent reputation for quality. Both of these companies have been moved to Worcester. The business of The E. Jenckes Manufacturing Company is continued as before under the management of The Wire Goods Company. The Woods-Sherwood Company has been absorbed by The Wire Goods Company, and its lines of merchandise are manufactured and sold by the latter under the Woods-Sherwood trade-mark.

The Company employs at present about three hundred and fifty men and women when running at capacity. There are many different nationalities represented, including American, Irish, French, Greek, Italian, Swedish, Scotch, Polish, Armenian and Hebrew.

Hamblin & Russell began in Front Street the manufacture of a variety of wire goods similar to those made by the National Manufacturing Company and The Wire Goods Co. This company has a flourishing business at 28 Water Street.

The Parker Wire Goods Co. manufacture general and special wire hardware and metal stampings in The Osgood Bradley Building in Grafton Street.

Henry E. Dean, Austin Street, manufactured in 1889 a special line of general hardware and house goods,

elevator and window guards, also all kinds of steel wire brushes. The business is now known as Dean Wire Goods Co.

A very important business in which wire is the raw material consumed is that of Reed & Prince Manufacturing Company. In April 1886, Edgar Reed and Thomas Prince formed a partnership under the name of Reed & Prince, for the purpose of manufacturing rivets and burrs, renting the basement in the Stone Mill, located at the corner of Tainter and Gardner Streets, which at that time was owned by the Forehand Arms Co. Beginning with seven thousand square feet of floor space, and employing five people, the Company gradually added to its equipment as the increasing business demanded, remaining in this location for seventeen years.

In 1902 the Company, under the name of Reed & Prince Mfg. Co., was incorporated under Massachusetts laws, the officers being: Edgar Reed, president; William L. Ames, treasurer; E. Howard Reed, secretary. These, with Thomas Prince and Chester T. Reed, are its directors.

In July 1903, the Company moved into its own buildings, which had been erected to meet the particular requirements of the business, on the line of the B. & A. R. R. Co., at Duncan Avenue, near Webster Square. The Company now occupies one hundred and sixty-five thousand square feet of floor space, employs over five hundred people and has an output of over four hundred tons of finished products per month, consisting of rivets, burrs, wood screws, machine screws, stove bolts, tire bolts and many special goods of similar kinds.

Charles Hill Morgan, at that time general superintendent of Washburn & Moen Mfg. Co., believing, about 1880, that there was a rapidly developing market for

steel wire springs and knowing how to produce and where to obtain wire of the required quality, organized The Morgan Spring Company, which was incorporated in 1881 for the manufacture of steel springs and articles made from tempered wire. Francis Henry Morgan, a younger brother of Charles Hill Morgan, was also one of the incorporators of the Company, and became its treasurer and manager, which position he filled until his death in 1899. In 1881 C. H. Morgan purchased land and buildings on Lincoln Street, near Lincoln Square, from The Worcester Gas Light Company, the property having been a part of Worcester's first gas plant. The business started in this location, and grew steadily. The process of oil tempering wire continuously was developed, and proved to be an important step in the advance of spring making.

In 1883 a brick building of four stories was erected at 21 Lincoln Street by C. H. Morgan for the use of the Company. The drawing of wire and the production of articles made from wire other than springs, was undertaken. In 1903 land was purchased in Greendale, near Barber's Crossing. Two years later buildings were erected upon this property and in 1906 the business of the Company was removed entirely from Lincoln Street to its present location.

In 1905 an extensive plant was purchased at Struthers, Ohio, where rod rolling and wire making machinery was installed. Two years later this property was sold to the Youngstown Sheet & Tube Company. In 1916 the plant and business of National Manufacturing Company, located on Union and Summer Streets, were purchased. At the present time from six hundred and fifty to seven hundred people are employed.

Charles Hill Morgan was president of the Company from its incorporation until the time of his death in 1911, a period of thirty years. He was succeeded by his son, Paul B. Morgan. Francis Henry Morgan was treasurer of the Company for eighteen years, being followed in that office by Paul B. and Charles F. Morgan, and Evan F. Jones, who now holds the office. Mr. Jones is also general manager of the Company, having succeeded F. F. Bullard in 1907. The officers are: president, Paul B. Morgan; treasurer and general manager, Evan F. Jones; directors, Rufus B. Fowler, Jerome R. George, Charles F. Morgan, Edgar F. Scott, W. H. Beecher, H. W. Heedy, Charles H. Booth, Evan F. Jones and Paul B. Morgan.

It was natural that Charles H. Morgan, who, while general superintendent of the Washburn & Moen Mfg. Co., had devoted much time to the construction of mills for rolling wire rods, should have continued in this field after he left the service of that corporation. He organized the Morgan Construction Company which was incorporated September 23, 1891, associating with him his son Paul B. Morgan, a graduate of the Worcester Polytechnic Institute in the class of 1890, and Victor E. Edwards, in the class of 1883.

Before dealing directly with the Company, I will speak generally of the art of rolling wire rods to which I have already referred in connection with the Washburn & Moen Mfg. Co. Wire rods have always been rolled in this country on two distinct types of mills,—the Garrett mill and the Morgan mill. Originally the Garrett mill consisted of hand charged Siemens heating furnaces, a three-high eighteen-inch hand roughing train and ten-inch finishing trains, hand operated reels and a large force of skilled men. At the time Garrett became

interested in rod rolling the roll trains consisted of simple Belgian trains, and the billet used was about three inches square. Mr. Garrett claimed to have invented and introduced the four-inch square billet. Continuous heating furnaces were also applied to this type of mill by Mr. Garrett. He rearranged the finishing trains into two groups, introduced the automatic reel and later introduced the McCallip repeater, and sloping floors for the loops, invented and patented by another man. Later he substituted the continuous roughing train for the hand roughing, and then later the gravity end discharge continuous heating furnace, so that at the time of Mr. Garrett's death a few years ago, all that was left of his original ideas was the four-inch billet. These mills, however, produced a very large tonnage of wire rods at a very satisfactory cost. The weight of billet which could be finished in one piece was limited to about one hundred and seventy-five pounds because of the rapid cooling of the rod when looped out on the floor.

The pure continuous type of rod mill built exclusively by the Morgan Construction Co. has gradually displaced the Garrett type of mill as far as new construction is concerned, and no Garrett mills have been built in this country for six or eight years. The great advantage of the pure continuous mill is in lower labor and lower power cost, the power required for the pure continuous process being not more than two-thirds of that required when rolling at the lower temperatures which obtained in the Garrett mill. These mills are now rolling coils up to four hundred pounds weight, and the latest designs of double strand continuous mills produce an average of four hundred tons a day of number five wire rods. By improvement in details alone, the tonnage has been more than doubled in this type of mill in the last twenty years.

There has been no change whatever in the general principle of rolling during that time. The automatic types of reels used are known as the laying and pouring type, invented by Charles H. Morgan and Fred H. Daniels while they were with the Washburn & Moen Mfg. Co., and these two types of reels are now in universal use throughout the world. The number of men employed on a pure continuous mill producing four hundred tons in twenty-four hours and operating two twelve-hour shifts is from forty-three to forty-five. This includes taking the billets from the cars, heating, rolling, coiling and putting the finished coils back on the cars.

Although the Morgan Construction Company is building practically all of the continuous wire rod rolling mills in the world, this type of mill is now but a small part of the business of the Company, which does almost an equal amount of business in the form of special rolling mill equipment, producer gas machines and wire drawing machinery. There have been no radical inventions or improvements made by the Morgan Construction Co. in connection with wire rod rolling. The continuous heating furnace for thirty feet billets, the continuous roll trains and the automatic reels were all in use prior to the formation of the company. The increase in tonnage of more than one hundred per cent, the lower cost of power, maintenance, labor, etc., have been brought about entirely by improvement in the multiplicity of details, excepting the introduction of the Edwards Flying Shear, which is used at about the middle of the mill for cropping the first end. This undoubtedly has contributed largely toward a better yield and a better tonnage.

Charles H. Morgan was a great believer in the future of the continuous mill long before and after the organization of the Construction Company. He was identified

with the first continuous mill brought to this country, which was used for the purpose of rolling wire rods, and he undoubtedly contributed more toward the introduction of the continuous wire rod mill than any other man. It is interesting to note that the continuous mill for a good many years was used exclusively for rolling wire rods. In later years it has been demonstrated conclusively that the continuous mill is perfectly adapted to the production of skelp, hoops, cotton ties, billets and sheet bar.

Some adequate idea of the extent of the operations of the Morgan Construction Company may be gained from the fact that it has designed and built, for operation in this country, twelve mills for rolling wire rods, sixteen mills for rolling billets, eight billet and sheet bar mills, twenty-one merchant mills, eight roughing mills, one hoop and tie mill, one rod, tie and spike rod mill, one steel works and billet mill, one bar, hoop, tie and rod mill, two sheet bar mills, four skelp mills, one flat mill. For operation in other countries: in Canada, one rod mill, two billet mills, two rod and merchant mills; in England, one roughing mill, one bar, hoop, tie, and rod mill, two billet mills, one rod mill; in Germany, one hoop mill, two merchant mills, one bar, hoop, tie and rod mill; in Belgium, one rod mill; in Austria, one rod mill; in Australia, one rod mill; in India, one billet mill, one billet and sheet bar mill, one merchant mill.

At the present time the officers of the Corporation are: Paul B. Morgan, president and treasurer; Victor E. Edwards, vice-president; Jerome R. George, chief engineer. The works are located at 21 Lincoln St., the site of the old gas works.

An interesting illustration of the utilization of waste products is found in the manufacture of sulphate of iron

or green vitriol—commonly known as copperas, and popularly, but erroneously supposed to be a salt of copper—from the waste sulphuric acid used in cleaning wire. This waste acid, heavily charged as it is with iron, was taken from the wire mills, in 1889 and previously, to the works of W. E. Cutter & Co. (W. E. Cutter and Waldo Lincoln), located on Hammond St., opposite the present location of the Wright Wire Co., where, after being evaporated in lead-lined tanks in which iron in the form of waste wire was placed to further neutralize the acid, it was drawn off into large cooling-tanks. The copperas was deposited in green crystals upon sticks suspended in the liquid. Copperas is used in dyeing as a disinfectant, and in the manufacture of ink, and largely in the manufacture of Venetian red, which was also made by W. E. Cutter & Co. In 1899, 7,000,000 pounds of copperas were manufactured by this company annually, representing about seven hundred short tons of metallic iron; about one-third of the copperas was converted into Venetian red, of which the annual product was two thousand tons. This is an oxide of iron paint, and was very extensively used. This business as stated elsewhere has been purchased by the American Steel & Wire Co.

Copperas was also obtained by the oxidation of iron pyrites—sulphate of iron. In 1830 a bed of iron pyrites was discovered in Hubbardston, and Mr. Bennett, of that place, with Messrs. John Green, Benjamin F. Heywood and James Green, of Worcester, formed a company for the manufacture of copperas, and began operations; but the enterprise did not prove successful. In December, 1828, the canal boat "Worcester," Captain Green, among other things,brought one ton of copperas from Providence.

CHAPTER VI

Carriages and Cars—Wood-working Machinery—Musical Instruments—Envelopes.

The business of carriage-making was conducted in Worcester at a very early day. Curtis & Goddard were in business in 1808.

In 1822 Osgood Bradley came to Worcester, and started the stage and carriage business in a small shop in the rear of Parker Block in Main Street, and the same year moved into Atchison's carriage shop in School Street, where he manufactured and kept on hand mail coaches, chaises, gigs, wagons, sleighs, cutters, etc. Associated with Mr. Bradley was John Manning, harness-maker, who afterwards, in 1825, went into business with Edward M. Burr, in the manufacture to order of coaches, chaises, saddles and harness, opposite Stiles & Butman's store, a few rods north of the brick hotel. Osgood Bradley & Co. continued in the manufacture of coaches, chaises and harness in School Street, near Captain Thomas' coffee house, and were succeeded by Solon Fay, September 2, 1829.

Albert Tolman was born in Lincoln, Mass., and came from Concord to Worcester in 1833. At that time it must be remembered, manufacturing in Worcester was in a very primitive condition; the shops were all very small, and the proprietor, with one or two workmen and an apprentice, usually did the work. In 1833, Mr. Tolman formed a copartnership with Samuel L. Hunstable, and advertised to do chaise and harness-making in the yard of the Central Hotel. At this time a Mr. Goddard had a harness shop north of the Bay State House, near where the Waldo Block now is. Benjamin Goddard was

a carriage maker, and had a shop on the corner of Waldo and Exchange Streets.

William Leggett was at that time an old harness-maker here, and was afterwards one of the first conductors on the Nashua Railroad. The firm of Tolman & Hunstable continued until 1837, when the firm of A. Tolman & Co. was formed, composed of A. Tolman and G. W. Russell, which continued forty years. Their work for many years was the manufacture of first-class family carriages, which they sent all over the world, some of them going to California, and even to Africa and Australia. Mr. Tolman once built a carriage for Mrs. Governor Duncan, of Ohio, before the days of railroad communication; it was shipped to New Orleans, and from there went up the Ohio River to its destination. Later hundreds of carriages came from Ohio to the East by rail.

Meantime Mr. Bradley had again gone into business. In 1833, he commenced building passenger cars, which were the first cars constructed for the use of steam roads. Passenger cars at that time were simply stage coach bodies placed on wheels which were flanged, for use on tracks, in place of the ordinary wheels for service on highways. The first cars built at the shops were hauled to Boston over the turnpike. From that time the business of building steam cars rapidly increased. Early in the history of the business some were sent to foreign countries. In the early forties a Mr. Rice became a member of the firm, the name of which was changed to Bradley & Rice. Mr. Rice went to California in 1849, and the firm was dissolved. From that time the business was conducted under the name of Osgood Bradley.

Just before the Civil War a large contract for equipment for Egypt was awarded to him. During the war, the works were employed by the government. Gun car-

riages and caissons were built during the last two or three years of the war, in addition to cars. There were several instances where cars delivered in the South were captured by the Southern forces, and were burned before being put in service.

In the late sixties the company built sleeping cars that ran on the New York and Boston sleeping car line, and about that time sent a sleeping car to the far West. This was running on one of the roads out of Chicago, and Osgood Bradley, Jr., had charge of it. George M. Pullman, also, had a car of which he was in charge, running on another road. It was decided, at that time, to sell to the railroads the car sent them for trial, while Pullman kept his car. This was the nucleus of the present large business of the Pullman Company.

The Osgood Bradley business was later moved to the corner of Water and Winter Streets and in 1844 to the corner of Grafton and Franklin Streets. This site was occupied until 1910, when its manufacturing value was destroyed because the railroads took part of the land in connection with the elimination of grade crossings and the construction of a new Union Station. The Osgood Bradley building was subsequently built on this location.

In 1881 the firm name was changed to Osgood Bradley & Sons, Osgood Bradley, Sr., taking into the business at that time Henry O. Bradley, father of John E. Bradley and Osgood Bradley, Jr. In 1884 Osgood Bradley, Sr., died and the business was then in the hands of Henry O. Bradley and Osgood Bradley, Jr. It was continued by them up to the time of the death of Osgood Bradley, Jr., in 1896, after which time the business was conducted by Henry O. Bradley until his death in 1902. From that time until 1909, the business was carried on and owned by John E. Bradley, the son of Henry O. Bradley.

The elimination of the grade crossings already alluded to, forced the removal of the car plant to a new location, and a large tract of more than fifty acres was purchased at Greendale, near the Summit, where was constructed the most modern car building plant in the country. It contains approximately eighteen acres of floor space, and is equipped with the most modern machinery and appliances for the lessening of manual labor. The works are fitted for the erection of all classes of steam and electric equipment for both domestic and foreign service, in wood, steel and all-steel. The steel car business is in its infancy in this country, as they have been manufactured for the past five or six years only, yet this Company has built, up to the present time, between five hundred and six hundred cars of this most modern type. The plant at Greendale ranks second in the United States, the only company exceeding it in size being the Pullman plant near Chicago.

The surviving member of the family, John E. Bradley, is president of the new corporation, the Osgood Bradley Car Company, incorporated in 1909, under the laws of the Commonwealth of Massachusetts. Under normal conditions, the works employ about twelve hundred men, and do a business of from seven to eight million dollars a year.

In 1847 Abraham Flagg, at his shop, 22 Exchange Street, manufactured I. Woodcock's patent "Worcesteree," a two-wheeled vehicle. Woodcock, Jones & Co. also manufactured them.

In 1851 the carriage business in Worcester supported about fifty families. The largest factory was that of Tolman & Russell; it embraced some half-dozen buildings and gave employment to twenty-five hands. Most of their carriages were of the more expensive kind. At

this time they were finishing three, one for the Adams House, Boston; one for a New Bedford merchant, and one for Mr. White, of Worcester, "the attentive and obliging hackman, whom everybody knows and everybody employs." Besides these heavier carriages, Tolman & Russell manufactured a great many lighter vehicles of various patterns and prices, such as chaises, phaetons, rockaways and buggies. It is said that the members of this firm at one time refused to take a large contract from the Government for the supply of army wagons for the use of the army during the Mexican War, solely on the ground that they believed the war to be unjust and did not wish to participate in the profits of such injustice. The average number of vehicles manufactured by Tolman & Russell at this time was about one hundred per year.

The establishment of Breck & Wilder was situated in School Street, employing somewhat fewer hands than Tolman & Russell. Their shop occupied the site formerly occupied by Osgood Bradley, and their business was confined especially to omnibuses and stage-coaches. They built some of the largest omnibuses running between Boston and the adjacent towns, and had, in April, 1851, just finished an omnibus of immense proportions, named the "Jared Sparks," intended to run on the line between Cambridge and Boston.

George W. Wilder built a new light carriage known as the "York wagon." William C. Whiting's carriage factory, in Mechanic Street, employed ten hands on light carriages of all descriptions.

For some time prior to 1889 Tolman & Russell confined themselves almost entirely to the manufacture of hearses, which found a market in all parts of the United States. Mr. Tolman retired from the firm in 1879. The business was then conducted by H. J. & J. E. Russell,

and now by Herbert J. Russell at the old location, 32 Exchange Street.

Under the old apprentice system in this business, boys were taken from fifteen to twenty-one years of age, and were paid from thirty to fifty dollars a year and their board. They bought their own clothes and the last year of their apprenticeship were paid seventy-five dollars, which included a "freedom suit." About 1830 the working day averaged from twelve to thirteen hours, and all the work was hand-work, down to the rivets and bolts. The average wages of a good workman, $1.25 per day.

As late as 1866 a good many carriages were made by O. Blood & Sons, Tolman & Russell and Geo. T. Atchison, who also built water carts.

The automatic wood-planing machine was invented by William Woodworth in 1828. Previous to 1836 the manufacture of wood-working machinery was not carried on as a separate industry in any part of the United States. In that year the firm of J. A. Fay & Co., composed of J. A. Fay and Edward Josslyn, commenced the business in Keene, N. H., and a few years later united with the firm of C. B. Rogers & Co., at Norwich, Conn.

In April, 1839, Thomas E. Daniels was located at Court Mills, manufacturing his patent planing machines, "which are useful in squaring out timber for machinery, planing floor and other boards, door, bed-stead and table stuff, also for hollowing circles for water-wheel roundings and drum locks; he also builds machines for matching boards, grooving floor plank, and under floor plank, where it is desirable to put mortar between floors in factories to prevent fire; recommended by Davis & Howe; Ruggles, Nourse & Mason; White & Boyden; Henry Goulding & Co.; Horatio Phelps." He sold out his business to Deacon

Richard Ball and Thomas Rice, who were succeeded by Ball Ballard.

In 1843, Goddard, Rice & Co., put in the first planing machine that went by power in Worcester County. In October, 1846, Arad Woodworth, New Worcester, showed a machine for planing window blind shades; and in 1847 Charles Price, successor to Price & Hartwell, was engaged in building planing machines at No. 2 Central Street.

In 1849 Howe, Cheney & Co., at Court Mills, had made arrangements to build the Daniels Planing Machine, to plane all wood from eight to ten inches wide and from four to fifty feet in length.

At the Mechanics' Exhibition in 1851, Ephraim C. Tainter exhibited a Daniels Planer embodying many improvements. His factory was at the Junction shop, and he was soon after joined by Gardner Childs, who, in 1853, sold his interest to the Keene and Norwich companies already referred to. The business was conducted as a branch under the name of J. A. Fay & Co., who also manufactured plows, power and foot mortising machinery, tenoning and sash-moulding and matching machines. The machines of their manufacture became known throughout this country and in Europe. In December, 1858, they were building a fifty-foot planer and other machinery for the Don Pedro Railroad in Brazil.

In 1858, and prior to that time, Ball & Williams (Richard Ball and Warren Williams), successors to Ball & Ballard, were engaged in School Street, in the manufacture of planing machines for wood-working and of improved sash and moulding machines. They had just sent an improved Woodworth planer to R. Hoe & Co., of New York. Warren Williams retired in 1865. Mr. Ball, with his son-in-law, built the factory in Salisbury Street, at one time occupied by Witherby, Rugg & Richardson and now by Hobbs Mfg. Co.

In 1859 J. A. Fay & Co. occupied one hundred feet of the second floor of Col. Estabrook's shop at the Junction, and employed thirty hands in making wood-working machinery, and had then recently sent a saw-mill to Rio Janeiro. In 1859 Mr. Fay died, but the business was carried on by his widow and the remaining partners. In 1864 they opened a warehouse at 107 Liberty Street, New York, for the sale of their products, and were the pioneers there in this line of business.

In 1877 William B. McIver and his brother, J. C., purchased the tools, stock and good-will of the old firm and continued the business under the name of McIver Bros. & Co. They engaged in the general manufacture of wood-working machinery on a more extensive scale than had been done in the former companies. McIver Bros. & Co. in 1889 occupied the shop below the Junction, built by Wood, Light & Co., and in addition to their other business were largely engaged in the manufacture of coffee machinery for Central America and other coffee-growing countries.

Witherby, Rugg & Richardson began business in 1864, in the Armsby building, with twenty men, and employed in 1889, at their location in Grove Street, seventy-five men. They made a large variety of wood-working machinery, which was sold to all parts of the country.

The principle of producing music by the vibratory motion of a reed is most simply illustrated in the jewsharp, and the development of this principle through the successive stages of harmonium, accordion, elbow melodeon, with foot pedal for working the wind-chest, resulted finally in the cabinet organ. This development took place within the last century.

The business of organ-building had been conducted in Worcester for more than forty years prior to 1889.

In 1847 N. B. Jewett was engaged here in making melodeons, and in 1849 Milton M. Morse, who came from Concord, N. H., manufactured seraphines, melodeons and eolians for church and parlor use. The first melodeon was copied from the accordion. Abraham Prescott, of Concord, N. H., manufacturer of bass viols and violoncellos, made an accordion for James A. Bazen, of Canton, who thereupon had an enlarged one made by Mr. Morse, then in his employ.

In 1847 the firm of Farley, Pierson & Co., consisting of John A. Farley, John G. Pierson and M. M. Morse, began business, which was conducted in the old Burnside Building, in Main Street. The first cases for this company were made by Partridge & Taber. The first melodeon made was a four-octave melodeon, held in the lap, with two rows of keys, sharps and flats. The round keys were pushed in like the keys upon small concertinas. The sharp keys had black rings painted on the ivory. The melodeon was held in the lap, and, while the keys were operated by the hands, the elbows worked the bellows. These instruments were greatly enlarged until they were put upon legs and called seraphines, the bellows still being worked with the elbows. The cabinet organ is the melodeon on a large scale. Modern instruments have the exhaust bellows, while the old instruments have the pressure bellows. At the beginning this company had six hands; Mr. Morse did the tuning, Mr. Farley made the reeds, and Mr. Pierson the wood-work. Subsequently, in 1852, Pierson & Loring succeeded to the business.

One of the first melodeon-tops made by this company was twenty-two inches long, twelve inches wide, with four octaves. The bellows were made in two folds; when the wind went out of one fold it came in and filled the other. At the New England Fair in 1888 one of these instru-

ments, made forty years ago, was shown and operated. Taylor & Farley were manufacturing melodeons in 1855, and in 1862 harmoniums for parlors, churches and schools. In 1865 their factory in Hermon Street was erected.

In 1856 the Steam Music Company was formed to manufacture the calliope, an instrument designed to produce music by steam—the invention of J. C. Stoddard.

In June, 1858, E. Harrington & Co., at the Junction shop, manufactured melodeon reeds; he was succeeded by A. Davis & Co.

In 1859 the American Steam Music Company was located in Estabrook's building and employed twelve hands in the manufacture of calliopes and terpsichoreans. As was said at the time, "The latter is an entirely new thing, and this company has just completed the first one as an experiment. Its notes are agreeable and pleasant to the ear. The music for these instruments is arranged by M. Arbuckle, leader of Fisk's Cornet Band, on the same floor."

In 1860 the calliope was introduced into England.

The Loring & Blake Organ Company, in 1889 located in Union Street, was incorporated in 1868. Messrs. Loring & Blake, the founders, were at one time with Taylor & Farley Organ Company, and first engaged in business in Southbridge Street, in French's building, and afterwards moved to the building in Hammond Street, which was later burned down and never rebuilt. From there they moved to the Adams Block, between Main and Southbridge Streets, the site of the Post Office, and also hired some rooms of E. S. Stone, their mill work being done in Cypress Street. They later occupied a large five-story brick factory in Union Street. The lumber used by this company came comparatively dry, but they had two large dry-houses with a capacity of fifty thousand feet.

From the dry-houses the lumber passed to the mill-room, was cut up into the proper sizes and glued; it then passed through the scraping and smoothing machines. This company used a machine for carving, which did many parts of the work formerly done by hand, although some of the work could still be done cheaper by hand than by machinery. From the mill-room, with its multiplicity of saws and wood-working machinery, the work went to the case-room, adjoining which was the tuning-room; here the tuner had a set of reeds pitched, from which the reeds were fitted for the organ. Formerly the reeds were left perfectly straight, but later were bent somewhat, which was supposed to give a superior tone. This was a return to the earlier practice, as the reeds of the first melodeons were made in this way. This company used a patent stop motion of its own on its organs. The work of the factory was divided into departments; the reeds and reed-boards were purchased outside, and put into the cases in the factory. The bellows stock was also purchased.

The Taber Organ Company in Hermon Street, in 1889 —N. H. Ingraham, president, William B. Baker, treasurer, —was established in 1872 as the Worcester Organ Company. Shortly afterwards, William B. Taber, who had been with Loring & Blake Organ Company, bought the business, and later, in 1877, the Taber Organ Company was formed, starting with fifteen hands, and later employing forty. Their product went all over the world. The changes and improvements made in organ-building, have, for the most part, been in the styles of cases, in couplers and tremolos—the change in the latter having been from the valve to the fan tremolo.

The company in 1889 known as the Worcester Organ Company, was a continuation of the business formerly

conducted by E. P. Carpenter, which later included the manufacture of pianos. The manufacture of organ-reeds, while closely connected with the manufacture of organs, was a distinct business. Previous to 1846 reeds were made by hand. About that time Jeremiah Carhart, of New York, devised machinery for making the organ-reed to be used with exhaust bellows, which he had invented and patented. Redding & Harrington, of Worcester, also devised a machine for making the reeds. A. H. Hammond bought a one-third interest in this business, and finally, all of it. The Hammond shop, in 1889 located in May Street, then did a large domestic and foreign business, and employed two hundred hands.

George W. Ingalls & Co., then in Hermon Street, manufactured organ reeds and reed-boards, Parker tremolos and octave couplers and fan tremolos.

The Munroe Organ Reed Company was established in 1860. It was incorporated in 1869 with a capital of $13,300, and employed ten men. In 1875 the capital was increased to $60,000, and in 1878 they added to the manufacture of reeds that of automatic instruments; after that they employed something like two hundred and fifty men at one time. In 1879 they moved to the location in Union Street, occupied by them in 1889, now occupied by S. Porter & Co., where they had the most complete facilities and most ingenious machinery for the prosecution of their business. They used from one hundred and fifty thousand to two hundred thousand pounds of sheet brass per year, from which the rough frame-work of the reed was punched; it was then planed and milled; the reed grooved and the tongue securely fastened in place by machinery; another machine lettered the reeds, of which fifteen thousand were manufactured daily. The reed-boards were made of the best Michigan quartered pine.

The places for the reeds were cut in the reed-boards by machinery. The product of this company went all over the world. The export business amounted to $100,000 per year. Most of these companies are no longer in business.

The Simplex Player Action Company was started by Theodore P. Brown in 1899 in a small factory located on the corner of Commercial and Central streets. The instrument made at that time was known as a Cabinet Player, and was one of the first put upon the market. The Simplex Player Action Company was organized as a corporation in 1905, and after a few years in quarters on May Street, was permanently located at Blackstone and Charles Streets in buildings purchased at that time. The player industry is new, but the business has been one of growth from the beginning, and is today showing a very large percentage of the total output of pianos in this country, being estimated as about fifty per cent. The business has developed from that of an Outside or Cabinet Player to mechanism installed within the piano case and known to the trade as a "Player piano" in distinction from the "Piano player." The business employs about one hundred and fifty skilled employees, a large number of whom are Swedes. The officers of the company are: Theodore P. Brown, president and treasurer; E. N. Kimball, Boston, C. C. Conway, New York City, directors. The capital stock is $125,000.

Envelopes were first used in England between 1830 and 1839, but only in a very limited way, as the use of an envelope called for double postage, the law then being that postage should be charged for the number of pieces of paper. This explains the custom, then prevailing, of folding the letter-sheet to make it answer the purpose of an envelope.

The Penny Post was established in 1840 by Sir Rowland Hill, and a demand for envelopes was at once created. Up to this time, and for several years after, all the envelopes used were cut by hand; each stationer had blank patterns of several sizes of envelopes, and with the aid of a sharp penknife cut the blanks three or four at a time. On rainy days these blanks were folded and stuck together in the form of envelopes. There were, in this country, within twenty-five years, stationers in business who in early life made in this way all the envelopes sold in their stores. The first machine for making envelopes was invented about 1840 by Edwin Hill, a brother of Sir Rowland Hill, the father of penny postage.

Worcester has taken a foremost place in the development of the manufacture of machine-made envelopes. The third United States patent on a machine for making envelopes was issued to Dr. Russell L. Hawes, of this city, in 1853; the two preceding patents were upon machines of no practical value, so that it may fairly be said that the first successful machine in the United States for making envelopes was invented and patented by a Worcester man and built in the city of Worcester. Dr. Hawes was then agent for Goddard & Rice, and saw in New York some hand-made envelopes, very likely made by a Pole named Karcheski, who is said to have made the first hand-made envelopes in this country.

Dr. Hawes thought he could make envelopes by machinery, and, returning to Worcester, built a machine in the shop of Goddard & Rice, which was subsequently patented. The blank for the envelope was first cut out by a die, then the sealing flap was gummed, the envelope blanks being spread out, one overlapping the other, and the gum applied with an ordinary brush. When the gum was dry the blanks were introduced into the folding-

machine, which was a self-feeder, and in this Dr. Hawes applied the principle which is used on every successful envelope machine in existence. Up to this time all attempts at making envelopes by machinery had dealt only with the folding of the envelope, the blanks being fed to the machine by hand. Dr. Hawes went a step farther, and attached a feeding device to his folding machine. The blanks, having been cut and gummed on one edge, were fed to the machine in bunches of five hundred; gum was applied to the under side of the picker, which descended on top of the pile of blanks; the top blank adherred to the picker and by it was lifted to the carriage, which conveyed it under the plunger by which the blank was forced into the folding-box. Small wings then folded over the flaps of the envelope and the gum by which the blank had been elevated to the carriage now performed a second office, that is, sticking the envelope together. The envelopes thus made by Dr. Hawes were sold to Jonathan Grout.

It required the services of one girl to attend the machine, while it took half the time of another girl to spread the gum on the sealing-flaps, so that three girls could produce a finished product of about twenty-five thousand envelopes in ten hours. Thinking the machine had reached its maximum product, Dr. Hawes, who meantime had moved to the factory of T. K. Earle Manufacturing Company in Grafton Street, sold out, in 1857, to Hartshorn & Trumbull (Charles W. and George F. Hartshorn and Joseph Trumbull), who were succeeded in 1861 by Trumbull, Waters & Co. (Joseph Trumbull and Lucius Waters.) In 1866 Hill, Devoe & Co. succeeded to the business. W. H. Hill, the proprietor in 1889, was succeeded in 1892 by The W. H. Hill Envelope Co., which in 1898 became the W. H. Hill Envelope Co. division of the United States Envelope Co.

The principal improvements made in machinery have been in increasing the capacity, and with that, improving the quality of the manufacture, as the envelopes made on the old machines would not now be considered saleable.

In 1889 one girl attending two machines could produce seventy thousand envelopes in ten hours. W. H. Hill owned the patents on his machines, which had been assigned to him by the inventor, in his employ, Abraham A. Rheuton, who did much to contribute to improvements in envelope machinery. The Reay machine was used in this establishment. This was the invention of George H. Reay, of New York, and was patented in 1863. From one hundred and twenty-five to one hundred and fifty hands were employed in this factory in 1889.

The next Worcester man to make valuable improvements in envelope machinery was James G. Arnold, who, in 1858, devised a machine for cutting the material for an envelope from a roll of paper, which also gummed and folded the envelope complete in one operation. He introduced into this machine the drying chain. By this invention, the gum, which theretofore had been applied to the sealing-flap with a brush, was applied to the envelope by the machine, and after the machine had folded the envelopes they were deposited in this drying chain, or endless belt with fingers, the envelopes being kept separate while the gum on the envelopes was drying. This principle is a feature in nearly all envelope machinery of the present day, excepting the machines invented by D. W. and H. D. Swift. While Mr. Arnold's machine was not a practical success, it had in it the foundation principles upon which the success of the self-gumming envelope machine depends.

In 1864 G. Henry Whitcomb came into possession of the Arnold machines, and under the name of Bay State

Envelope Co., began the business of envelope-making on the second Arnold machine, in a small building in School Street, where the engine-house now stands. In 1865 he removed to the north corner of Main and Walnut Streets, where he remained until January, 1866, when here moved to Bigelow Court; he was then making one hundred thousand envelopes per day. This factory was the first building in the United States used exclusively for the manufacture of envelopes. At that time David Whitcomb sold out his interest in the hardware store of Calvin Foster, and joined his son, the firm being G. Henry Whitcomb & Co.

In 1873 the business was moved into the present factory in Salisbury Street, additions to which were built in 1878 and in 1886. In 1884 the firm became a corporation known as the Whitcomb Envelope Company. The machines used were built on their own premises, and the patents upon them were owned by the company. The machines were the invention of D. W. & H. D. Swift, who, in 1871, built one upon an entirely new principle, capable of making thirty-five thousand envelopes in ten hours. In 1876 the Messrs. Swift invented their first self-gumming machine. A girl could run two of these machines, making seventy thousand envelopes in ten hours. The product was automatically registered, these being at that time the only machines in the world with a clock attachment.

Besides the invention of four distinct envelope machines, the Messrs. Swift patented an automatic printing-press, for printing envelopes. The blanks were fed to the machines in three or four thousand lots, picked up singly by the air-feed, and carried into the press, where they received the impression. They were then discharged on the opposite side of the machine and piled up, ready for the envelope folding machine. The construction of this

press was very simple. It had a stop-motion attachment, and was so delicately adjusted that a single hair stretched across the attachment would spring the let-off motion and the press would stop. Seven presses, each capable of producing thirty thousand impressions in ten hours, could be run by a man and girl, making a total of two hundred thousand impressions with only two operatives. The great efficiency of this machine will be appreciated when it is considered that eleven thousand to twelve thousand impressions was a large day's work for an operative on an ordinary job press.

One hundred and fifty hands were, in 1889, employed in the Whitcomb Envelope Factory. Their daily product was one million envelopes, with a capacity of double that amount. To illustrate the efficiency of the Swift machine owned by the Whitcomb Envelope Company, it may be said that Herman Schott, the largest envelope-maker in Germany; Alexander Pirie & Son, Aberdeen, Scotland, then the largest envelope-makers in the world; and Fenner & Appleton, of London, then one of the largest envelope-makers in England, several years prior to 1889 equipped their factories with the Swift machine.

In December, 1882, James Logan left the Whitcomb Envelope Co., and with George H. Lowe, of Boston, organized the Logan & Lowe Envelope Co., and began the manufacture of envelopes in Stevens block on Southbridge Street. Soon after the Whitcomb Company invited Mr. Logan to return and enter the firm. At the same time Carter, Rice & Co., of Boston, made overtures to Mr. Lowe to return to them and enter the firm. In August, 1883, the arrangements were completed and the partnership of Logan & Lowe Envelope Co. was dissolved. Differences arising in connection with the reorganization of the Whitcomb Company, Mr.

Logan decided not to enter the firm. He, with H. D. & D. W. Swift and John S. Brigham withdrew from the service of The Whitcomb Co. and on Feb. 1, 1884, organized the Logan, Swift & Brigham Envelope Co., and began the manufacture of envelopes in the factory at No. 16 Union Street, now owned and occupied by the Wire Goods Co. In 1889 the Logan, Swift & Brigham Envelope Co. having outgrown its quarters at 16 Union Street, began the erection of a factory at the corner of Grove, Faraday and Lancaster Streets, into which they moved in 1890. The business continued to grow and in 1897 the addition on Lancaster Street and in 1907 a still larger addition was made to the plant.

August 18, 1898, the United States Envelope Company was organized. It was made up of ten of the leading envelope manufacturing companies of the country. It was incorporated under the laws of Maine and had an authorized capital of $4,000,000 of preferred stock, all of which has been issued, and $1,000,000 common stock of which $750,000 has been issued. It had also an issue of $2,000,000 in six per cent bonds. Of the ten companies, three, The W. H. Hill Envelope Co., the Whitcomb Envelope Co., and the Logan, Swift and Brigham Envelope Co., were of Worcester; James Logan, Charles W. Gray, of the Hill Company; C. Henry Hutchins, G. Henry Whitcomb and D. Wheeler Swift were members of the Board of Directors; C. H. Hutchins, of Worcester, was president and James Logan, chairman of the Executive Committee.

The Emerson, Lowe & Barber Co., a Massachusetts corporation with a capital stock of $15,000, was organized in 1889, and located at the corner of Foster & Bridge Streets, where it still remains. The officers of the company were Everett M. Lowe, president; W. B. Emerson,

secretary; and Geo. D. Barber, treasurer. In 1893 Messrs. Lowe and Emerson withdrew from the business and the Worcester Envelope Co., a new Massachusetts corporation with a capital stock of $38,000, was formed, which purchased the entire assets of the Emerson, Lowe and Barber Co. The officers of the new corporation were Henry S. Pratt, president; E. P. Waterhouse, secretary; and Geo. D. Barber, treasurer. The officers at present are: E. P. Waterhouse, president; John N. Barber, secretary; and Geo. D. Barber, treasurer. The capitalization of the company remains the same.

In the fall of 1898 John A. Sherman, who had for about thirteen years been the Superintendent of the Whitcomb Envelope Company, organized the Sherman Envelope Co. In December, 1899, or January, 1900, he started to build envelope machines in the old bicycle factory owned by H. H. Bigelow on the corner of Winona & Nebraska Streets. February 1, 1900, the business was incorporated with a capital of $50,000. In April the manufacture of envelopes was begun on the upper floor of the building. On February 1, 1901, the business was moved to the corner of Union and School Streets, into the Geo. C. Whitney building. On February 1, 1907, the company moved into its new factory, which was erected during the year 1906 and 1907 on the corner of Prescott and Otis Streets. The incorporators and the first directors were J. H. Clark, Otis E. Putnam, Frank H. Bigelow, Walter H. Davis and John A. Sherman. The capital stock was increased to $75,000.

The New England Envelope Co., a Massachusetts corporation, was organized December 8, 1906, with capital $35,000 which was increased to $60,000 in 1908, and is located at 2-16 Eden Street, Worcester. The directors are: Charles W. Gray, Willard C. Poole, Henry H.

Hayes, George F. Brooks, Frank L. MacNeill; and the officers: Charles W. Gray, president; Willard C. Poole, vice-president; Henry H. Hayes, secretary and treasurer. C. W. Gray was for many years the manager of the W. H. Hill Envelope Co. Mr. MacNeill was for many years with that division of the United States Envelope Co.

On September 1, 1914, a partnership consisting of August C. Meyer, Sidney M. Scott and Frederick V. Hugo was formed, under the name of the Colonial Envelope Company. The object of the partnership was the manufacture of papeteries, paper boxes, envelopes, and to do all kinds of printing, etc. The company was operated by the three above named until December 21, 1914, when Sidney M. Scott and Frederick V.Hugo bought out the interests of August C. Meyer and were incorporated under the same name and took as an associate Harry L. Scott. The amount of capital was $25,000. Sidney M. Scott is president, Frederick V. Hugo is treasurer, and Clarence E. Tupper, temporary clerk. The location was 68 Prescott Street and now is 4 Cherry Street.

It is apparent that Worcester has been most prominently identified with the inception and development of machine-made envelopes. The most important contributions that have been made to this art have come from Dr. Hawes, Mr. Arnold, Mr. Rheutan and the Messrs. Swift, and their associates, who have collectively taken out many patents. Several of the pioneers in the business are no longer living. W. H. Hill died January 30, 1892. John S. Brigham died February 19, 1897. D. Wheeler Swift died June 14, 1910. A. A. Rheutan died March 15, 1913. G. Henry Whitcomb died February 13, 1916.

CHAPTER VII

Fire-Arms—Iron and Steel Business—Screws—Steam-Engines—Boilers.

Harding Slocomb, December 6, 1820, notifies his friends that he has established his business as gunsmith in Worcester, opposite Jeremiah Robinson's drug store, a few rods south of the Court-House, where he manufactures twist and straight rifles, fowling-pieces, and has musket-guns and pistol flints for sale. These fire-arms were, of course, all made with the old flint-lock. At this time Asa Waters (2d) had a gun factory in Millbury, where he made government arms. Ware & Wheelock, at the top of Front Street, opposite the City Hall, in 1825, manufactured guns, and in 1833 Joseph S. Ware and John R. Morse were established in Main Street, where guns, rifles, fowling-pieces and muskets were made to order.

Ethan Allen was identified with this business from an early day up to the time of his death, and contributed very largely to improvements in methods and machinery. Mr. Allen was born in Bellingham, Mass., in 1810, where he received a common school education. His first mechanical employment was in a machine shop in the town of Franklin. In 1831 he was engaged in manufacturing shoe cutlery in Milford, and in 1832 moved to what was then known as New England Village, in the town of Grafton, where he commenced the manufacture of the Lambert Cane gun, in connection with shoe cutlery. This was the beginning of the fire-arms business which he prosecuted so successfully thereafter.

In 1833 he built a shop, which he occupied for some time for the manufacture of fire-arms and shoe-kit; this was standing in 1889 and used for manufacturing purposes.

In 1834 Mr. Allen manufactured the saw-handle target rifle pistol, and it is said that in 1835 he took one of these pistols to New York, and showed it to a Mr. Speis, who was engaged in selling fire-arms, and asked if there would be any demand for such an article. Mr. Speis looked at the pistol, and said: "Do you make these?" Mr. Allen replied, "Yes." "What is your price?" Mr. Allen named it. "Why don't you ask twice as much?" was the reply; "I will take all you can make." Thus encouraged, Mr. Allen returned to New England Village and began to make the pistols. Soon after he invented the self-cocking revolver, which was widely known at that period, and subsequently during the Mexican War and the California gold discoveries, during which time the business was most prosperous and profitable. As a gold-miner, Mark Twain in "Roughing It," gives an amusing description of his experience with this self-cocking revolver, and the degree of skill in marksmanship which he had acquired by constant practice. "There was," he says, "no safe place in all the region round about." On one occasion he brought down a cow fifty yards to the left of the target, when an interested spectator persuaded him to purchase the carcass.

About 1837 Mr. Allen took into partnership his brother-in-law, Charles Thurber, who remained in business with him until 1856, when the firm was dissolved, Mr. Thurber retiring. Early in the fifties he associated with himself another brother-in-law, T. P. Wheelock, who died in 1863, the firm being Allen & Wheelock. In 1842 the company moved to Norwich, Conn., where they carried on the manufacture of fire-arms. In 1847 they came to Worcester and located in Merrifield's building, where they remained until the great fire of 1854. Immediately after, they erected a shop at the Junction, in 1889 occupied by the L. D. Thayer Manufacturing Company

and the Worcester Elevator Company, where the business was for some years prosecuted by them and their successors. The removal from Norwich was the practical beginning of the fire-arms business in Worcester; since which time it has been a most important industry. Previous to that date there was nothing that could properly be called a manufactory; there were a few small shops, but nothing more.

In 1865, subsequent to the death of Mr. Wheelock, Mr. Allen took into partnership his two sons-in-law, S. Forehand and H. C. Wadsworth, under the name of Ethan Allen & Company, and so continued until the death of Mr. Allen, January, 1871; after that, the business was continued by the surviving partners, under the firm name of Forehand & Wadsworth. After 1883 the business was carried on by Mr. Forehand, and after 1876 was located in the Stone shop at the Junction, known as the Old Tainter Mill. After the death of Mr. Forehand the business was sold to the Hopkins and Allen Arms Co., of Norwich, Conn.

Mr. Allen was a mechanic and inventor of superior capacity. He invented a doubled-barreled breech-loading sporting gun, and was probably the first to use steel shells in connection with such an arm; these shells could be re-loaded indefinitely. He was the pioneer, in this country, in the manufacture of double-barreled shot guns and fowling-pieces. Between 1855 and 1858 a change was made from the system of muzzle-loading to breech-loading fire-arms, although the breech-loading system had been adopted in Europe before that date, and, at the same time, the change was made from loose to fixed ammunition.

Allen & Wheelock were among the first to adopt the breech-loading system and to introduce the metallic

cartridge. Neither in this country nor in Europe had metallic cartridges been made except by hand—a slow and most tedious process. Mr. Allen recognized the necessity of making the metallic cartridges by machinery, and invented and patented the first set of machinery that was ever built for that purpose. The heading-machine, which in 1889 was used by every manufacturer of metallic cartridges in the world, was his invention, and has stood the test of litigation. Prior to this, no one, so far as is known, had conceived of any process of forming the head except by spinning it up in a lathe.

At the Centennial Exhibition in 1876 the Government exhibited a set of this machinery, and there was nothing in the Mechanical Exhibition which attracted more attention. The whole process, from beginning to end, was the product of Mr. Allen's brain. Probably no fire-arms manufacturer in the country made so great a variety of arms as he: from the whale bomb-lance to the cheap Fourth of July pistol, and every variety of fowling-piece. Formerly all work was done with the file, cold chisel and anvil, but methods have greatly improved, until now there is no finer work done than what is popularly spoken of as "gun work." The parts are all interchangeable and made with the greatest nicety.

Charles Thurber, at one time associated with Mr. Allen, was a successful teacher in Worcester, and is credited with having invented the first type-writing machine, which was said to be in existence in 1889.

Franklin Wesson, after his return from California, in 1859, began to manufacture fire-arms in Merrifield's building in Exchange Street. The first arm he manufactured was a single-shot breech-loading pocket pistol using a cartridge. Mr. Wesson, during the war, manufactured twenty thousand stands of arms for the Govern-

ment. In 1889 he manufactured long range, short range, sporting rifles and pocket pistols.

Frank Copeland, 17 Hermon Street, established a manufactory for fire-arms in 1863; he was formerly in the employ of Allen & Wheelock, at their old shop at the Junction. He first manufactured revolvers, and in 1876 devised a single-shot breech-loading sporting gun, called "The Champion." Mr. Copeland's second gun was a single-barreled sporting gun, called the "F. Copeland Gun," which was more strongly constructed, better in action and capable of standing heavier charges, and altogether more durable.

The Harrington & Richardson Arms Company was established in 1871 by F. Wesson and G. H. Harrington, under the firm name of Wesson & Harrington, for the purpose of manufacturing a shell-ejecting revolver, invented and patented by Mr. Harrington. The business was located at 18 Manchester Street, in the building owned and used by Mr. Wesson as a rifle factory, a business in which he had been engaged for many years. This firm continued until 1874, when Mr. Wesson's interest was purchased by Mr. Harrington, who soon afterward formed a copartnership with William A. Richardson, under the firm name of Harrington & Richardson, and the manufacture of the same style of revolver was continued. This revolver, which was the starting point of the present business, was an improvement in convenience over any other then made, being so constructed as to load and have the exploded shells removed by the sliding ejector, without detaching the cylinder or removing any portion of the arm. It is believed to have been the first successful shell-ejector used on a metallic cartridge revolver. It had a large sale for a number of years. Various other styles of revolvers have been added and im-

provements made and patented from time to time. In the fall of 1876 the business was removed from Manchester Street to the more commodious quarters, 31 Hermon Street. Here new and improved machinery and appliances were introduced and additional room occupied.

In 1880 Messrs. Harrington & Richardson became the sole licensees in the United States for the manufacture of the celebrated Anson & Deeley hammerless gun, an English invention. This was a high cost arm, ranging in price from eighty-five to three hundred dollars. The manufacture of this gun was continued for about five years. In January, 1888, Harrington & Richardson dissolved their copartnership, and reorganized as a stock company, with the following officers: Gilbert H. Harrington, president; William A. Richardson, treasurer; George F. Brooks, secretary.

The business of the company until 1899 was the manufacture of revolving fire-arms exclusively, which were produced of various styles and of different prices, from the plain, substantial, solid frame arm, from which the cylinder is removed by the withdrawal of the centre-pin upon which it revolves, to the more elaborate hinge-frame revolver, employing the automatic shell-ejecting system, by which all the exploded shells are thrown out automatically by the act of opening the arm for reloading. All the arms manufactured by the company have a high reputation for quality, beauty of appearance and reliability. Very few persons not practically acquainted with this business have any idea of the amount and nicety of machinery and special tools and appliances required, and, where revolvers are produced in large numbers, of the care and close inspection necessary to maintain a high standard. If one would undertake to manufacture a new revolver of good quality and the average intricate

construction, and were already provided with all machinery that can be purchased of machine tool builders, adapted to this business, it would require a year to construct one small revolver, and make the tools and appliances necessary to produce the arm in quantities and of good quality.

Upon the death of Gilbert H. Harrington, June 22, 1897, William A. Richardson was elected president and Mr. Harrington's interest was divided equally between his two sons, Edwin C. Harrington and John W. Harrington. Upon the death of Mr. Richardson, on November 21, 1897, Edwin C. Harrington was elected president and George F. Brooks, treasurer.

In 1893-94, a new factory was built on Park Avenue, corner of Chandler Street, main buildings one hundred and eighty feet by fifty feet, five stories high, commodious engine and boiler rooms, and case-hardening building, with a main tower twenty-eight feet by thirty-seven feet. Toward the close of the year, 1899, it was decided to manufacture single barrel shot guns. A model was made, for which tools were gotten out and the first guns were placed on the market in May, 1900. It was found necessary to build an addition of sixty feet, three stories high, to use exclusively for the gun business. In 1901, another building was added ninety feet long, fifty feet wide, and five stories high, with a tower twenty-eight feet by thirty-seven feet, connecting with the tower of the same dimensions of the building built in 1893. In 1904 the machinery of John P. Lovell Company, of Portland, Maine, was purchased, and as that Company had manufactured the Bean's Improved Handcuffs, their manufacture was continued. The product of the Harrington & Richardson Arms Co. now includes double action revolvers, both solid frame and automatic, shell-ejecting, single barrel

shotguns, and handcuffs. The Company employs five hundred and eighty hands. In March, 1878, the number was thirty-five. The product is shipped to almost every civilized country on the globe and the export business is increasing every year.

Iver Johnson & Company, established in 1871, were located at 44 Central Street, and employed two hundred hands. Their products were air pistols, guns, revolvers and other arms; ice and roller skates. This company moved to Fitchburg in 1891.

January 30, 1856, notice is found of a new rifle invented by B. F. Joslyn, the manufacture of which was controlled by Eli Thayer. It was claimed to be superior to the "Sharpe rifle," both on account of the rapidity of its loading and the simplicity, safety and cheapness of its construction. In March, 1859, the *Spy* said that Mr. Joslyn and Mr. Freeman, of New York, had purchased the large stone shop at South Worcester, where they expected to commence the manufacture of pistols under Joslyn's patent at an early day; and, in 1860, the War Department ordered from Mr. Joslyn one thousand of his rifles, which up to that time was the largest single order for fire-arms ever given to one contractor in the country. The Navy Department had previously ordered five hundred.

In April, 1861, they were busy day and night at the Lower Junction shop manufacturing Joslyn's breech-loading carbines for the War Department. Fort Sumter had then been fired upon and the demand for arms became pressing. All the iron-working establishments in the city were busy furnishing the Government with ordnance. Nathan Washburn was making five tons of rifle-barrel iron per day for the Springfield Armory, and was under contract to furnish one hundred thousand musket

barrels. Osgood Bradley was at work on gun-carriages and forges. Wood & Light were busy making machinery for the government at Springfield Armory. November, 1861, Shepard, Lathe & Co. were under contract for Colt, the Burnside factory and Springfield Armory. Allen & Wheelock had two hundred hands at work for the government and private parties. L. W. Pond was building twenty light rifle-cannon of his invention, called the "Ellsworth Gun," at the shop of Goddard, Rice & Co. This was a "breech-loading rifle-gun, four feet long, six inches in diameter at the breech and 3½ at the muzzle, with a 1½ inch bore, carrying a chilled conical ball weighing eighteen ounces, which it would throw three miles. The gun weighed, carriage and all, four hundred and fifty pounds. Cost, three hundred and fifty dollars."

July 11, 1862, a patent was granted to Theodore R. Timby, of Worcester, for improvements in a revolving battery-tower and improvements for discharging guns by electricity. Joslyn's breech-loading carbines were in high favor at this time with the government.

In 1862, Ball & Williams, in School Street, employed one hundred men in the manufacture of the Ballard rifle,—a cavalry rifle which they continued to make until the close of the war. This was a breech-loading arm, using a .42 metallic cartridge, and the invention of Mr. Ballard, who had been a foreman for them.

December 29, 1862, the invention of Stevens' Platoon-gun, invented by W. X. Stevens, of Worcester, was noticed. In April, 1863, Charles S. Coleman invented a breech-loading gun. September 6, 1865, the Green Rifle Works was at the Junction shop. January 15th, Ethan Allen & Co. were making from twenty thousand to fifty thousand cartridges per day.

Nathan Washburn, at one time, worked for William A. Wheeler as a journeyman founder, and while in his employ invented a car-wheel, which he patented in 1852. In company with Mr. Converse, of his native town of Tolland, Conn., Mr. Washburn began the manufacture of these wheels in Franklin Street, next to Bradley's car shop, and continued there until 1857, when the new building was erected near the freight depot of the Western Railroad, since occupied by Washburn Iron Company, and later by the Worcester Steel Works. The building, as designed, was to be occupied in part by Nathan Washburn as an iron-foundry for the manufacture of car-wheels; the main building was to contain machinery for re-rolling iron rails and for making locomotive tires, while the western end was to be occupied by Henry S. Washburn for a rolling-mill and a wire factory. Meantime George W. Gill became associated with Nathan Washburn in the rail and tire business, and very likely suggested engaging in it; for he had been employed as foreman and contractor in charge of the iron work upon the cars built in Mr. Bradley's shop, where he must have become more or less familiar with the railroad business. Previous to the introduction of the wrought-iron rail, rails were made of wood, with flat bar-iron on the upper surface; when the rails were loosened, the ends, called "snakes' heads," were often forced up through the car-bottoms, to the great discomfort and danger of the passengers. Mr. Gill was born in West Boylston, and learned the blacksmith trade in this city. June 1, 1858, he retired from the partnership, but continued with Mr. Washburn as manager of the business.

In 1859 this business had reached considerable proportions, employing from one hundred and seventy to one hundred and ninety hands, and turning out forty tons of

iron per day. At this time, Mr. Washburn, in company with Canadian capitalists, established a rolling-mill at Toronto for re-rolling rails for the Grand Trunk Railway; he attended to the equipment of the mill, and three large steam-hammers were made for it by Wood, Light & Company.

In 1860 there was but one other establishment in New England doing railroad work of this character, and that was located at South Boston. The Washburn car-wheel was very popular, and there was a good demand for re-rolling rails and for locomotive tires. Five hundred thousand dollars capital was employed in the business, and from two hundred and twenty to two hundred and forty men with a pay-roll amounting to seven thousand dollars per month. The works extended over four acres of ground. In the foundry, one hundred and seventy-five feet by sixty feet, forty car-wheels were cast each day and eight tons of machinery. In the rolling-mill, two hundred and fifty rails weighing forty tons were rolled daily, and also four tons of tire for driving wheels, while seven puddling furnaces produced twenty tons daily of bar or puddled iron. The trip-hammers for working over and welding together the worn-out rails were of large size, made by Wood, Light & Company, at their shop at the Junction, by whom the first set of gun-barrel rolls was made in 1860 for Mr. Washburn; these were modeled after an English set in the armory at Springfield.

In 1864 the Washburn Iron Company was formed, with Nathan Washburn, president, George W. Gill, manager, and Edward L. Davis, treasurer. In 1864 Mr. Washburn went to Europe, and when he returned, brought with him an equipment for a small Bessemer plant of about one ton capacity, which he partially built but never completed. This must have been one of the earliest

attempts in this country to erect a plant for the manufacture of Bessemer steel, as the first steel actually made was at Wyandotte, Mich., in the fall of 1864.

In 1865, Mr. Washburn sold out his interest to his associates and built the works in Grafton Street, later occupied by the Washburn Car Wheel Company, where he continued the business of manufacturing car-wheels until about 1866, when he sold out his wheel business to the Washburn Iron Company, and engaged in the manufacture of steel tire car-wheels, and later started a foundry in Hartford to be run in connection with the Worcester shop. Mr. Washburn sold out his interest the same year altogether, but the business continued under the name of the Washburn Car Wheel Company, the product being locomotive truck and tender wheels. He then went to Allston, and remained until about 1887. In 1889 he was engaged at South Boston perfecting a new solid cast Bessemer wheel. After leaving Allston, his plant was leased by Jonas S. Hart & Co.; it was burned down, later re-built, and in 1889 was occupied for the manufacture of wheels by the late Samuel D. Nye, under the firm-name of Jonas S. Hart & Co. Mr. Nye had been connected with this business since 1859, having been associated with Mr. Washburn at that time and was with his successors in the business until the spring of 1888, when he resigned his position as manager of the Worcester Steel business and removed to Allston.

The Washburn Iron Company continued the business of re-rolling iron rails until 1881, when the demand almost entirely ceased by reason of the general adoption of the Bessemer steel rails, which resulted in a great saving in railroad construction. Iron rails were delivered in Boston in the summer of 1868 at eighty-eight dollars per ton of two thousand two hundred and forty pounds, while steel

rails were delivered in Boston, November, 1888, at thirty dollars per gross ton. In the winter of 1881 they began the importation of steel blooms, and in the spring of 1882 began rolling steel rails. Mr. Gill died April 13, 1882, and George M. Rice, of the Rice, Barton & Fales Co., then acquired an interest in the business, which was managed by the Gill estate until October, 1883, when the entire property passed into the hands of Mr. Rice and his associates, who organized the Worcester Steel Works. The work of rolling steel blooms into rails continued until the fall of 1883, when work was begun upon the Bessemer steel plant, and the first steel was made in June, 1884. Later, an open hearth furnace was put in, and during the year 1888 two new trains of rolls were added, modern heating furnaces, etc., for the manufacture of merchant bars.

About four hundred men were employed in these works, producing two hundred and thirty tons daily, made up of rails for steam and horse railroads, blooms, billets and shapes, merchant bars and castings. For over thirty years this business had a prominent place among the industries of Worcester, being at one time the largest single industry in the city. It followed the complete revolution of the rail business consequent upon the introduction of Bessemer steel, and in 1889 was equipped with all the modern appliances for the production of iron and steel. All this followed from the invention of a car-wheel in 1852 by Nathan Washburn in the Wheeler foundry in Thomas Street. George M. Rice died in 1894. The business no longer exists. Part of the land is now occupied by the Worcester Cold Storage and Warehouse Co.

On July 19, 1809, a patent was granted to Abel Stowell for cutting wood screws, but no screws appear to have been made in Worcester until 1831, when C. Read & Co.

commenced the manufacture of wood screws at Northville, as has been stated in connection with the early history of the wire business. In April, 1836, mention is made of a machine for making wood screws, invented by C. Read & Co., "which will cut thirty gross of screws per day with one pair of dies, and one boy can attend from two to four machines, according to the length of the screw." The business is then spoken of as growing and flourishing, but the parties in interest became discouraged and the business was moved to Providence, where it was originally located, and continued there for a time under the name of C. Read & Co., but finally came under the control of the company now and for many years known as the American Screw Company.

A. W. Gifford, who, when a boy, was apprenticed to parties in Providence, in 1853-54 engaged in making wood screws, and later was employed in Worcester by Allen & Wheelock in their fire-arms business, and by Ball & Williams in making the Ballard rifle for the Government, received in 1866 from the Worcester Mechanics' Association a testimonial for a case of milled machine screws, which were the first made for the market in the city or county, and probably in the State. The Worcester Machine Screw Company started in a very small way, with a few machines of their own manufacture, made after some of Mr. Gifford's designs. Originally, it was a copartnership between A. W. Gifford and E. A. Bagley, but later Mr. Gifford became and continued to be the sole proprietor.

The machine used in the screw business prior to 1866 was what was known as the turret-head machine, used by gunsmiths, sewing-machine makers, and at the Springfield Armory. This was not well adapted to the class of work required of it. Mr. Gifford was the inventor of the

machine used by himself and others which superseded it, and which remained in use till the introduction of newer machinery. The old turret-head machine consisted of a revolving traverse spindle, with a dial for holding a series of tools. That, in turn, was succeeded by a machine invented and patented by Mr. Gifford, September 28, 1875, and improved December 26, 1876, in which the blanks were cut automatically to the length required for the screw and fed into the machine, which was so arranged that they were simultaneously milled, threaded and pointed. The product of this factory went to all parts of the country. From eighty to one hundred hands were employed, in 1889, and some four hundred tons of iron and steel used per annum. In 1889 the factory was located at 75 Beacon Street, a brick building, two hundred and fifty by thirty-six, two stories high, with a basement under the main building, and a wing forty by thirty-six for office and packing room. The steam-power was furnished by a one hundred horse-power boiler, and an eighty horse-power Corliss engine. Besides his improvements and patents on screw machinery, Mr. Gifford took out patents on small hardware articles, such as tweezers, cutlery, etc.

Since 1889 the Company has added about twenty thousand square feet of floor space and much new machinery, greatly increasing the output. The new machinery has all been of an improved type, and is the invention of Mr. Gifford, who owned the business up to April first, 1900. At that time he sold out to the Standard Screw Co., a holding Company incorporated under the laws of New Jersey, with a capital stock of $1,500,000. The Standard Screw Co. at that time took over the properties of the Chicago Screw Co., Chicago, Ill., and the Detroit Screw Works, Detroit, Mich.

In the year following they took over the properties of the Lavigne Machine Screw Company, of New Haven, and the Pearson Machine Company, of Chicago, Ill. In 1903, they took over the business of the Illinois Screw Company, of Chicago, Ill. In March, 1904, they took over the properties of the Hartford Machine Screw Company, Hartford, Conn., and its western branch, namely, the Western Automatic Machine Screw Co., of Elyria, Ohio, and increased their capitalization to $4,500,000. In December, 1905, they took over the properties of the Walker & Ehrman Mfg. Co., of Chicago, Ill., and now have a very large percentage of the business of the country. The officers of the Standard Screw Co. were: W. B. Pearson, President, Chicago Ill.; E. B. Cadwell, First Vice-President, New York City; A. W. Gifford, Second Vice-President, Worcester, Mass.; E. B. Dolliver, Treasurer, Worcester, Mass.; George Thrall, Secretary, Detroit, Mich.

Employment is given to about seventeen hundred hands, with a yearly output of about $3,500,000. On the death of Mr. Dolliver, July 6, 1910, W. W. Dadmun was made manager. In 1913 a three-story building, which added approximately twenty-six thousand feet, was built. The Standard Screw Company now operates five factories, some of the plants acquired having been sold, —the Hartford Machine Screw Company, of Hartford, Conn.; the Detroit Screw Works, of Detroit, Mich.; the Chicago Screw Company, of Chicago, Ill.; the Western Automatic Machine Screw Company, of Elyria, Ohio; the Worcester Machine Screw Company, of Worcester.

McCloud, Crane & Minter, manufacturers of machine screws, were located at 57 Union Street. The business was purchased in 1872 of James H. Gray, who in 1870 had bought a patent of Bagley's. Meantime, in March,

1869, Mr. Minter started the same business and continued up to 1884, when he consolidated with McCloud & Crane, and the firm became McCloud, Crane & Minter. Their business was milled machine work, standard and machine screws, studs for steam-engines, pumps, etc., and machinists' taps, to which they added finished and case-hardened nuts. Improvements were made from time to time in the machinery, and their capacity constantly increased, but the advance was for the most part in the direction of turning out an increased quantity from a given number of machines, and in the department of thread-cutting. Beginning with twelve hands, they employed forty-four in 1889. Their iron was purchased in the square, round and hexagon, and also in the shape of wire drawn to size. Several years ago the business was sold to A. H. Anthony and continued under the name of Anthony Screw Co. until 1913, when it was discontinued.

A. A. Bedard & Co., 89 Exchange Street, were also engaged in this business in 1889.

The mills in Worcester depended almost exclusively on water or horse-power until 1840. Wm. A. Wheeler is said to have had a steam-engine of some sort to run a fan in his foundry prior to his removal to Brookfield, and upon his return to Worcester, in 1831 or 1832, he abandoned this engine and substituted horse-power, which he used until 1840, when he put in another engine. Howe & Goddard, at the Red Mills, had an engine of some kind in 1836. Mr. Wheeler is credited in Bishop's "History of American Manufactures," with having the first steam-engine employed in the State west of Boston.

In 1840 Mr. Merrifield put in an engine of from four to six horse-power, and probably the first efficient steam-engines in Worcester were put in at this time by both Mr. Merrifield and Mr. Wheeler. The demand for power

was larger than the supply, so that an engine purchased one year was discarded the next for a larger one. Between 1840 and 1850 Mr. Merrifield put in five engines. The last one, in 1854, and known as the "Lawrence," was in continuous service for forty-six years, until January 1, 1900.

Steam-engines were not manufactured in Worcester to any extent until 1864. Wm. A. Wheeler made an engine in 1842 for Wm. T. Merrifield.

Jerome Wheelock, at one time engineer of the Washburn Iron Works in this city, commenced his business career by making and introducing the sectional ring and piston packing, patented in 1864, and afterwards extensively used in every type and make of engine. Meeting with marked success, he completed, in 1865, arrangements for its manufacture with William A. Wheeler, of Worcester. The demand soon became such that he left the Washburn Iron Company, to give his entire attention to the packing business. In the fall of 1865, or spring of 1866, he formed a partnership with Charles A. Wheeler. This led to a considerable repair business, and that in turn led to the invention by Mr. Wheelock of several improvements in steam-engines. In the fall of 1869, the first engine embodying these improvements was built; this proved to be the beginning of a considerable business. The earlier engines of this type were constructed with a single rotary valve, which proved imperfect in many respects, but contained the germ of success. The growth of the packing business and the prospect of engine-building occasioned the removal to 178 Union Street in 1869, where the business was continued until March, 1890.

Step by step the Wheelock engine was improved, until in 1873, at the American Exhibition in New York, the four-valve engine was introduced to the public. This

employed the rotary tapered valve, suspended on hardened steel spindles—a new type of valve, which became widely known and used. Mr. Wheelock invented and patented numerous improvements relating to the steam-engine, such as feed-water heaters, condensers, and various details of the Wheelock engine. The building of these specialties, together with the piston-packing and a large increase in the engine business, required successive enlargements, until two floors were occupied, and a force of from fifty to seventy-five men employed. During the interval from 1873 to 1884 a great number of engines were built, including a large proportion of machines of five hundred horse-power. In 1883 and 1884 the most important of Mr. Wheelock's inventions was being developed and tested, the patents upon which were issued in 1885. This was the so-called new system valves, undoubtedly at that time the most original and important departure in engine construction since the invention of Corliss. This well-known valve system had for its main idea the combining of the valve, valve-seat and operating parts within a shell or tapered plug which was driven into a corresponding hole in the cylinder and retained in place without bonnets or bolts. It also employed an entirely novel method of driving the valve and combined a number of improvements which secured economical results in the use of steam.

Patents were taken out in all the larger manufacturing countries of the world, and much of Mr. Wheelock's time during the years 1886 and 1887 was spent abroad negotiating for the manufacture of the new system engine. His success was such that it was extensively built in all those countries. During his absence his home business so greatly declined that in the latter part of 1887 he decided to offer it for sale, which resulted in its purchase

by a company organized for the purpose of carrying on the building of the new system engines. The Wheelock Engine Company took possession in January, 1888. Edward K. Hill was president and manager, and the late Edward F. Tolman was the treasurer of the Company, both of the class of 1871, the first class graduated from the Polytechnic Institute.

The Wheelock business was continued in the shop in Merrifield Building, Union Street, until March, 1890, when it was removed to a new plant on Southgate Street, South Worcester.

In 1896 the company sold its plant and business to a successor, the American Wheelock Engine Co., which carried on the same until 1902, when the business was merged with other interests in the American & British Mfg. Co., a New York corporation. Meantime the output had so increased in number and size of engines that the Worcester plant had become inadequate. From 1896 to 1899, Wheelock engines were being built for the American Wheelock Engine Co., in Philadelphia, Chicago and Milwaukee. The product at Worcester had become a small part of the total business. In consequence of this condition, the Corliss Steam Engine Co. plant at Providence, R. I., was acquired in 1899, and the Worcester business was moved to Providence in the spring of that year. Since that date the business has continued at the Corliss Works under the ownership of the American & British Mfg. Co. The product during this time has been the George H. Corliss engines as well as the Greene-Wheelock engines, the latter being the improved successor of the Wheelock engine. At one time about eight hundred men were employed at the Providence works in building these engines.

Edward K. Hill, having in his engineering practice, become well acquainted with the Wheelock engine, recognized the desirability of some changes which would better meet the more exacting conditions which the increase in electric lighting and power were imposing upon steam engines. This was one of the reasons for acquiring the Wheelock business, and soon after doing so improvements were adopted which finally resulted in a valve gear consisting of a combination of the latest inventions of Nathaniel T. Greene, with those of Edward K. Hill, and based upon the Wheelock foundation. This valve gear has been in use since 1895 in all Greene-Wheelock engines, a great number of which have been built, and are to be found in every section of the country and in nearly every state. They have attained, at least, an equal rank with the George H. Corliss engines.

In response to my request my friend, Edward K. Hill, has made the following statement of his estimate of the contribution of Jerome Wheelock to the development of the steam engine:

The Wheelock Engine as invented, developed and built by Jerome Wheelock from its inception in the early sixties until 1888, embodied several unique features, the most important of these being the valve system, although there were others of his invention which had real value as essential parts of an improved steam engine. This valve system was probably the most original in type, and the widest departure from the prevailing Corliss type, of any of the several successful valve gears that have been developed. The exception, if any, was the inventions of the late Nathaniel T. Greene, of Providence, R. I., which were embodied in the Greene Engine, a type that had a considerable use in certain localities.

All automatic cutoff valve gears employ the detachable principle, invented, or at least controlled and introduced by George H. Corliss. While the Wheelock system necessarily

involves the use of that principle, in practically every other respect it is as original and unlike the Corliss or any other system as a valve gear can well be. This originality was acknowledged and appreciated by engineers generally. It was quite commonly considered that the Wheelock system was potentially the most serious rival that the original Corliss system ever had.

A fair idea of the true value of the former system cannot be had from the extent of its use in this country for there were unfortunate limitations not dependent upon the value of the system. It is necessary to take into account the extensive adoption by engine builders of other countries where it attained greater popularity and proportionally wider use than it did in the United States. Under foreign patents there were licensed builders in Canada, England and France, concerns of first magnitude and high standing, in each case. These builders gave a high character to the Wheelock system and built a great number of the engines. In Canada they became the most prominent type of engine, while in Europe they achieved an equality with the Corliss system as a general thing. Numerous modifications were adopted in several countries, particularly in Germany, where a number of hyphenated Wheelock system engines were evolved by builders.

The English licensees, Daniel Adamson & Co., Manchester, built many for export, conspicuous examples being found in the great cotton mills of Bombay, India. Geographically the use of this system has been as widespread as the Corliss system, and had the business in this country had the advantage of the character and administrative ability of another George H. Corliss, it would probably have ranked only second to that famous business in Providence.

The potential and intrinsic value of the Wheelock engine was widely recognized in this country. It's limitations and attainments as a manufacturing enterprise can be gauged and appreciated from the following incident: In 1886-7, the writer was engaged in planning changes in the plant of the Crompton Loom Works. A new engine was required and Mr. Horace

Wyman, at that time the head of the business, stated that he would have no other than a Wheelock engine provided he could have one built under the inspection of his representative. A contract was entered into on these terms and an engine built under the supervision of the writer, which proved a highly satisfactory machine in all respects. It is no small compliment to the system that so many engines built without such supervision, should have given such satisfactory service upon the whole.

The writer regards Mr. Wheelock as having had in his inventions the ample foundation for one of the largest, most dignified and creditable enterprises in the city of Worcester in his time. Were it not for unfortunate limitations, his name in this city could undoubtedly have attained much of the unique distinction of that of George H. Corliss in the city of Providence, and a second place only, in the country. In the foreign countries mentioned his name stands very near the head of the list of the world's improvers of the steam engine.

As an illuminating incident, the following is apropos: Soon after the writer had succeeded to the Wheelock business, while still occupying the unbelievable shop on Union Street, a dark complexioned gentleman was shown into the dingy enclosure that served as an office. An extraordinary perplexity and dubiousness of countenance and manner of this gentleman was explained when it finally came out that he was the East Indian representative of Daniel Adamson & Co., British builder of the Wheelock engine. As such he had installed many of them, notably, several of 2000-3000 horse-power in Bombay cotton mills. His admiration of them was such that, planning his return to India via United States, a prime object was to visit the Wheelock Home Works, in Worcester, Massachusetts, where he expected to find a plant commensurate in size and equipment with his most natural fancy or with misleading statements he may have heard. In fact, he finally stated that he expected to see a magnificent plant covering many acres and replete with equipment of the best known kind. The writer has never had to deal with a man so dumbfounded as this one

was when, after a half hour of explanation and assertion he became convinced that we were not playing off some Yankee trick on him, and that the old rat hole we were in was the cradle and home of the great Wheelock Engine.

E. H. Bellows commenced engine-building in August, 1864, renting a shop in Merrifield's building in Exchange Street. His specialty was portable engines, ranging from the smallest up to forty horse-power. He also built some small stationary engines, not exceeding fifteen to twenty horse-power. In 1865 Byron Whitcomb became a partner in the business, the firm-name being Bellows & Whitcomb. The same line of manufacture was continued until 1868, when the firm was dissolved.

The Washburn Steam Works were incorporated in 1867, with George I. Washburn, president. The object of the company was to build a novel, high-speed, valveless steam-engine, the invention of Mr. Washburn. The chief peculiarity of the engine and the essence of the invention was in so arranging the pistons of a pair of cylinders that each acted as a valve to the other, performing the functions of inlet and outlet of steam, thus doing away with valves. Its arrangement was upright, with twin cylinders, each having several pistons on one piston-rod. The movement of these compound pistons, passing over and by suitable ports connecting the cylinders, produced the requisite opening and closing for the admission and release of the steam. The stroke of these engines was proportionally very short, and the rotative speed consequently great, which features, in connection with the other mechanical objections, proved fatal to the success of this ingenious invention.

The business was commenced in 1865, in a small upstairs shop in one of the blocks in Main Street, between Park and Southbridge Streets. In the spring of 1869 the

works were removed to the Wheeler building, Hermon Street, and again, in the spring of 1871, to Central Street. The defects of the engines soon becoming apparent, Mr. Washburn turned his attention in another direction, the outcome of which was the Washburn Steam Pump, embodying some of the principles of the engine. The manufacture of this pump was begun in the fall of 1868, and continued with success for a number of years. A serious interruption in the business resulted from the death of Mr. Washburn, in the spring of 1871. In 1872, A. Burlingame, for four years previous foreman of the Washburn Steam Works, bought the business and continued the manufacture of the Washburn Steam Pumps on a considerable scale until 1880, when the change to the firm-name, A. Burlingame & Company, was made. About this time the attention of the firm was turned to steam-engines as a supplement to the pump business, which was suffering from the competition of the injector as a boiler feeder. From a general repair business they gradually went into building plain slide-valve engines up to fifty horse-power, followed by an improved pattern balanced slide-valve engine, and later by a Corliss type engine, each of which was built by this firm in a full line of sizes up to one hundred horse-power. Additional to engine building was the making of boiler feed-pumps, and the fitting of complete steam plants, beside a large general mill-work and repair business. The location of the Washburn Steam Works, in Central Street, was abandoned by Mr. Burlingame in 1869, when he moved to School Street. During the year 1888, he moved to the location in Cypress Street, where the A. Burlingame Co. is now located.

S. E. Harthan began the manufacture of stationary, semi-portable and launch engines on a small scale at 44

Central Street, in the year 1874. Increasing business up to 1878-79 required the employment of from twenty to forty men, engaged mostly in building engines of small power of the types mentioned. In 1882 he sold to the Glen Rock Manufacturing Company, of Glen Rock, Pa., that portion of the business relating to stationary and semi-portable engines, including patterns; after which he gave his whole attention to building yacht and launch engines, high and low pressure and compound, together with complete steam outfits. Becoming engaged in electric work, the engine building was gradually abandoned. Besides many stationary engines, Mr. Harthan built the steam machinery for about fifty-three yachts and launches among which was a very fine private yacht for Jacob Lorillard, another for Mary Anderson, and one for Chauncey Ives, of New York, as well as seven smaller boats for Lake Quinsigamond, Worcester.

Clark & Knight established the business of engine-building in 1877. They manufactured upright engines up to thirty horse-power. The business was later conducted by E. O. Knight.

Frank Copeland, gunmaker, 17 Hermon Street, made in 1889 small vertical steam-engines from one to twenty horse-power.

The Stewart Boiler Works were established in 1864 as Stewart & Dillon. The late Charles Stewart learned his trade in Hull, England. He came to Worcester first to manufacture boilers for Bellows & Whitcomb, who were building engines. In 1869, C. Stewart succeeded to the business, and prior to 1872 had purchased the boiler business of Rice, Barton & Fales.

Mr. Stewart and William Allen were in partnership from 1872 to 1875, when they dissolved. The business has since been conducted by Charles Stewart and C.

Stewart & Son. Their castings were all made in the city, and their boiler-plate from American steel. They manufacture locomotive and stationary boilers. The Plant was removed from Union Street to its present location on Albany Street and Boston & Albany Railroad, where it occupies over two acres of land. The firm is carried on by three sons of Charles Stewart,—James C. Stewart, John C. Stewart and Charles M. Stewart. In later years electric cranes and pneumatic tools have been substituted for handwork in the several processes of making boilers, tanks, etc. Special types of boilers and some other specialties in plate work have been added.

William Allen & Sons were established in 1875, after the dissolution of the partnership between Stewart & Allen. They were first situated in Southbridge Street, near the Junction, and later removed to the location in Green Street, in the old shops of the New York Steam-Engine Company. They manufactured all classes of steam-boilers,—tubular, locomotive and marine boilers, feed-water heaters, bleaching kiers, dye-well extractors and iron tanks of all kinds; iron cases for water-wheels and boilers for residences; had an iron and brass-foundry, and made their own castings. They occupied a substantial brick two-story building, a boiler-shop and foundry, and sixty thousand feet of land. William Allen was an Englishman, and served his apprenticeship at the works of James Watt, Birmingham, England.

The company is now known as Wm. Allen Sons Co., proprietors of Worcester Steam Boiler Works, 65 Green Street.

CHAPTER VIII

Boots and Shoes—Bigelow Heeling-Machine—Leather Belting—Boot and Shoe Machinery—Lasts—Dies.

From Caleb A. Wall's Reminiscenses we learn that Captain Palmer Goulding, a cordwainer, came to Worcester just previous to the first organization of the town, and built a house on the east of the Common, where his son, Palmer, Jr., and grandson Daniel afterwards lived. They also carried on the business of tanning, shoe-making, making malt, curing hams, etc. Their place of business was in front of their dwelling, and occupied ground between what are now Front, Mechanic, Church and Spring Streets. Almost every town had a tanyard, and leather of sufficiently good quality was made to serve the needs of the shoemakers and saddlers.

The embargo and War of 1812 greatly stimulated the cordwainers, who began to make boots and shoes in quantities in anticipation of the wants of their customers, and when a few dozen pairs had accumulated, they were put in saddle-bags and taken to market, principally Bristol, R. I., the first wholesale boot and shoe market in the country, it being a sea-port town. At this time the bottoms of all boots and shoes were sewed on; putting them on with pegs was an invention of a later date, and very greatly reduced the cost; this improvement aided materially in the development of the industry. Among the first to adopt it was Joseph Walker, of Hopkinton, Mass.

The next step in the development of the boot and shoe industry was for the makers of leather to sell it to merchants in the larger towns and cities, who, in turn, sold

to the shoemakers, and they, in course of time, paid for it out of the product, in boots and shoes, which were sold by the leather dealers to the jobbers in Bristol, Providence, Boston and New York. These cities held the trade for many years. The next step in the development was the separation of the leather business from boot and shoe manufacturing, the firms dealing in the leather requiring money payment for leather and the boot and shoe manufacturers selling their product to firms dealing in boots and shoes only, who, in turn, sold them, usually by the case of sixty pairs of shoes and twelve pairs of boots, to country store-keepers, who from that time have kept them in stock as universally as dry-goods or groceries.

Among the first towns in which this business was begun was Hopkinton; then in the adjoining town of Milford; and about the same time in several other eastern towns; shortly afterwards in Grafton, where Oliver Ward learned his trade of Clark Brown. Mr. Ward started in business in North Brookfield in 1810, and from the history of North Brookfield we learn that "he made his own pegs; maple logs were sawed in sections of the proper length, which were then split with a long knife and the splint divided into pegs. The next improvement was to cut the points of the pegs in the blocks with a knife and mallet before splitting; and the next was to cut the points with the tail gouge driven like a carpenter's plane; and the next to do the whole by machinery."

Tyler Batcheller, of Brookfield, also learned the shoemaker's trade in Grafton, and, returning to Brookfield, commenced business in 1819, with his brother Ezra, who learned his trade of Oliver Ward.

Worcester was more than a quarter of a century behind these towns in the boot and shoe business, but later had an important place in this industry. Previous to

1813 the only man engaged in boot and shoemaking in Worcester was John Tyler Hubbard, whose shop was on Front Street, corner of Spring. He would hardly be called a manufacturer at the present day, as he did business in a very small way, and, when he had accumulated a few dozen pairs, would take them to Bristol, R. I., for sale.

In 1813 John Dolliver and Foster Newell made for the market, ladies' morocco and kid shoes, opposite the Court House.

In February, 1818, Earle & Chase had a quantity of goat-skin leather dressed in the manner of black kid, which they were having manufactured into shoes and boots.

In 1824 Benjamin B. Otis commenced business near the harness shop of Enos Tucker, and continued until 1850, part of the time with John C. Otis, as B. B. Otis & Co. In 1850 C. H. Fitch became a partner, the firm-name being Otis, Fitch & Co. The same year B. B. Otis retired, and a new firm was organized of Fitch & Otis, which continued until 1860. For three years from 1863 the firm was Dike & Fitch, and from that time until 1886 the business was conducted under the name of C. H. Fitch & Co.

In 1828 Scott & Smith were manufacturing ladies' shoes of various kinds, nearly opposite the Central meeting-house, at the sign of "The Golden Slipper," where they made ladies' kid and double prunella walking shoes and pumps.

In 1834 Charles Wolcot and Nathaniel Stone had a shop three doors south of the Centre School-house, under the *Ægis* printing office, where they manufactured boots and shoes, also ladies' kid, morocco and satin shoes. In the same year Thomas Howe & Co., at the head of Front Street, advertised for eight or ten journeymen to make bootees for the Military Academy at West Point.

Barnard & Hager were at the same time making goods on Front Street, corner of Summer.

In 1835 T. S. Stone began to manufacture in Washington Square, and in that year and the year following, he took a premium for his boots at the Cattle Show. In 1839 he admitted as a partner Ansel Lakin, who was with him but a short time. Mr. Stone continued with various partners until 1864, when Samuel Brown became associated with him. In 1868 A. G. Walker entered the firm, and the business was conducted under the name of Stone, Walker & Brown. In 1871 the firm was again changed, Messrs. Brown and Walker retiring and Mr. Stone's sons being admitted. The business was continued until Mr. Stone's death, in 1873.

George and Ebenezer H. Bowen came from Leicester and commenced the currying of leather, as early as 1836, from which time for twenty years they were, in addition, directly and indirectly connected with the manufacture of boots and shoes.

In 1837 Ansel Lakin began in a small way in the village of Tatnuck, and was afterwards in partnership with Timothy S. Stone. In 1841 he was doing business with Bemis & Williams, and after this he continued with various partners for nearly twenty years.

In 1838 Wm. A. Draper came from Spencer and started in business in Pleasant Street. In 1842 Otis Corbet was admitted to the firm and they continued until 1847, when Mr. Draper went out and the business was conducted by Mr. Corbet alone. In 1850 Mr. Draper returned, and for two years the firm was Wm. A. Draper & Co.

In 1842 E. H. Bowen and William Barker began to manufacture as E. H. Bowen & Co. Barker retired in 1844, and Bowen formed a partnership with T. S. Stone, under the firm name of Bowen & Stone, which was dis-

solved in 1848. After this, Bowen continued alone until 1857.

In 1843 Joseph Walker came to Worcester from Hopkinton, and began business in a wooden building in Front Street. In 1844 the firm of Barker & Walker was formed, occupying a building at the corner of Main Street and Lincoln Square. Mr. Barker retired from the firm in 1846. Joseph Walker continued alone until 1851, when his eldest son, J. H., being of age, was admitted, and the firm name was Joseph Walker & Co., their place of business being at Lincoln Square. G. M. and A. C. Walker, two other sons, were admitted to partnership on their becoming of age. In 1862 this firm dissolved, J. Walker and his son, A. C. Walker, continuing under the old name until 1871.

In 1845 Cyrus, William R. and George W. Bliss moved their business from Milford to Worcester, and continued until 1853. George W. Bliss then succeeded to the business and moved into the Merrifield Building in Union Street, retiring in 1857.

Levi A. Dowley was at this time manufacturing brogan shoes in a small way.

In 1846, on the dissolution of the partnership of Barker & Walker, Wm. Barker commenced business on his own account, and was alone until 1850, when Courtland Newton was admitted, remaining in the firm till 1853. In 1857 Newton Penniman was admitted. Mr. Barker afterwards continued for several years alone.

In 1847 J. Munyan was manufacturing shoes in Main Street, and continued until 1850.

In 1849 Rufus Wesson, Jr., came to Worcester from Shrewsbury, and was in business in Harding's Block, 45 Front Street, until 1873. His son, J. E. Wesson, began alone in 1868, and in 1889 was doing a large business in

Mulberry Street. The firm is now J. Edwin and W. G. Wesson, 7 Asylum Street.

In 1851 W. A. S. Smythe commenced the manufacture of shoes at the corner of Union and Market Streets. In 1860 his brother, Robert L. Smythe, joined him. They gave up manufacturing in 1872, being then situated in Foster Street.

In 1852 Hiram French succeeded to the business of Wm. A. Corbet, and continued the manufacture of boots until 1871.

In 1853 Aaron G. Walker commenced manufacturing, and continued alone until 1857, when he went into company with E. N. Childs.

In 1853 C. C. Houghton began the manufacture of boots at Lincoln Square. In 1857 he admitted his brother, Alba Houghton, into the partnership of C. C. Houghton & Co., and continued with him until 1864, when Alba Houghton retired. In 1864 the partnership of Houghton & Heywood was formed and was dissolved in 1867. H. B. Adams was then admitted, and the firm of Houghton & Adams continued for one year. Mr. Houghton was alone until 1871, when Wm. Warren became a partner, the firm name being C. C. Houghton & Co. Mr. Warren retired in 1884. In 1889 the firm consisted of C. C. Houghton, F. N. Houghton and E. W. Warren and was known as C. C. Houghton & Co., which was located in Houghton's Block, corner of Front Street and Salem Square.

In 1853 E. N. Childs came to Worcester from Millbury, and engaged in business with Albert Gould for one year. In 1854 Albert S. Brown became a partner. They did business as Childs & Brown until 1857, when Mr. Brown retired, and A. G. Walker was admitted under the firm of E. N. Childs & Co. In 1862 Mr. Walker retired and Mr. Childs continued under the same firm name until

1881. During the preceding few years his sons were interested with him in the business.

In 1855 Luther Stowe came to Worcester from Grafton and commenced business in Mechanic Street, soon after which he formed a partnership with E. A. Muzzy, as E. A. Muzzy & Co. The firm dissolved in 1865. Mr. Stowe and J. F. Davenport, under the title of L. Stowe & Co., commenced business in Washington Square. In 1875 Mr. Davenport retired, and the business was continued under the firm name of Luther Stowe & Co. In 1880 they moved to a factory in Grafton Street, and continued there under the old firm name.

In 1857 David Cummings began with Mr. Hudson, the firm name being Cummings & Hudson. Mr. Hudson retired in 1862, and Mr. Cummings continued alone until 1866, when he left Worcester. He returned in 1880, and with his partners, E. H. Hurlbert and D. E. Spencer, built and occupied the factory in King Street, occupied by them in 1889.

E. A. Muzzy and Luther Stowe commenced manufacturing in 1857, as E. A. Muzzy & Co., continuing until 1865, when Mr. Stowe went out and Mr. Muzzy retired from manufacturing, the business being continued by G. L. Battelle and F. A. Muzzy, under the old name of E. A. Muzzy & Co., until 1875.

In 1860 H. B. Jenks came to Worcester from North Brookfield, and commenced the manufacture of boots and shoes, continuing until 1871.

Also, in 1860, H. B. Fay came to Worcester from Shrewsbury. He continued to manufacture until 1887, most of the time under the firm name of H. B. Fay & Co.

In 1862 J. H. Walker commenceed business in Eaton place. In 1864 George M. Walker was admitted, the firm name being changed to J. H. & G. M. Walker. They

afterwards built a factory in Front Street and one in Eaton Place. In 1870 they built and moved to a factory in Water Street, the capacity of wich was doubled in 1879. G. M. Walker retired in 1870. Samuel Davenport took his place, and in 1880 H. Y. Simpson was also admitted, the firm name always remaining J. H. & G. M. Walker. The specialty of this firm was the widely-known "Walker Boot." They retired from business January, 1888.

In 1863 J. W. Brigham & Co., who had been manufacturing for three or four years in a small building near the junction of Main and Southbridge Streets, built and moved into the factory in Southbridge Street, where they were in 1889.

In 1864 Bigelow & Trask commenced the manufacture of shoes in Austin Street. In 1866 they were incorporated under the name of the Bay State Shoe and Leather Company. The headquarters of this corporation were in New York, J. Munyan, before referred to as manufacturing in 1847, was vice-president and Worcester agent.

In 1865 E. H. and O. N. Stark formed a partnership under the name of E. H. Stark & Co. In 1889 they were located in Main Street, above Myrtle.

In 1866 Simon J. Woodbury, of Sutton, moved a building from that place to the site of the shop occupied by Goddard, Fay & Stone in 1889, and he, with others, manufactured for a short time. In 1866 Rawson & Linnell moved their business from West Boylston to Worcester, bringing with them twenty-two families and commenced manufacturing in Pleasant Street, near Main, under the name of E. C. Linnell & Co. In 1868 they built a factory on the site of the Woodbury building in Austin Street. Mr. Linnell withdrew in 1869, and a new firm was organized under the name of D. G. Rawson & Co., consisting of D. G. Rawson, D. S. Goddard, W. B. Fay, which continued until 1881.

In 1867 Alba Houghton withdrew from the firm of C. C. Houghton & Co. and commenced business on his own account under the name of Alba Houghton & Co. and continued until 1882. In 1867, on the dissolution of the firm of Houghton & Heywood, S. R. Heywood went into business for himself and was alone until 1873, when Oscar Phillips was admitted as a partner, and business was done under the firm name of S. R. Heywood & Co. In 1880 they moved to their new factory in Winter Street, and in 1884 were incorporated under the name of the Heywood Boot and Shoe Company. In 1889 the officers of the corporation were: Samuel R. Heywood, President; Frank E. Heywood, Vice-President; Oscar Phillips, Treasurer.

During 1889, Oscar Phillips retired and was succeeded by Frank E. Heywood as Treasurer. The officers remained, President, Samuel R. Heywood; Vice-President and Treasurer, Frank E. Heywood, until 1899 when, upon the death of Frank E. Heywood, the following officers were chosen: President, Samuel R. Heywood; Treasurer, Bertram S. Newell; Vice-President, Albert S. Heywood. The following year the officers were: President, Samuel R. Heywood; Vice-President and Treasurer, Albert S. Heywood; Assistant Treasurer, Bertram S. Newell. These officers continued until the death of S. R. Heywood in 1913. Since that time they have been: President, Albert S. Heywood; Vice-President and Treasurer, Bertram S. Newell; Assistant Treasurer, Chester D. Heywood, a son of Frank E. Heywood.

Since 1889 there have been four enlargements of the factory building—in 1894, 1905, 1907, 1913, the total of all these additions more than doubling the floor space of the original factory. The factory building was originally owned by S. R. Heywood, but in 1907 was purchased by

the corporation. During this period the gross business has increased over three hundred per cent.

In 1899 the Company was changing over from the manufacture of boots to shoes, and for some years after that the product was rated as medium fine, while today the Company is manufacturing strictly high-grade shoes. It is of interest to note that of all the boot manufacturers in Worcester, in the early years of the industry, S. R. Heywood was the only one who continued in the business and changed over from the old, heavy boot to fine shoes. The Fiftieth Anniversary of the founding of the business occurred in 1914.

In 1871, A. G. Walker and Samuel Brown withdrew from the firm of Stone, Walker & Brown, and, commencing under the name of Walker & Brown, continued until 1879, when Mr. Walker retired. Mr. Brown went on alone under the same firm name, and in 1889 was doing business as Walker & Brown, in Barton Place, his son being a partner.

In 1871, Whitcomb, Dadmun & Stowe commenced in Southbridge Street, and continued for four years, when the firm dissolved, and C. C. & C. H. Whitcomb formed a new partnership, under the name of Whitcomb Brothers, and were manufacturing for nine years, when the firm was again dissolved. They were succeeded by C. C. Whitcomb and E. B. Miles, under the name of Whitcomb & Miles, who were manufacturing in Shrewsbury Street in 1889.

In 1872, H. B. Adams, H. W. Hastings and A. C. Walker, began business in the block corner of Allen Court, second story, and then moved to Cherry Street, and, under the name of Adams & Hastings, continued until 1878.

In 1875, J. F. Davenport left the firm of L. Stowe & Co., and he, with Alfred W. Long, started in Eaton Place as Davenport & Long, continuing until 1885.

In 1875, G. L. Battelle, under the name of G. L. Battelle & Co., succeeded E. A. Muzzy & Co., and engaged in the manufacture of a cloth-boot, called "Alaskas," and custom boots and shoes. He was situated in Mechanic Street in 1889.

In 1878, J. U. Green, coming from Spencer, began business in Cherry Street, under the name of J. U. Green & Co., afterwards moving to Front Street, where he continued in business until 1883.

In 1881, upon the dissolution of the partnership of D. G. Rawson & Co., C. S. Goddard, W. B. Fay and A. M. Stone, formed a new company, under the name of Goddard, Fay & Stone, and continued in business until January 1, 1889, when they were succeeded by Goddard, Stone & Co. They always occupied the factory in Austin Street, the capacity of which was doubled by them in 1886.

In 1883, Bemis & Fletcher began business in Mechanic Street, under the name of the Waverly Shoe Company, and in 1889 located in Front Street. Their specialty was the "Waverly School Shoe."

In 1888, F. W. Blacker, who was with the firm of J. H. & G. M. Walker from 1865 until their retirement, succeeded to the business, leased the old Walker factory in Eaton Place, with its machinery, tools and patterns, and continued to make the widely-celebrated "Walker Boot."

Until the year 1868 nearly all the boots and shoes manufactured in Worcester were hand-made, machinery, excepting the sewing-machine, being little used. Worcester manufacturers were not quick to adopt boot and shoe

machinery, and they did not use it until long after it had been adopted in other places. From 1850 to 1868 a large proportion of the boots and shoes were taken to the adjoining towns of West Boylston, Oakdale, Holden, Grafton, Millbury and Auburn to have the bottom stock put on; and then they were brought back and finished in the factories in Worcester.

After 1868 the quantity thus bottomed steadily decreased. There was at one time a great prejudice among consumers against goods made by machinery, hand-made work being considered far superior, and for the first few years after the introduction of the pegging-machine, it was absolutely necessary that the manufacturer "sand off" from the bottom of every boot the impressions made by the machine, for fear the boots might be rejected by the customer. To such an extent was this feeling carried, that as late as 1870 large quantities of goods were sold stamped "Warranted Hand-made," on which nearly the whole work was done by machinery. Up to 1889, there was probably no industry in which the improvement in methods had been so radical and complete as in this. The only department where there had not been a great improvement was in that of the upper leather cutting and treeing. The cutting of upper leather was still done by hand. Treeing was done substantially as it was when boots were first made, and, although machines had been invented for doing this work, they had never been considered satisfactory.

By the use of machinery in its present perfected state, goods can be produced that are more uniform than any that can be made by hand. A striking feature in the manufacture of boots and shoes is the division of labor. As far back as 1840 all who called themselves shoemakers were able to take leather in the side and complete a perfect

boot or shoe. In these days, in the large factories an ordinary boot will go through the hands of fifty or sixty different persons, the work in each room being minutely divided, and few of the men being skilled in any but their particular part. This is one reason why boots and shoes are produced and sold so cheaply at the present time. Each man takes up that branch to which he is best adapted, and continual practice makes him an adept. The cost of labor on a case of twelve pairs of ordinary heavy boots in 1889 was about five dollars. To produce the same number of boots by hand, by old methods, would take the wages of two weeks. The making of lasts, patterns and dies now used, has been so far reduced to a science that one can go into a first-class boot and shoe store and procure boots or shoes that will fit him perfectly.

Worcester was practically what was called a boot town, comparatively few shoes being made in the earlier days. Heavy shoes, called "brogans," and plow-shoes were made, but these were considered about the same as boots, and were usually made in the same factories by the same workmen.

In my article of 1889 I said: In treating of the boot and shoe industry, it is not generally understood that the manufacture of boots and shoes is distinct. A workman is seldom found who can do equally well on each kind of work. The manufacture of ladies' fine shoes, such as are made in Haverhill and Lynn, has never been attempted here. In order to do this it would be necessary to obtain the help from those towns, and this has always been found unsatisfactory. Many attempts to make boots in shoe towns have failed, and the fact is fully recognized.

The manufacture of boots and shoes is now, and has been for years, one of the leading industries of Worcester,

and has been uniformly successful. This is not due to the manufacturers alone. In most of the large boot and shoe towns the workmen are the unsettled population. In Worcester it is not so. Nearly all are permanent residents, a large number owning their homes, and, even in times of great business depression, few leave the city. To this fact must be largely attributed the absence of strikes. While other places have been visited with labor troubles, but two strikes of any consequence have been known here, one in 1867 and one in 1887.

It is to the credit of employer and employees that they have considered their interests mutual, thus enabling the differences between them to be readily and satisfactorily adjusted. It is worthy of notice that, with scarcely an exception, none of the early manufacturers of Worcester had any educational advantages superior to those of the common school. They nearly all learned their trade at the bench, and to this, in a great measure, must be attributed their success. Being able to do any part of the work themselves, they were competent to judge if the work were properly done by others. They have proved themselves to be enterprising and worthy citizens, and have held a full share of the honorable positions in the gift of their fellow-townsmen. They have been represented in the directorates of the various banks, in the common Council, Board of Aldermen, State Legislature, and in the United States Congress by Joseph H. Walker.

The Bigelow heeling-machine was an improvement upon the McKay machine, with which its interests were identified. H. H. Bigelow patented the heel in 1869, and the machine in 1870. By means of it all the odd or "V"-shaped pieces of sole leather, which were formerly considered worthless, were utilized. These were joined or fitted closely together, under a solid upper lift, and fed

to the machine, which consisted of a revolving cylinder, making one revolution in four motions. First, the heel was pressed; then, a quarter revolution and the heel was pricked for the nails; then, another quarter revolution and the nails were driven; with the final quarter revolution the completed heel was forced from the cylinder.

The machine not only utilized pieces of leather of every kind and shape, but took all heels, whether whole, half or quarter lifts, and saved one good lift on each boot or shoe heel, since the leather which would otherwise be trimmed off was by reason of the equal pressure upon the heel from all sides, evenly and smoothly forced into the heel, elevating it, and making a difference of one entire lift in height. A good lift was worth about two cents. The machine not only made pieced heels, but all styles, heights, shapes and sizes, and was undoubtedly a most valuable contribution to this industry, since while it effected the greatest saving it accomplished the most laborious part of the work. With it, a man and boy could heel five thousand pairs of boots or shoes in a day, effecting a saving of the wages of forty-eight additional operatives per day.

The amount of royalty upon a pair of boots or shoes was one-half of one cent, but by the saving of leather, and the saving of wages, the seller was not only able to dispose of his goods at a less price, but the durability of the boot or shoe was increased tenfold by means of this improvement in the method of manufacture.

A. H. Dean, in 1866, established the business of manufacturing shoe heels from upper leather remnants bought at the boot and shoe factories. He was among the first in the country to engage in this occupation as a distinct business. Heels had been made for the most part of sole leather in shoe factories. Most of this work was done by

hand. The heel pieces were cut by dies. The business had so grown that in 1889 there were two hundred concerns in the country in this special line of work.[1]

On February 13, 1861, the first Day Book of the firm which later developed into The Graton & Knight Manufacturing Company was opened. The entire capital invested was $1,057.29, which was furnished by the two partners, Henry C. Graton and Joseph A. Knight, both of whom had had twelve years' experience as belt and card makers, having been for four years with the Earle and Ames Co., and seven years with the T. K. Earle Company, from the latter of which they bought their first stock of belt tools. The first place of business was at 137 Front Street (Harding's Block), and here the belting was manufactured from leather, which was purchased until 1867 when a tannery was built on Bloomingdale Road, whose capacity was about one hundred and fifty hides a week. In 1872 the company was incorporated with $100,000 capital. In 1882 a department known as the Worcester Counter Co. was opened in a building near the tannery for the manufacture of counters, soles and other shoe accessories. In 1899 the capacity of the tannery was increased to six hundred hides a week. The leather was carried to the factory at 137 Front Street and there curried and made up into belting. At the Bloomingdale Road factory, in addition to the products of the Worcester Counter Company, various kinds of straps, such as mill and harvester straps were manufactured.

In 1893 a branch store was opened at Chicago. During the next three years four other branches were established in different sections of the country. In 1893 the belt shop was moved to new quarters at Bloomingdale Road,

[1]The late Hon. Joseph H. Walker and Mr. F. W. Blacker furnished me with some of the material used in the chapter upon Boots and Shoes. C. G. W.

and five years later the office was also moved there, thus leaving Front Street altogether. The Graton & Knight Manufacturing Company is at the present time the largest belt maker in the world, giving employment to nearly fourteen hundred persons. The capacity of the tannery is seven hundred and fifty hides a day. The Worcester factory has floor space of almost four hundred and fifty thousand square feet, or over nine acres. In addition to this, there are two branch factories in other parts of the country. The number of stores has increased to twenty, including one in England, and these employ one hundred salesmen and assistants. The capitalization which had been steadily increasing was fixed a few years ago at $2,000,000. Walter M. Spaulding is President of the Company.

H. O. Hudson & Co., successors to Peter Goulding, established in 1854, manufactured leather belting, rubber belting, loom straps, etc.

J. F. & C. G. Warren (now the J. F. & W. H. Warren Co.) also manufactured leather belting.

Boot and shoe and belting machinery was made by A. F. Stowe, on Cypress Street.

H. C. Pease & Co. and John J. Adams also manufactured shoe machinery.

Samuel Mawhinney, in company with A. P. Richardson, commenced the manufacture of lasts January 1, 1857, in Merrifield's Building. At that time the lasts were turned out in the rough in Canada and finished in Worcester. In 1868 Mr. Richardson retired, and in 1869 Mr. Mawhinney bought land on Church Street and built the shop occupied by him in 1889. About that time R. L. Golbert became a partner. One hundred thousand pairs of lasts were made annually. The material used was rock maple. In addition to the last business, this com-

pany made boot and shoe trees. Golbert Last Company, Robert L. Golbert, President, is now in business at 54 Commercial Street.

A. M. Howe began the die business in Westboro in the year 1857, and moved to Worcester in 1860. In 1861 he had a contract from the Government to make primers for guns. Mr. Howe made boot and shoe, envelope and harness dies; in fact, cutting dies of almost every description. He formerly bought his die stock from the Coes, but in 1889 prepared it under a patented process of his own. John J. Adams bought the business in 1895 or 1896 and still carries it on at 81 Mechanic St., the old location. Mr. Howe died December 26, 1905.

Davis, Savels & Co. was the only other concern in the city which made dies in 1889. They commenced business in 1870. Mr. Davis was formerly in the employ of A. M. Howe. O. M. Savels & Co. now make cutting dies at Plum, corner East Worcester Street.

CHAPTER IX

Paper Machinery—Razors—Norton Company; Grinding Machinery—Corsets—Skates—Chairs—Gas—Electricity—Hydraulic Elevators—Cartridge Belts—Drop Forgings—Pressed Steel—Wall Paper—Labeling Machines—Sprinklers.

Isaac Goddard was born in South Royalston, Vt., in 1800. He came to Massachusetts in 1812, and was apprenticed to Elijah Burbank at Quinsigamond to learn paper-making. After serving his time, he went to Millbury, and about 1823 made paper there by the pound for General Burbank. In 1836 he came to Worcester, formed a partnership with Mr. Howe, and, under the firm name of Howe & Goddard, began making paper machinery at the old Red Mills. It is said that six months after starting they put in a steam-engine of six horse-power. This they used for two years, in conjunction with their water-power. February 1, 1843, they moved to the Union Street factory. In the summer of 1846 Mr. Howe died, and George M. Rice shortly after became a partner.

In April, 1856, Goddard, Rice & Co. bought from Isaac Davis, for thirty-one thousand dollars, the factory occupied by them in Union Street. April 1, 1862, Goddard, Rice & Co. dissolved, and May 1, George M. Rice, George S. Barton and Joseph E. Fales formed a company for the manufacture of machinery under the style of Rice, Barton & Co. At this time they advertised to make steam boilers, and in 1863 manufactured the Vandewater Waterwheel. George S. Barton came to Worcester in 1845; was apprenticed to Howe and Goddard, and in 1849 became a partner in Goddard, Rice & Co.

The Rice, Barton & Fales Machine and Iron Company was organized in 1867, and succeeded to the business of

manufacturing paper-making, calico-printing and dyeing machinery, printing and dyeing machines for cotton and woolen mills, bleaching, paper-printing machinery, hydraulic presses, architectural iron and other large work.

This Company removed from Union and Foster Streets to the present location in 1892, having purchased from the late Joseph H. Walker, a tract of land of nearly five acres. A modern machine shop and foundry were erected, and occupied in the summer of 1893. Since the original buildings were built, five or six other smaller buildings have been added, thereby increasing the floor space very considerably. The sales of the business have largely increased at the new location, and the number of employees is probably one-third to one-half greater now than it was twenty-five years ago.

In the machine shop, the first-class machinists are largely Americans and Swedes. Irish, Finns and Poles are also employed. The foundry employees are largely Irish, although there are a number of Americans.

The main lines of manufacture are today the same as twenty-five years ago, namely the building of paper-making and textile printing machinery, although since that time other classes of machinery have been added; notably, laundry mangles for use in commercial laundries. The manufacture of pulp machinery has been largely increased. This Company is the exclusive builder, in this country and Canada, of several patented machines.

The Company has recently shipped to the largest individual newspaper manufacturing concern in the world the biggest paper-making machine, for the manufacture of newsprint, that has ever been made; this machine weighs in the vicinity of 1100 tons, and is capable of producing a sheet of newsprint one hundred and forty-six inches wide, at the rate of one thousand feet per minute.

George S. Barton succeeded his father, Charles S. Barton, upon the death of the latter in July, 1914, and the management of the Company is now in the third generation, in this respect unique among the manufactories of Worcester.

J. R. Torrey & Co. manufacture razor strops and dressing-cases, and are situated at the corner of Piedmont and Chandler Streets. The business was begun in a very small way in 1858 by J. R. Torrey, with eight employees. In 1885 his son, Lewis H. Torrey, was admitted to partnership. The business has increased until the product is known the world over.

The J. R. Torrey Razor Company was incorporated in 1880. Joseph Turner, a practical razor maker from Sheffield, England, was president, and J. R. Torrey, treasurer. The original factory was erected in 1882 and doubled in floor space in 1905. Upon the death of Joseph Turner, in 1907, his oldest son, William Turner, was made president of the company.

This company was the first to successfully manufacture razors in the United States, and has introduced many improvements in processes, special machinery, and the vulcanized rubber handle. This is the only factory in the country exclusively occupied in the manufacture of razors. There are about one hundred and fifty operatives.

The Holyoke Machine Company was established at Holyoke in 1863. In 1882 a branch factory was built at Worcester, situated opposite the old Wheeler Foundry on Thomas Street. This company manufactures the Hercules Turbine Water-Wheel, shafting, hangers, pulleys and power transmission machinery.

In 1784 there was a pottery in Worcester two and a half miles from the meeting-house on the road to Springfield. In 1875 F. B. Norton had a pottery in a small wooden

building on Water Street where, in 1879, he began the manufacture of grinding wheels by the vitrified process. Since that time, the production of these wheels has far outstripped that of any other kind and grinding has taken a large and revolutionizing place in many lines of manufacture.

The Norton Emery Wheel Company was incorporated June 20, 1885, with the following Board of Directors: Milton P. Higgins, George I. Alden, Walter L. Messer, Horace A. Young, Fred H. Daniels.

Mr. Higgins was the Superintendent of the Washburn Shops of the Polytechnic Institute, Mr. Alden was Professor of Mechanical Engineering. Both of them were my instructors when I was a student. Mr. Young was the Master Mechanic at the plant of the Washburn & Moen Mfg. Co., and Mr. Daniels was assistant to Mr. Morgan, the General Superintendent of that Company.

In July, 1886, the Norton Company began the erection of new works at Barbers' Crossing at the junction of two divisions of the Boston & Maine R. R. This building was finished and occupied about January 1, 1887. It contained 17,280 square feet of floor space, and two kilns. The plant gave employment to thirteen persons and was considered the best equipped in the country.

Changes in 1892 made Milton P. Higgins, president; George I. Alden, treasurer; Charles L. Allen, secretary and general manager; John Jeppson, superintendent. The two latter had been employees of Mr. Norton, Mr. Allen in the office and Mr. Jeppson a potter. Since then Aldus C. Higgins (son of Milton P. Higgins), has been added to the board of directors and is Corporation Counsel; also George N. Jeppson (son of John Jeppson) who is Works Manager. R. Sanford Riley, son-in-law of Mr.

Higgins, President of the Sanford Riley Stoker Company, is also a member of the board.

The Norton Grinding Company was incorporated in 1900. Its products consist of machines for cylindrical grinding, for grinding plain surfaces, roll grinding, car wheel grinding, car axle grinding, tool and cutter grinding and bench and floor stands. The Norton machines for cylindrical grinding are widely recognized as the heaviest types built for grinding with extreme accuracy and rapidity.

One of the recent installations was a roll grinding machine that weighed one hundred and ten thousand pounds. It was designed for grinding rolls fifty-five inches in diameter, twenty-one feet long, which weighed sixty-four thousand pounds or thirty-two tons. Recent developments have made possible the use of grinding wheels, with a face as wide as ten inches.

The railroad industry is greatly aided by the development of car wheel and car axle grinding machines; the methods of rolling sheet metal have been revolutionized by grinding machinery.

The perfection in the manufacture of the automobile is largely due to the development of grinding, to which the agricultural and textile industries also owe much. The pearl, marble, granite, concrete and cutlery industries, even the manufacture of breakfast foods such as shredded wheat, toasted corn flakes and flaked rice, and flours of smooth and velvety texture, chocolate and many other products are more or less dependent upon grinding machines and grinding wheels. Indeed, it may truthfully be said that, in addition to the uses already mentioned grinding has become a great factor in the low cost and high rate of production of machine tools, locomotives, wood working machinery, armament, printing presses, linotype and

monotype machines, cash registers, adding machines and typewriters and it may be added that many of them owe their present state of perfection to grinding machinery.

In the early years the abrasive materials used in the manufacture of the Norton products were emery and corundum. In 1906 Alundum, an artificial or manufactured abrasive, developed by the company, superseded emery and corundum, and a carbide of silicon abrasive, Crystolon, another electric furnace product, became a factor in 1910.

In addition to the Worcester works, the Norton Company operates two electric furnace abrasive plants, one at Niagara Falls, N. Y., and the other at Chippewa, Ontario, Canada; a plant at Bauxite, Ark., for the preparation of the bauxite ore, and a grinding wheel plant at Wesseling, Germany. It has been necessary to develop the abrasive plants on which the Worcester plant is dependent for its raw material in the same proportion as the Worcester plant.

In the year 1916 these plants produced twenty-six thousand tons of abrasives, Alundum and Crystolon, and additional equipment completed in the early part of 1917 has given them a productive capacity of forty-eight thousand tons annually. In order to supply abrasives to maintain the present production at the Worcester works, the electric furnace plants must produce at the rate of at least one hundred and thirty-five tons a day.

The Norton Worcester plant in March, 1917, had a floor space area of 1,214,940 square feet with additional buildings under construction which will add 127,105 square feet. Eighty-two kilns similar to the old type of pottery kiln are employed in the manufacture of grinding wheels, and the number of employees is 4513, of which 3665 are connected with the Norton Company in the manufacture

of grinding wheels and other abrasive products, and 848 with the Norton Grinding Company in the manufacture of grinding machines.

The Norton Company has been among the pioneers in establishing factory hospital free medical service and a system of medical supervision including physical examinations of workmen. Its methods have been carefully watched by large employers of labor and medical experts, and have been adopted elsewhere. Perhaps the most unique among the welfare projects of this company has been the development of the Indian Hill Community, which provides private homes for workmen. Miss Ida M. Tarbell, in her book on "New Ideals in Business," says of it: "Of recent undertakings there is no doubt but that Indian Hill, founded by the Norton Company of Worcester, Mass., is the most suggestive and promising. It is planned for utility, economy and beauty. It will be the most attractive town of its kind in the United States if it is carried out as begun." The Indian Hill Company is a subsidiary of the Norton Company with the same ownership and officials. It provides a way for the workman to buy and own a home of his own which involves an original payment of only ten per cent of the purchase price.

Adjacent to the Norton plant is a farm of forty acres which each year is plowed up by the company, apportioned in garden plots, free of charge, among those employees who care to cultivate the land. The Norton Agricultural Society has become one of the important organizations of the company's employees. The gardeners have been successful each year, and as a stimulus to their efforts, the company holds an agricultural fair annually in connection with a "Folk Fest" which all employees and their families attend. The work of the Agricultural Society, the

success that the gardeners have met with, and possibly the present high cost of living have excited unusual interest, and at this time, March, 1917, four hundred and eighty employees have become farmers and each has been provided with ground for a garden.

Upon the death of Milton P. Higgins in 1912, George I. Alden became President of the company and Charles L. Allen, Treasurer and General Manager.

Milton P. Higgins was the president of the Norton Emery Wheel Company and the other Norton Companies from their beginning until his death in 1912. He was primarily a mechanic with a keen appreciation of mechanical methods. He was early attracted to the possibilities of the vitrified wheel as compared with the elastic wheel which preceded it. It was largely through his optimism and foresight that the vitrified wheel was so effectively developed. He established the Plunger Elevator Company (now merged with the Otis Elevator Company) and the Worcester Pressed Steel Company, and took a very active interest in the Polytechnic Institute, of which he was a trustee. He was very deeply interested in the Worcester Trade School, his relations with which are considered elsewhere.

Among the group of plants at Greendale is that of the Heald Machine Company, established by Stephen Heald in the year 1830, in Barre, Mass. In 1890 the business was carried on by L. S. Heald & Son, Leander S. Heald being a son, and James N. Heald a grandson of the founder of the business. In 1903 James N. Heald, the present general manager of the Heald Machine Company, bought out his father's interest, organized the Heald Machine Company and moved the business to Worcester. For some time previous to the removal of the business the firm was engaged quite extensively in the manufacture

of grinding machines. After moving to Worcester this line of grinding machinery was increased by the addition of the ring and surface grinder, which was designed especially for grinding piston rings for automobile and gas engines, also discs, dies, thrust collars, etc. The success of this machine led the Company to design a machine for grinding gas engine cylinders, for which there was beginning to be a demand. The production of a successful machine for this work proved to be an extremely difficult problem, and involved a great deal of study and experimental work to achieve success. This has been adopted as the standard machine for the work by almost all of the leading automobile and gas engine manufacturers, and there are few machines of any other make used in this country on this work. The next machine brought out by the Company was an internal grinding machine for grinding either straight or taper holes in the more common classes of work which can be rotated to advantage. This machine marks a great advance in the art of internal grinding, because it was especially designed for this particular work, was made heavy and rigid, was provided with quick change speed boxes for easily obtaining correct speeds and feeds, and was highly developed in all its details to make it rapid, accurate and extremely efficient in operation. The works occupy over one hundred thousand square feet of floor space, and are served by a spur track from the B. & M. R. R.

The growth of the Company can perhaps be indicated by referring to the size of the shop in 1903, when the business was moved to Worcester, which was ninety feet wide by one hundred feet long with a shed in the rear containing a small vertical boiler. Additions were made in 1907, 1909, 1911, 1915 and 1916, so that the shop now measures one hundred and

ninety feet in width by five hundred and twenty feet in length, four-fifths of this being saw-tooth roof construction giving the finest light possible in a shop of this character. The artificial lighting is also very cleverly worked out so that the lighting either by day or by night is most satisfactory. The number of persons employed by the Company in 1903 was about twenty-two, while the number at present is about three hundred and seventy-five. The products, while used largely in this country, are exported in considerable amounts.

The officers are: Paul B. Morgan, president; James N. Heald, treasurer and general manager; Paul B. Morgan, John W. Harrington, Oliver B. Wood and James N. Heald, directors.

In the year 1861 D. H. Fanning, still living, an active and useful citizen, finding that hoopskirts were becoming popular, secured a small room in what was then Clark's Block, situated at the corner of Main and Mechanic Streets, and with one operative began their manufacture.

The product of this small establishment found a ready sale. He continued the manufacture of hoopskirts exclusively until the year 1864, when the manufacture of corsets was introduced into this country and Mr. Fanning added this industry.

The plant was enlarged to meet the increasing demands made upon it. In 1872 the business was removed to the W. W. Rice building, 564 Main Street. The manufacture of corsets proved the more important part, and at length the manufacture of skirts was discontinued. The name of the firm, at first the Worcester Skirt Company, was changed to the Worcester Corset Company.

Theodore C. Bates was employed by Mr. Fanning in 1875. In 1876 Mr. Fanning sold to Mr. Bates an interest in the business and formed a limited partnership with

him. Subsequently Mr. Fanning bought Mr. Bates' interest.

The business continued to develop, and a section of the Franklin building, adjoining, was added. In 1880 the Heywood building, located in the rear of the Rice building, was added to the other two.

In 1885, finding the market for its products reaching over a constantly increasing area, at length covering the entire country, the Worcester Corset Company established branch salesrooms in Chicago, Ill., the great distributing point for the West and Northwest, and also opened an office in New York City. Subsequently the name was changed to the Royal Worcester Corset Company and in 1897 the business was moved to the plant now occupied on Wyman Street.

The total number of square feet in the floor space of the various buildings is one hundred sixty-eight thousand, two hundred and eighteen. The number of operatives is about eighteen hundred, including men and women.

A few years ago many parts of the corset were made by hand. Today they are made by high power, motor-driven machinery. This is one of the largest corset plants in the world, and there is no corset plant anywhere which excels this one in modern equipment, sanitary arrangements and general perfection of conditions. David H. Fanning is president of the Company and Edwin J. Seward, treasurer.

The Park Corset Works, in Front Street, was established in 1868, and incorporated in 1885.

The Massachusetts Corset Company was organized February, 1907, with a capital stock of three hundred thousand dollars and succeeded to the business of the United States Corset Company, purchasing the building at No. 15 Union Street and all other property. It has continued its business at the same location and has been

enlarging its manufacture of high-grade corsets under the names of "Wilhelmina" and "Regal Quality." About two hundred operatives are employed. The New England Corset Co. is located at 140 Green Street. Several other successful manufacturers of corsets are located here.

In 1856 S. C. & S. Winslow, who had been engaged in business at Newton Upper Falls, occupied a small room in Cypress Street, in Merrifield's building, doing machine jobbing. In 1857, observing that skating was becoming popular, they ventured to make twenty-five pairs of skates, of which they sold nineteen during the first year. In 1858, in anticipation of the demand, they manufactured two hundred pairs, but before the end of the year had manufactured and sold two thousand five hundred. Seth C. Winslow died in 1871, and his interest was purchased by Samuel Winslow.

In 1872 Mr. Winslow made roller skates for J. L. Plympton, of New York, which were used in this country and exported to Europe and to India. He continued to manufacture them for several years; meantime the business had so increased that a factory was built in Mulberry Street. In 1880 Mr. Winslow invented the Vineyard roller skate, which has been the most popular roller skate made. The demand in this country continued until the fall of 1885.

During the year 1884 Mr. Winslow built an addition to his factory. In 1886 he sold his business to the Samuel Winslow Skate Manufacturing Company.

In 1889 the demand for roller skates in the United States had, for the time being, ceased, but the company exported them to Australia, India, Japan and South America, and the demand has revived in this country.

The capacity of the company in 1889 was twelve

hundred pairs of skates per day, including forty different styles of ice skates and fifteen different styles of roller skates, which varied in price from fifteen cents to ten dollars per pair.

This company also manufactured at one time an excellent bicycle, which was sold at a moderate price, and which found a ready market for the reason that it was as durable as the more expensive machines.

During the last twenty-five years the variety of ice and roller skates has increased threefold, the volume of business and number of operatives fourfold. In 1889 the operatives were almost exclusively Americans, Irish and French Canadians. Today are added Swedes in large numbers, Armenians, Assyrians, Italians, Poles, Greeks and Hebrews.

In 1863 E. W. Vaill, who had previously been in the furniture business, engaged in the manufacture of camp-chairs, which were in large demand by the army and navy. The business was begun at the corner of Main and Walnut Streets, but in January, 1877, was moved to Union Street, the present location of the Massachusetts Corset Co. The old water-wheel, which furnished power for Ruggles, Nourse and Mason, at Court Mills, supplied twenty-eight horse-power for this factory.

At the close of the war the demand for camp-chairs largely decreased, but the principle was carried into all variety of chairs, from the plainest to the most expensive. Over one hundred different styles were made, many of which were patented,and they were sent all over the world. February 5, 1889, the E. W. Vaill Chair Manufacturing Company was incorporated and succeeded to the business, which has since been discontinued.

The Worcester Gas Light Company was organized June 22, 1849, with a capital of $45,000. John W. Lincoln was president, and Warren Lazell, agent.

The works were built in Lincoln Street, and, under date of July 23, 1849, the company gives notice in the Worcester *Spy* that the works will be ready to supply gas to the citizens of Worcester in the following streets, early the next fall, viz.: Main Street, from Lincoln Square to Park Street, School, Thomas, Exchange, Foster and Mechanic Streets, severally, between Main and the railroads; also in Front from Main Street to Washington Square, and in Pleasant Street from Main to Chestnut Streets.

Those desirous of becoming consumers of gas were requested to give early notice at the office of the agent, 205 Main Street, in order that supply-pipes might be carried into their buildings, the pipes to be put in at the expense of the company.

The company was incorporated in 1851; the works were enlarged from time to time, and in 1870 were removed to the present site near the Junction. The older residents of Worcester will remember that on December 16, 1870, escaping gas in the purifying house was ignited by a lantern. A serious explosion followed which fatally injured Honorable James B. Blake, superintendent of the works, who died the following day.

Mr. Blake was appointed agent and superintendent of the works in 1852 which position he held until his death. He was elected Mayor in 1865 and re-elected for five succeeding years.

The capacity of the plant as of June 30, 1916, was as follows:

Number of meters in use	32,365
Miles of gas mains	215.01
Gas sold during previous 12 months,	968,171,000 cu. ft.
Approximate daily capacity	5,000,000 cu. ft.
Net price of gas to all consumers	75c. per M
Coke sold during previous 12 months	13,638 tons of 2,000 lbs.

The present officers are: Dana D. Barnum, president and general manager; Francis H. Dewey, vice-president; DeWitt Clinton, secretary and treasurer. The manufacture of water-gas was introduced in October, 1884, the company having purchased a license under the patents of the Granger Water-Gas Company, of Philadelphia. Twenty-five years ago about two per cent of gas was used for fuel purposes. At the present time about ninety-five per cent of gas used is for its heating value.

The Worcester Electric Light Company was organized in December, 1883, with a Capital of $100,000. The members of the first Board of Directors were: Stephen Salisbury, Jr., Loring Coes, Thos. M. Rogers, Theodore C. Bates, Wm. A. Denholm, Samuel Winslow, Samuel E. Hildreth, Chas. B. Whiting, Josiah Pickett, A. B. R. Sprague, N. S. Liscomb.

Business was begun in February, 1884. The first report of the Treasurer, made December 31, 1884, showed the gross business for the first eleven months as follows:

Sale of electricity.	$31,179.43
Sale of heat	266.67
Total	$31,446.10

For the year from July 1, 1915 to June 30, 1916 the directors were: R. W. Rollins, president and general manager; M. J. Whittall, Edgar Reed, G. T. Dewey, W. E. Sibley, F. A. Drury, T. H. Gage, F. L. Coes, R. H. Bullock, J. A. Denholm, C. E. Hildreth. F. H. Smith is assistant general manager, and H. H. Fairbanks, treasurer. The gross income for the year was $1,142,075.58; 40,750,690 KW. Hrs. Since July 1, 1916, the capital stock has been increased from $1,400,000 to $1,600,000. About thirty-seven per cent of the revenues of the Company are derived from the commercial use of

electricity for power purposes and sixty-three per cent from lighting. The works are located on Faraday Street and on part of the Albert Curtis property at New Worcester.

There has been no more marvelous advance in the industrial field during the last seventy-five years than in the development of power. As I have stated, the mills of Worcester, prior to 1840, depended exclusively upon water or horse power; then the steam engine transmuted the water in our ponds and streams into an effective force, practically without limit. Later, the gas or explosive engine appeared, which has worked a great transformation, particularly in the production of power in comparatively small units. The great rival of steam today, however, is electricity, generated through dynamos which convert the heat units stored in the coal into electrical energy, and also the mechanical energy produced in the fall of water into electricity which is conveyed through wires from the place of development to the point of consumption, often many miles away. Worcester has taken advantage of all these means for obtaining power.

The New England Power Company operates plants on the Deerfield River.

Water power is purchased from the Metropolitan Water and Sewage Board, generated at the Wachusett Reservoir at Clinton, amounting to three thousand KW; and from the Turners Falls Power Co., generated at Turners Falls, amounting to six thousand KW.

The New England Power Company also owns a steam plant at Uxbridge and leases one at Fitchburg, besides having reciprocal contracts with steam stations belonging to the Fitchburg Gas & Electric Company, the Berkshire Street Railway Company, the Blackstone Valley Gas and Electric Company, the Worcester Electric Light

Company, the Narragansett Electric Lighting Company and various smaller public utilities and industrial customers, having a combined capacity of about 149,200 KW.

The total capacity is as follows:

Water plants owned	56,000KW	
Water powers under contract	9,000	
Steam plants owned and leased	8,000	
		73,000KW
Capacity of connecting steam stations, having reciprocal contracts		149,200KW
Total		222,200KW

The electricity is transmitted by a loop system of steel towers carrying double circuits designed for one hundred and ten thousand volts. The greatest length of transmission, at present, is something over one hundred miles.

In July, 1909, the board of aldermen granted a franchise to operate in Worcester. This franchise is limited by the Massachusetts Board of Gas and Electric Light Commissioners under their ruling of October 23, 1909, as follows:

"The company may supply electricity to the Worcester Electric Light Company, electric railroads and railways, but shall not, directly or indirectly, supply electricity to any other customer whose motors and apparatus connected for use shall be of an aggregate rated capacity of less than three hundred electrical horse-power; and whose annual consumption shall be less than 450,000 horse-power hours; and all sales of electricity and all contracts therefor made by said company, except to and with the Worcester Electric Light Company, shall be upon the express condition that no purchaser thereof shall, directly or indirectly, resell the same or any part thereof; but the terms, limitations and restrictions in this paragraph expressed may, at the written request of said Transmission Com-

pany, or upon the complaint in writing of at least twenty users of power in Worcester, from time to time be amended, altered or added to by the Board of Gas and Electric Light Commissioners."

The rates for electricity, in amounts of three hundred horse-power and over, vary from $1.35 per KWH for a ten-hour plant to $1.15 for a 24-hour plant.

The following table shows the total kilowatt hours generated from the various power stations, together with the actual amount delivered to Worcester users:

YEAR	Total KWH Generated.	KWH delivered in Wor.
1910	34,117,593	9,888,651
1911	50,171,917	15,090,022
1912	64,226,101	17,598,554
1913	98,392,654	18,932,268
1914	119,622,020	14,963,240
1915	172,863,764	25,168,536
1916	240,100,000*	36,900,000*

Early in the history of the Washburn Shops of the Worcester Polytechnic Institute, it was found desirable to confine the product as much as possible to articles that did not compete with other Worcester manufacturers. One of the new lines selected was the plunger elevator, so-called, designed by Charles H. Morgan and Milton P. Higgins, who operated the first elevator on the premises of the Washburn & Moen Mfg. Co. The first elevator installed by the Washburn Shops was in 1870 in the building then occupied by Holden Bros., Grocers, at 89 Front Street, as then numbered or 158-60 as now numbered.

This type of elevator, particularly for short lifts, became quite popular because of the ease and safety of its operation, and also because of its durability and freedom from costly repairs. As the business increased in volume there was also a tendency to make passenger elevators.

*Estimated from eleven months.

This led to higher speeds and longer runs. Drilling machines for drilling rock and other apparatus for sinking cylinders in the earth were devised. The business grew at the Washburn Shops and proved profitable financially, and valuable for the experience it gave the apprentices.

About the year 1879 a company was formed in Worcester that proposed to operate under the "Thayer Patent," which covered the telescope plunger. This arrangement required a cylinder less than the length of the run of the elevator. The load that could be lifted, however, was diminished in the upper part of the run. The first elevator of this type had a run of fifty-two feet and had four separate moving parts in its plunger. This new company also made the regular plunger type in competition with the Washburn Shops. This Company went out of business in a few years. The plunger elevator business continued at the Worcester Polytechnic Institute until 1896. At that time Superintendent Milton P. Higgins resigned and a company was formed under the name of the Plunger Elevator Company. Milton P. Higgins, president; George I. Alden, treasurer, W. F. Cole, general manager. The Worcester Polytechnic Institute gave up the elevator business and the Plunger Elevator Company carried it on at Barbers Crossing for four years. During that period the plunger elevator came into greater use as a passenger elevator. Plunger elevators were installed in the Jewelers Building in Boston, which with other similar installations, attracted the attention of the Otis Elevator Company. As this company had practically all the passenger elevator business in the country it acquired the Plunger Elevator Company. The business was carried on in Worcester by the Otis Company for about six or seven years, but through the Plunger Elevator Company organization. During this time several large installations

of plunger elevators for passenger service were made in New York and other places, the largest being a battery of some fourteen or more elevators with runs of from one hundred and eighty to two hundred and twenty feet. The cylinders were set in holes drilled in rock. In April, 1907, the manufacturing part of the business was removed from Worcester. The Otis Company still installs Plunger Elevators, and has an office in Worcester, through which repair parts may be had or orders for plunger elevators may be placed. The growing use and greater perfection of electric elevators made by the Otis Company, has decreased the demand for plunger elevators. About 1903 the Standard Plunger Elevator Company was started in Worcester. This company was financed by New York capitalists and operated by former employees of the Plunger Elevator Company. It is still doing business in Worcester on Stafford Street.

The Mills woven cartridge belt is one of the many inventions which have been developed in Worcester. The inventor was Anson Mills, who, as a captain in the United States Army, saw objections to the cartridge belt of leather or of canvas with stitched loops; and having in his boyhood on a pioneer farm in Indiana "handed in" for his mother to weave homespun, he had sufficient knowledge of weaving to suggest the idea of weaving a fabric, part of which should be a belt and the other part, homogeneously woven therewith, loops for carrying cartridges upon the outer surface of the belt. The invention was made in Paterson, N. J., in 1877, but Captain Mills could get no one to encourage him in the building of a loom until he came to Worcester and found George Crompton sympathetic, but unable to take practical interest in the invention. Charles W. Gilbert eventually constructed the loom under the direction of Mills.

The first patent to Mills was granted August 20, 1867, and was for a leather cartridge belt. The manufacture of the woven belt began in Worcester in 1880, a patent on which was issued December 28, 1880, and on the same date a patent was issued on the loom for weaving the cartridge belt fabric. The business was domiciled in Union Street, North Foster Street and Central Street for several years, the first manufacturer being Charles W. Gilbert, who was succeeded by Thomas C. Orndorff, a brother-in-law of Mills, the inventor. The business was confined to the making of cartridge belts for sportsmen and small orders for the United States Army until the outbreak of the Spanish War, when the plant was greatly enlarged in the premises at 51 Union Street, now owned and occupied by G. L. Brownell. In 1905, Mills, who had become a Brigadier General on the retired list, sold all his interest in the cartridge belt business to a corporation, which at first continued the business at 51 Union Street, and in 1909 removed to a new plant at 70 Webster Street, New Worcester. The business has been expanded by the invention and manufacture of many articles of equipment, for which improvements in small arms and the steadily increasing cost of leather have created a demand, so that instead of the simple belt originally made by Mills, with a single row of loops for cartridges thereon, there are now manufactured hundreds of forms of equipment. The business has been extended to other countries, Great Britain being the first great foreign nation to adopt the Mills system for the equipment of soldiers. When started in Union Street, this business gave employment to not more than half a dozen people and up to the time of the Spanish War operated a maximum of ten looms; the number now employed varies from one hundred in quiet times to three hundred in busy times, operating ninety-five looms and accessory machines.

All but a small percentage of the output of the Worcester factory is destined for the use of the regular Army, Navy and Marine Corps of the United States and the Militia of the several States. Foreign orders are made in Worcester only in case of emergency, it being possible to produce the same goods in England at fifty per cent of the cost of producing them here, due very largely to the difference in wages paid.

The officers of the company are: H. W. Goddard, president; F. R. Batchelder, treasurer and general manager.

The Wyman-Gordon Company, Manufacturers of Forgings, had its beginning in the partnership of H. Winfield Wyman, a graduate of Worcester Polytechnic Institute, class of 1882, son of Horace Wyman, so long identified with the loom business, and Lyman F. Gordon, a graduate of the same institution, class of 1881, under the name of Wyman & Gordon.

The original building, built on Bradley Street, December, 1883, was one story, of wooden frame construction, sixty feet long, forty feet wide, and contained a forge shop, machine shop and office. The business started as a manufactory of drop forgings, with two men, one to make the dies and the other to make the forgings. Mr. Wyman and Mr. Gordon shared the responsibilities of engineer and fireman, and were the first to arrive in the morning and the last to leave at night.

Some of the first forgings made were parts of looms, such as crank shafts, shuttle box binders and other forgings used in the manufacture of this class of machinery. The shop was equipped with two small drop hammers, a very old-fashioned helve or trip hammer and machinery adapted to make dies and tools such as a planer, a lathe, a die sinking machine and drill.

From the connection with the loom industry, in 1885

the company started the manufacturing of shuttle irons or trimmings for loom shuttles, such as shuttle tips, shuttle and bobbin spindles and springs, both in the shape of forgings and the finished product. This character of work was later abandoned for a heavier grade of forging work, and in 1891 the company started to manufacture the steel car coupler knuckles which have superseded the old link and pin for joining railroad cars. It was in the making of these forgings that the necessity was discovered for a toughening or heat treating process that would eliminate forging strains and brittleness that caused excessive breakage in use. As the result of expert advice, the company devised a method of heat treating these steel knuckle forgings so as to render them practically indestructible. From these experiments was developed the first commercial system of heat treating of materials now in such general use in the country and so necessary for use in many of the vital parts of the automobile of today.

In 1891 the company had a force of between thirty-five and forty men, and engaged quite extensively in the manufacture of forgings for bicycles, which occupied its attention for several years.

In 1894 the company was engaged in perfecting and producing for the Washburn & Moen Mfg. Co., later American Steel & Wire Company, copper rail bonds for the bonding of rails of electric railroads, in connection with the regular business of making iron and steel forgings.

In 1902 the first drop forged crank shaft for an automobile was made. The experience obtained in the various lines of product handled during the previous years, particularly the pioneer work in heat treatment, gave the company at once a commanding position in supplying the demands of the automobile industry. The plants at Worcester and Cleveland now represent the largest drop

forging industry in the country. A specialty is made of the manufacture of intricate and important forgings, such as crank shafts, gears, axles, steering knuckles, etc. A most extensive chemical and physical testing laboratory is maintained. The name of Worcester is associated with high-grade crank shafts, a large proportion of those used in this country being manufactured here.

The character of the machinery now required is widely different from that used in the early years of the business. Small light board drops have been replaced by heavy steam hammers with heads running up to twelve thousand pounds in weight, and hydraulic presses of twelve hundred tons and more capacity.

In 1894 the plant had a floor space of thirteen thousand square feet; today this has increased to one hundred and sixty thousand square feet and there are about five hundred and fifty employees.

Mr. Wyman died in 1905 and Mr. Gordon in 1914.

The officers of the corporation are George F. Fuller, president; H. G. Stoddard, vice-president and treasurer; Charles C. Winn, assistant treasurer.

The works of the Worcester Pressed Steel Company are located on the Boston & Maine Railroad, about one-eighth of a mile south of Barbers Crossing, Greendale. The business was founded in 1883, under the name of Worcester Ferrule Manufacturing Company, employing twenty hands and occupying eight thousand square feet of floor space at 17 Hermon Street. This Company manufactured steel and brass stove trimmings, patent nickel-plated knobs, hinge pins, towel racks, foot rails, steel, iron and brass ferrules, nickel-plated steam pipe collars. In 1894 larger quarters were secured at 100 Beacon Street.

In that year the company developed the manufacture of bicycle frame fittings in pressed steel, which revolutionized the cost of bicycles. The company has been a pioneer in the development of the pressed steel industry, some of the notable inventions being pressed steel ball cups for ball bearings now used extensively in automobiles, bicycles, and roller skates. In 1904 the Worcester Ferrule Manufacturing Company was bought by the Worcester Pressed Steel Company, a corporation organized under the laws of Massachusetts, with Milton P. Higgins, president; George I. Alden, treasurer; and John W. Higgins, secretary and general manager.

At that time a new department was added for polishing, nickel-plating and buffing. In 1905 six acres of land were purchased on the Boston & Maine Railroad, near Barbers Crossing, and a mill building two hundred feet long by ninety feet wide, two stories high, was erected.

The company purchased the first oxy-acetylene autogenous welding plant made in this country for commercial purposes. In this department it has likewise installed from time to time every new and practical device invented for autogenous welding purposes. In 1908 a department was added for cold rolling, shearing and pickling strip steel. In 1909 a new building one hundred and twenty-five feet by thirty-five feet was erected for annealing and case hardening, a portion of this building being used for an iron foundry for making semi-steel castings used in die blocks, bolsters and dies. In 1910 facilities were increased by a new building, ninety feet by one hundred feet, two stories, for storage and shipping departments and general office. In 1912 the company erected a new building for the pickling of steel and stampings. This building is mill construction, sixty-nine by one hundred and eight feet, and contains the most

modern equipment for the efficient manipulation of strip steel. At the same time an additional eight acres of land were acquired to provide room for future development.

In 1913 and 1914 a new building was erected, ninety feet by one hundred and fifty feet, one story, of monitor fire-proof steel construction, metal sash and glass. This building contains a new rolling mill, which is the only three-high cold rolling mill in this country; it also contains the most modern equipment for the economical and efficient rolling, shearing, straightening, polishing, slitting and coiling of cold rolled steel. In order to efficiently manage the cold rolled steel department, which has grown by leaps and bounds, a subsidiary company has been incorporated under the Laws of Massachusetts, to be known as the Worcester Strip Steel Mills Company, with John W. Higgins, president and treasurer. The controlling interest is owned by the Worcester Pressed Steel Company. In order to manufacture and market a pressed steel pulley, which has been developed by the Worcester Pressed Steel Company, a subsidiary company has been incorporated under the Laws of Massachusetts under the name of the Worcester Pressed Steel Pulley Company, with John W. Higgins as president and treasurer. The Worcester Pressed Steel Company own a controlling interest in this subsidiary company. John W. Higgins is the executive head of all these affiliated industries

In 1883, J. Fred Wilson, of the class of 1877, W. P. I., engaged in the business of metal stamping. Later George A. Smith, a nephew of Thomas Smith, metal puncher and nut maker, for many years in Cypress Street, joined Mr. Wilson in the firm of Wilson & Smith.

In January, 1906, H. R. Sinclair, W. P. I., 1893, bought Mr. Smith's interest. The partnership then formed was known as the W. & S. Mfg. Co.; W. representing Wilson and S. both Smith and Sinclair.

Mr. Smith continues in the stamping business under the name of George A. Smith Company at 172 Union Street. In November, 1910, Mr. Sinclair bought Mr. Wilson's interest and became the sole owner of the business. In December, 1916, the business was incorporated as the Worcester Stamped Metal Co., with a capital of $150,000. H. R. Sinclair is president of the corporation and F. E. Billings, treasurer. The company occupies a commodious factory, built in 1905, at Hunt, off Shrewsbury Street. The Worcester Ferrule Co., now absorbed in the Worcester Pressed Steel Co., and this business were both established in 1883.

The business of the Hobbs Manufacturing Company was begun in Boston in 1889. In 1891 it was brought to Worcester, when Clarence W. Hobbs entered into a partnership with Richard Sugden and Harry W. Goddard, both of Spencer, and the business was located at 15 Union Street in the building now occupied by the Massachusetts Corset Company. This partnership continued until 1894, when on the death of Mr. Sugden the business was incorporated, with Mr. Hobbs as president and Mr. Goddard as treasurer, they owning all of the stock excepting one share by the qualifying director. During the early years the business was confined to the manufacture of paper box making machinery, for which there was a brisk and a growing market, and this branch of the manufacture has been continued to the present time. In 1903 the quarters on Union Street becoming inadequate, the plant and business of the Witherby, Rugg & Richardson Company at 26 Salisbury Street was acquired. The plant was enlarged by a four-story addition on Prescott Street. The manufacture of wood-working machinery was carried on in connection with the other business until 1911, when it was disposed of. In 1910 an addition to the

plant fifty by seventy and five stories in height was made on the Salisbury Street front, which has since been used for storage and shipping purposes. In 1904 there was added to the business a line of nut locks made from wire by special patented machinery, and this has become a very substantial part of the business. In 1910 a large interest was acquired in coin-operated machines for the sale of postage stamps, tickets, etc. The tariff legislation of 1913-14 caused a material restriction in the output of paper box making machinery, which will no doubt continue until a change in the fiscal policy of the Government once more permits the expansion of the protected industries in which paper boxes are most largely used. In 1891 the business employed thirteen operatives, one superintendent and one office clerk, and amounted that year to $56,000. In 1910 the output exceeded $450,000, and the number of operatives was one hundred and sixty. The number of employees in the manufacturing and sales departments was one hundred and seventy-five.

The nationalities employed are chiefly American, Irish, and Swedish, except in a piece work department of the nut lock division, where Syrians are chiefly employed, doubtless because one Syrian found he could make good pay and induced his fellow-countrymen to apply for work as opportunity offered.

Allen-Higgins Wall Paper Company was located here in 1898 through the immediate efforts of the Board of Trade. There was then but one factory, at Chelsea, in this industry in New England. Messrs. John P. and George W. Allen, and George F. Higgins were the practical promoters of the undertaking, and were, in due course, assisted by local capital to the amount of about $250,000, and a subsequent bond issue of $35,000.

The plans of the promoters contemplated the manu-

facture of medium, high-grade wall paper. The purpose was to avoid, as far as possible, being brought into close competition with the large general factories, producing goods of cheap grade in an ever-increasing amount, where volume is indispensable to compensate for a small margin of profit. This policy of the new company was well considered and has been productive of good results. Owing, apparently, to lack of adaptation of the business organization to trade and other conditions the financial success of the initial enterprise was not satisfactory. In 1905 a re-organization took place. The grade of the product was not materially changed, although added emphasis was given to special designs of high artistic merit. Financial success rewarded the new endeavor.

The value and volume of the annual product was more than doubled. During the past ten years this factory has been accorded the foremost place in the trade. Those directing its activities have been prompt to avail of advanced methods.

This business does not require a large amount of manual labor. About one hundred hands are usually employed, mostly men. The mechanics, so-called, including machine printers, color mixers and block cutters are all of high grade, receiving large wages. This industry is strongly unionized throughout the United States.

The season of productive activity is short, extending from about September 1 to April 1. Sampling of a new line takes three months additional. A manufacturing volume of four million rolls is usually considered a good average for a factory of this class, where the printing has to be done slowly and with great attention to details.

Comparatively few of the employees in this industry are of American parentage. It is somewhat difficult to account for this in view of the type of skilled labor required.

The market is largely confined to the United States. Foreign trade has never reached any considerable volume owing mainly to the fact that the sales season here and abroad do not correspond. The fact also that a new line is sampled every twelve months leaves little time for handling duplicate orders at long distances. These are conditions which have grown up with the business and for which there has as yet appeared no satisfactory remedy.

The company creates most of its designs. The officers are: Albert E. Lyons, president; Frederick Staib, vice-president; John Tuck, vice-president; William Woodward, treasurer; Albert H. Anderson, secretary.

Among the many mechanical products of Worcester is one that occupies a somewhat unique position, namely the labeling machines manufactured by the Economic Machinery Company, 72 School Street. Worcester is one of the very few cities that contain factories confined exclusively to the manufacture of machines for placing paper labels on containers of various kinds. The Economic Machinery Company was originally incorporated under the laws of West Virginia in 1901, and was engaged in manufacturing labeling machines on a somewhat small scale previous to that date. Their first product was known as the Star Foot Power Labeler, a small machine operated, as its name would indicate, by foot-power. A number of these machines are in use today. From this original machine a simple power machine was developed and later a machine that would place body and neck labels on the same package at one operation. Previous to this time there had been a number of machines that placed one label at a time. Where it was necessary to place an additional label on the bottle, it was done by hand, or the bottle was passed from the first machine to a second machine, for the second labeling operation.

The placing of two labels at one operation, by the Economic Machinery Company's World Labeler, was a great economic gain.

The company originally occupied a small amount of rented space. It now occupies forty thousand square feet in its own plant, the old Lombard factory, at the corner of School and Union Streets. After the first World Labeler had been in operation for several years, a machine following the same general lines, but combining numerous improvements, was produced; this was called the World Labeler, Improved. Special devices were later developed for use on this improved machine that, for the first time, made it possible to place a label around the entire surface of a bottle. Another adaptation of this machine is the Center Gum World Labeler, adapted for bottles having flat surfaces, it being necessary on this type of bottle to gum the entire back surface of the label. The Center Gum machine is, with the exception of two machines not largely used, the only one doing this work.

One of the more recent products is called World Labeler, Junior. It is a simply constructed, very durable machine, designed especially for the smaller plants. It is limited to the placing of a single label and was immediately successful with the class of trade it was designed for.

The scope of the machines has been gradually enlarged until there is hardly a single variety of glass package, bearing paper labels, that is not manipulated by some kind of a World Labeler. An entirely new machine has recently been brought out called World Automatic Rotary Labeler and is designed to do the work of three standard type hand-fed machines. This machine is fully automatic and will give an output with one operator, of from ninety to one hundred and twenty bottles a minute, bearing body and neck labels.

Because of the fact that machines are as a rule operated in plants where they can not be given the necessary attention by competent mechanics, a Service Department has been developed. Inspectors are constantly covering the entire country and Canada. It is their business to call upon all users of the World Labeler, and to make a careful inspection of machines giving such instructions and making such adjustments as are necessary in order to insure the greatest efficiency. Branch offices are maintained in New York, Philadelphia and Chicago, with agencies in Atlanta, Ga., Jacksonville, Fla., Fort Smith, Ark., San Francisco, Cal., and Portland, Ore. Salesmen traveling as direct representatives from the home office, cover the sections of the United States and Canada, not taken care of by the branch offices and agencies. The officers of the company are: D. W. Gurnett, of Boston, president; Arthur J. Wallace, secretary-treasurer and general manager; Herman Stake, vice-president and works manager. The late Frank O. Woodland was at one time vice-president. The officers of the company, George Putnam and Carl Bonney constitute the Board of Directors.

The O. & J. Machine Company, 116 Gold Street, manufacture an automatic labeling machine.

The fire loss in the United States of America during the past ten years has remained substantially constant, the destruction totalling in round numbers two hundred million dollars annually. This is, roughly speaking, ten times the rate at which fire destroys property in any European country. This is true notwithstanding the superior cost and efficiency of our city fire departments. The reasons for the preeminence of America in this regard are principally two: first—inferior building laws; and second—carelessness in setting fires by such agencies as matches and cigarettes.

The Fire Underwriters, both Stock and Mill Mutual, have recognized for many years the extent of the American fire loss and have done much to diminish it through the scientific investigation of fire resistive building construction and the development of automatic fire extinguishing apparatus; so that, while the total fire loss per annum has not been diminished, it is relatively much less than formerly, as the total property values have enormously increased, while the loss has remained stationary.

It was not, however, until the introduction of the automatic sprinkler, by far the most important of all fire protection devices, that any real headway was made in the reduction of the fire loss. This was due to the difficulty of throwing water on the seat of the fire at its very inception through the agency of such simple means as water pails, stand pipes and hose. Still less could outside hose service do more than prevent the spreading of fire to surrounding premises.

It has been a saying with fire experts that the presence of a man with a pail of water at the moment a fire was lighted would suffice to control almost any fire that ever started. The automatic sprinkler does mechanically, by night or by day, what the alert man with the pail of water could as easily do if he were on hand when fire starts.

Early types of automatic sprinklers were crude and unreliable, but now, after a period of nearly forty years of use, they have been so perfected that little improvement remains to be desired. The thorough tests made in insurance laboratories, the advice given as a result of these tests, and the study they involve, together with the work of a number of inventors, have achieved this result; but the rebate in the cost of insurance allowed by the Insur-

ance Companies for sprinkler protection was undoubtedly the most powerful factor in the growth of the business, which is now of large proportions.

While the first practical automatic sprinkler was designed in England it may be considered an American invention, for the first sprinkler to be used in practice was invented here and most of the early development took place in this country.

Oversight in the manufacture of automatic sprinkler devices by the Insurance interests has been brought to such a point that it may be truly said to have reached practical perfection.

An automatic sprinkler may be defined as a device which, when heated to a predetermined point, will automatically release and distribute a stream of water.

Patent records show that over four hundred and fifty patents have been taken out in the United States since 1872, and there have probably been a great many more inventions than have ever been patented, yet out of this vast array there are today on the approved list of the National Board of Fire Underwriters only six surviving sprinklers. There are a large number that have been quite practical and used in years past, but which have been superceded by improved types and gradually eliminated from use.

The Rockwood Sprinkler Company is a Massachusetts Corporation formed in 1906 to manufacture Rockwood Automatic Fire Sprinkler Devices, and also to enter the fire protection engineering and contracting field as contractors for the design and installation of complete fire sprinkler systems in all classes of buildings throughout the United States and Canada.

The Company operates under the now well known Rockwood patents, and its apparatus has the formal

approval of both the National Board of Fire Underwriters and the Associated Factory Mutual Fire Insurance Companies.

In addition to the Rockwood Automatic Sprinkler Head, the Rockwood Automatic Dry Pipe Valve, and the Rockwood Variable Pressure Alarm Valve, the company manufactures the Rockwood and Carlson Beam Clamps and Pipe Hangers in all sizes; the Carlson Concrete Hanger Blocks; Piper's Bench Vises; Extension Drilling and Tapping Machines; Special Pipe Bending Work; and Special Pressed Metal Work, and a full line, from one-eighth inch to three inch, of Rockwood Bronze Seat Pressed Steel Pipe Unions.

During the past ten years all of the above devices have been manufactured and thoroughly tried out in use on a large scale. The mechanical methods and tools used have been perfected to the highest possible degree according to the most modern and expert ideas. The object has been, first, to secure 100% of absolute accuracy in their reduplication according to fixed models, and, second, as much economy of labor as is consistent in attaining such accuracy. This policy, faithfully carried out, has earned for the Company the good will of the Underwriters as well as of the public, and lies at the base of its business success.

Starting as it did nine years ago with but $10,000 capital, the number of sprinklers made and erected all over the United States and Canada is now in the millions.

Over $100,000.00 has been spent on machinery and tools; the Company owns $150,000.00 worth of real estate; has several hundred thousand dollars worth of present contracts on hand; and has total assets in excess of half a million dollars.

The Company operates a large selling office and con-

structing force of men in New York City, another one in Boston, others in Chicago, St. Louis, Cleveland, Minneapolis, Buffalo, Seattle and Canada.

The volume of its business is over sixteen hundred thousand dollars a year. Its total losses in nine years of business, due to uncollected debts receivable has been less than twenty thousand dollars. It has an outstanding issue of two hundred and fifty thousand dollars of Preferred Stock on which it pays 7% interest, and which has at all times been many thousands of dollars less than the liquid assets of the Company. It employes an average of five hundred persons.

Its Worcester Plant occupies an area of six acres of land, served by a spur track on the Boston & Maine Railroad on the corner of Harlow and Crescent Streets. Its Chicago plant is situated on the Belt Railroad.

The articles manufactured by the Rockwood Sprinkler Company are shipped not only all over this continent, but to its agents in all the countries of Europe and Asia.

The officers of the Company are: George I. Rockwood, president and treasurer; John P. Ashey, vice-president; Halford W. Park, secretary. Among its officers and engineers there are nine graduates of the Worcester Polytechnic Institute. A large part of the manufacturing success which this Company has enjoyed, so Mr. Rockwood has told me, has been due to the ingenuity and ability of its General Superintendent, Hjalmar G. Carlson.

Whitney Manufacturing Company grew out of the Edward Whitney Company. Edward Whitney Company was engaged in the wholesale stationery business begun in Worcester about 1860 by the late Edward Whitney. This company sold its merchandise in Worcester and New England.

In November, 1899, Whitney Manufacturing Company was established. This change was made for the purpose of manufacturing fine stationery. Room was secured at 7 Vine Street and the beginning was made with about ten or twelve employees. Within four or five years the amount of room occupied was increased fourfold and the number of employees was increased to about sixty.

During the year 1911 the company bought land in Greendale from the Trustees of the Art Museum and built the present factory which was occupied in January, 1913. The business could be carried on here under ideal conditions of light, air and railroad facilities. The present number of employees is about one hundred. The company manufactures a fine grade of ladies' stationery and its produce is sold all over the United States. The business is owned and managed by Edward C. Whitney and his brother, Harry S. Whitney, W. P. I., class of 1894.

At an early day, at the old Fox Mills on Green Street, Pierce Ryan was engaged in the business of dyeing.

The business of the Worcester Bleach and Dye Works Company was started by Messrs. Taft and Wheeler in 1865 at the corner of Southgate and Gardner Streets. It was then known as the Springside Dye Works. In 1868 the company was taken over by a new firm under the name of Hackett & Healey. In 1870 the business was purchased by George F. Orr and Neil Walker. In 1873 Mr. Walker retired and his interest was purchased by Peter Wood. The firm name was changed to Worcester Bleach and Dye Works. This company continued in the original location at the corner of Southgate and Gardner Streets until 1879, when the business was moved into a wooden building on Grove Street, adjoining on the north works of The Washburn & Moen Mfg. Co. In 1888 the business was moved to a new plant on Fremont St.

In the year 1892 the company was incorporated under the laws of the State of Massachusetts and is engaged, among other things, in the bleaching, dyeing and mercerizing of cotton yarns in skeins and warps, also in the glazing of cotton yarns. James E. Orr is the president and treasurer of the company.

It is not my purpose to say anything of the contractors and builders of Worcester, prominent as they have been, because the subject is not included within the somewhat limited area of investigation which I have attempted to cover. I will, however, because of the great genius of Orlando W. Norcross, now in his seventy-eighth year, mention the fact that he and his brother James began business in Swampscott, Massachusetts, in 1864. In 1866 they took their first contract of any importance, the building of the Congregational Church in Leicester. Since that time that firm and its successor, Norcross Brothers Company, have built many schoolhouses, business blocks, churches, public buildings, club-houses, monuments, memorial buildings, and private residences in all parts of the country. The main office of the corporation has always been in Worcester. When I wrote my article upon the Manufacturing and Mechanical Industries of Worcester in 1889, I did not attempt, nor shall I now, to give an extended account of all of them; a list of these can always be found in the current directories. I will refer, however, to some of the industries which I have not named heretofore and which I mentioned in the article of 1889; some of them have disappeared, others continue individually, or are merged with other concerns.

The American Awl Company, 195 Front Street, was, in 1889, a manufacturer and dealer in raw-hide mallets, wax thread, needles, lasting-machine awls, wax thread

awls, Bigelow heeling awls, Bigelow heeling drivers, New Era drivers, New Era pegging awls, Varney pegging awls, Varney drivers, German pegging drivers, German pegging awls, shoe-knives, shoe-shaves.

J. McCarty, 19 Church Street, was proprietor of the National Awl Company; established 1878, and made machine awls for pegging-machines. The business still continues.

Sumner Packard & Co., of Grafton, made the first machine awls for boot and shoe pegging machines.

W. F. Burgess & Co. made band saws at 66 School Street in 1889. A. E. Cunningham, 23 Hudson Street, now makes hand and jig saw blades, and brazing, setting and filing machines for band saws.

In 1828 Wheelock & Rice manufactured nuts and washers at the machine shop then recently occupied by William Hovey.

In 1839 H. W. Miller was engaged in this business.

In 1855 the late Thomas Smith and William Conkey bought of J. and J. C. Brown and George Dryden their tools and interest in the manufacture of nuts and washers, chain links, etc., and fitted up a shop in Cypress Street, Merrifield's building. In 1859 they employed four hands making patent bit pieces and doing cold punching. Mr. Smith was an iron-worker in Worcester for many years; he made the first die in the world to make a mowing-machine knife. He manufactured bolts, nuts, rods, building irons for houses, bridges, cold iron punching. In 1835 Mr. Smith worked for Phelps & Bickford, in Grove Street, and worked on the first looms built for William Crompton in this country. The business is now carried on at 13 Cypress Street by the Thomas Smith Company, Estate of Frank W. Foye, proprietors.

J. Fred Wilson, class of 1877, W. P. I., in 1889, made

cold punched nuts, washers, chain links, etc. He was one of the founders of the W. & S. Mfg. Co., now the Worcester Stamped Metal Co.

Lasts were made by Porter and Gardner, Foster Street, now S. Porter & Co., Inc., 25 Union St., Walter E. Bigelow, president and treasurer.

Wooden boxes were made by Baker & Co., 82 Foster Street, and are now made at the same place by Baker Box Co., Charles Baker, treasurer.

There was a brewery in Worcester in 1822. Sixty-two and one-half cents a bushel was paid for barley delivered at the brewery. In 1827 the Worcester Distillery offers for sale New England rum, molasses, cider brandy, high wines.

Bowler Brothers, Quinsigamond Avenue, corner Lafayette Street, established the business of brewing ale and porter in 1883.

The Worcester Brewing Corporation has a plant at 75 East Worcester Street.

Ellis Thayer manufactured brushes in Worcester in 1849. In 1869 the firm became Thayer & Mason; in 1878 the late J. Fred Mason became proprietor. He manufactured brushes of all descriptions. The business continues under the name of Mason Brush Works, Charles A. O'Neil, agent.

The Coates Clipper Mfg. Co was located in 1889 at 237 Chandler St. The business continues at the same place. George H. Coates, president; B. Austin Coates, treasurer.

In 1889 Harry W. Smith was making fine dress ginghams at Wachusett Mills.

Loring Coes & Co., now Loring Coes & Co., Inc., Coes and Mill Streets, have for many years manufactured machine knives, cutter-plate for dies for leather, cloth and

paper; moulding cutter-plate for wood, marble, etc.; all kinds and sizes of shear plates, and strips for cotton and woolen machinery.

L. Hardy & Co., now L. Hardy Co., C. H. Bliss, president and treasurer, 9 Mill Street, manufacture machine knives, straight cutter ensilage, lawn-mower, meat-cutter, cork-cutter, rag-cutter and bone knives; shear-blades and strips for cotton and woolen goods. Also die cutter stock for boots and shoes; all kinds of welded stock rolled to any thickness from fourteen gauge to three-quarters inch thick. Wood-working machine-knives, planers, moulding-knives, and blanks; paper-cutting, leather-splitting and stripping-knives.

The Phenix Plate Company manufactures Phenix gelatine dry-plate, argentic plate for positive pictures, ebonized and maroon wood and metal panels; also japanned iron and tinned sheets of all sizes for painters and lithographers. The plant has for many years been at 286 Park Avenue.

In 1889 the Worcester Ferrule Manufacturing Co., manufactured steel and brass stove trimmings, patent nickel-plated knobs, hinge-pins, towel-racks, foot-rails, steel, iron and brass ferrules, nickel-plated steam-pipe collars, at 17 Hermon Street. The company is now merged in the Worcester Pressed Steel Co.

In 1889 Somers Brothers were making tacks and Hungarian nails. Shoe tacks a specialty. They located here because of the large amount of boot-making, and were running seventeen machines, and were the only concern of the kind in the city. They used tack machines invented by Thomas Blanchard, of Sutton.

In 1889 hosiery was made by the Holland Hosiery Company at 194 Front Street, and is now manufactured by the Aetna Hosiery Co., at 40 Vine Street.

Loom reeds for cotton, woolen, carpet and wire cloth mills were made in 1889 by John Whitaker, 194 Front Street. The business was established in 1869.

The Whitaker Reed Company, 84 Austin Street, now makes loom reeds of every description; also belt hooks and mill wire goods. The officers of the corporation are: J. T. Brierly, president; C. H. Streeter, treasurer; C. R. Simmons, superintendent.

In 1889 E. D. Cunningham made saws at 23 Hudson Street. Now, at the same location, A. E. Cunningham manufactures band and jig saw blades, brazing, setting and filing machines for band saws.

The late George C. Whitney commenced the business now operated under the name of The Geo. C. Whitney Co. in a small house in East Rutland, Massachusetts.

He worked in connection with his brother, Sumner Whitney, and together they afterwards transferred the business to a small cottage house, which is now standing, 86 Elm Street, near the corner of Fruit.

In 1866 Sumner Whitney retired and another brother, Edward C. Whitney, succeeded, who after three or four years retired.

George C. Whitney conducted the business in three different locations in Worcester during the next few years, one of them over Rawson's Cigar Store near the corner of Mechanic and Main Streets, the second in the upper floors of the block formerly occupied by the Clark-Sawyer Co., and later in the block at 184 Front Street.

During these years prior to 1898 Mr. Whitney bought out at least eight or ten competitors in this section of the country, and in that year the business was moved to the present location, 67 Union Street. At the time the business was conducted on Elm Street there were two employees. At the present time there are about four hundred

and fifty. The product includes cards, booklets, post cards and novelties for the Halloween, Christmas, New Year, Valentine and Easter seasons, calendars and calendar pads. The date of the death of George C. Whitney was November 7, 1915. He was succeeded by his son, Warren A. Whitney, who is president and treasurer of the corporation.

In 1858 a water meter was invented by Dr. E. D. Wetherbee, and manufactured by D. Newton, gunsmith. The Union Water Meter Company was established November, 1868, by Messrs. Fitts, John C. Otis, and Phineas Ball, and employed sixty hands. The meters were in use all over the country, and some in England and Germany. The product was covered by patents. The business is now conducted by the same company at 31 Hermon Street.

CHAPTER X

Reasons for Worcester's Prominence as a Manufacturing City—Room with Power for Rent—Merrifield Building—Heywood Building—Estabrook Building—Enterprise of Worcester's Business Men—Mechanics' Association—Worcester Polytechnic Institute—Washburn Shops—Boys Trade School—The Laboring Classes—Evening Schools—Worcester's Rapid Growth—Heart of the Commonwealth.

It has frequently been said that Worcester owes her prominence as a manufacturing center to the unusual opportunities offered to mechanics to begin business in a small way, and without incurring the risk incident upon the erection and equipment of a shop. Indeed, had this not been the case many individuals, companies and corporations doing today a prosperous business would never have started. Many instances might be given of individuals who have begun with one machine, gradually increasing their business out of the profits realized from day to day, until it has reached considerable magnitude. Growth of this kind is likely to be permanent.

It would be almost literally true to say that there is no large manufacturing business long established in Worcester that has not at some time in its history been situated in one or another of the buildings erected for rent with power to a number of tenants. There are some exceptions, but they are few. An idea of the number of industries begun in this way may be obtained by noticing the occupants of the buildings erected for the accommodation of those engaging in mechanical pursuits.

The old Court Mill had been built some years when, in 1832, Samuel Davis leased it from Mr. Salisbury. Among the tenants here at one time or another were L. & A. G. Coes, builders of woolen-spinning machinery,

and subsequently, manufacturers of wrenches; Ruggles, Nourse & Mason, manufacturers of agricultural implements; H. W. Miller, punching machines for manufacturing nuts and washers; Thomas E. Daniels, builder of the planing-machine; Samuel Flagg, pioneer in the machinists' tools business in Worcester. The old building was burned in October, 1839, and Mr. Salisbury made a contract with W. T. Merrifield to rebuild the mill by January 1, 1840. Ruggles, Nourse & Mason had threatened to move out of town unless it were finished by that time. After the foundations were in, Mr. Salisbury thought the building could not be completed in the winter, and offered to release Mr. Merrifield from the contract, but Mr. Merrifield went ahead, although Worcester masons refused to lay brick in the winter, and he was compelled to bring masons from Boston to do the work. The building was completed by January first.

Then came the Dr. Heywood building in Central Street, occupied by a number of firms, among them Samuel Flagg & Company and S. C. Coombs & Company, who established the business later conducted by the Lathe & Morse Tool Company. The late W. T. Merrifield occupied the present location of the Merrifield buildings in 1835; soon after he used a horse to furnish power to run a circular saw and a Daniels planer. In 1840 he put in an engine. The first brick building for tenants was erected in 1847, and additions were made to it every year until the fire of 1854, when the following were among the occupants: William R. Bliss, bootmaker; Town & Company, perforated board; Hovey & Lazell, straw-cutters; E. F. Dixon, wrenches; Lamb & Foster, carpenters; Williams, Rich & Company, machinists; Samuel Flagg & Company, machinists' tools; Prouty & Allen, shoe tacks; Daniel Tainter, wool machinery; C. Hovey &

Company, straw-cutters; C. Whitcomb & Company, machinists' tools; Charles E. Wilder, boot and shoe machines; H. Palmer & Company, box-makers; Towne & Harrington, portemonnaies; N. B. Jewett, seraphine-maker; Thayer, Houghton & Company, machinists' tools; Furbush & Crompton, fancy looms; Richards & Smith, sash and blinds; Luther White, machinist; F. J. Gouche, plane-maker; Isaac Fiske, musical instruments; A. Sampson, wheelwright; S. G. Reed, wheelwright; Worcester Knitting Company; Worcester Machine Company; George Dryden, machinist; Hood, Battell & Company, sewing machines; Edward Lawrence, tool-maker; Daniel Palmer, box maker; Howard Holden, grist-mill; Rodney A. M. Johnson & Company, wool-spinning machinery.

When rebuilt, the buildings measured over eleven hundred feet in length, fifty feet in width, and three stories in height; the area of the floors was over four acres and a half; the power was obtained from a three hundred and fifty horse-power engine. In 1859 Mr. Merrifield had leased rooms and power in his buildings to over fifty firms, each employing from two to eighty employees Among them:—

Alzirus Brown, on the corner of Union and Exchange Streets, who, with fifty hands, engaged in the manufacture of Manny's Patent Mower and Reaper combined. Daniel Tainter, in Union Street, employed thirty hands in making woolen-carding machines and jacks. Johnson & Co. employed twenty hands making jacks for woolen machinery. Richardson & Mawhinney, in the same street, employed twenty-four hands on lasts and boot-trees. L. W. Pond occupied about two hundred feet of the first floor, under the preceding, for the manufacture of engine-lathes, planing machines, etc., employing twenty-seven hands. He had a lathe thirty-seven feet long, capable of

cutting screws of any length from one to thirty-three feet. He also used the largest and heaviest planing machine in the city, thirty-seven feet long, six feet wide and four feet high, weighing forty tons.

Prouty & Allen, in the room north of Mr. Pond, employed from five to six hands in making iron or zinc shoe nails, of which they produced from one thousand to twelve hundred pounds per day. Battelle & Co., in the third story, had five hands engaged in the manufacture of sewing machines. J. L. & I. N. Keyes, on the east side of Union Street, did an extensive business, with eighteen hands, in board-planing. Hamilton Holt, in rooms over them, had four hands engaged in making patent gutters or conductors of water from the roofs of buildings. C. Whitcomb & Co. were doing a good business making machinists' tools and letter-copying presses, and employed fifteen hands. Towne & Harrington, with ten hands, made mowing-machine knives. Dresser & Wilson had about six hands making Jillson's patent animal-traps, manufacturing two hundred per day. S. G. Reed & Co., in Cypress Street, employed twenty hands in making carriage wheels and wheel-spokes of all kinds.

George F. Rice employed ten hands in the manufacture of Hovey's patent hay-cutters, corn-shellers and winnowing-mills, and a very superior article of boring-machine of his own invention. Joel W. Upham had from six to eight hands engaged in making very large water-wheels for manufacturing establishments, averaging from twenty to thirty per year. Isaac Fiske employed six hands making musical wind instruments. D. D. Allen & Co. manufactured boot forms. S. C. & S. Winslow employed from six to twelve hands in gear-cutting and light jobbing. Thomas Smith & Co. had four hands making patent bit-pieces and doing cold punching.

The Machine Lathe Company in Exchange Street, of which Jason Chapin was president and A. L. Burbank treasurer, employed seven hands making bedstead lathes and in iron job work. Charles E. Staples, with seven hands, made bit-stocks and window springs, and did light jobbing. Charles E. Wilder employed a few hands in the manufacture of boot-crimping machines. Franklin Wesson had three hands engaged in gun manufacture. P. Goulding with six hands, on the opposite side of the street, made thirty dozens of shuttles per week. U. T. and C. H. Smith made chair lathes and did jobbing, employing four hands. William H. Brown had a jobbing shop with three or more hands.

Meantime Colonel James Estabrook and Charles Wood in 1851, erected the stone building at the Junction, later occupied by the Knowles' Loom Works. Wood, Light & Co. were to occupy part of it, and the rest of the building was to be rented to tenants. Shepard, Lathe & Co. moved into the north end of the building very shortly after the occupancy of Wood, Light & Co. In 1857 Mr. Wood disposed of his interest to Colonel Estabrook.

The main building was four hundred and fifty feet long by fifty feet wide, and three stories high; another building used for a forge shop and other work, two hundred by forty; power was furnished by two fifty-horse-power engines, made by Corliss & Nightingale, of Providence. Among the tenants were Wood, Light & Co., who occupied the two lower stories in the south end of the main building for the manufacture of machinists' tools, water-wheels, mill works, castings. J. A. Fay & Co. occupied a hundred feet on the second floor, manufacturing wood-working machinery, employing thirty hands. Joseph Barrett & Co., in the south end of the second floor, employed

twenty hands in the manufacture of calico-printing machinery, Woodworth's planing machines, machinist's tools, etc. Shepard, Lathe & Morse occupied one hundred feet of the first floor under the preceding, and manufactured engine-lathes and iron-planing machines. Whittemore Brothers, in the upper story, employed twenty hands in manufacturing machines for paring, coring and slicing apples. The American Steam Music Company manufactured calliopes and terpsichoreans. Heywood & March made Holbrook's automatic bank-locks. David McFarland made card-setting machines. A. F. Henshaw manufactured machinists' tools and bonnet machinery.

Conspicuous among the buildings now available for renting in sections of varying size with power may be mentioned: The Osgood Bradley Building, Grafton corner of Franklin Street, The Graphic Arts Building, Commercial Street corner of Foster, occupied in 1913 largely by printers, publishers and book binders, and the Burgess-Lang Building on Commercial Street. There are about twenty tenants in this building, the rental is uniform, twenty cents per square foot except the basement. Heat and power are extra. All the power is purchased from Worcester Electric Light Co.

Stephen Salisbury, Sr., and his son, Stephen Salisbury, were of great assistance to the manufacturers of Worcester because of their willingness to build and lease factory buildings, most, if not all, of which were ultimately sold to the lessees. Their efforts in this direction were confined largely, but not exclusively, to Union Street.

Stephen Salisbury built the Grove Street Wire Mill for Ichabod Washburn. In 1834 and 1844 additions were made at a cost of fifteen thousand, five hundred and sixty dollars and a brick addition in 1850 at a cost of fifty-nine thousand, five hundred and thirty-nine dollars.

He built the building in Prescott Street, in 1874, for the Ames Plow Company, at a cost of ninety-eight thousand, eight hundred and twenty-three dollars. The factory at 15 Union Street, occupied in whole or in part from April 1, 1877, until February 1, 1891, by the E. W. Vaill Chair Co.; Hobbs Mfg. Co., 1891 to 1900; Flexible Door and Shuttle Co., 1892-1897; Worcester Corset Co., Washburn-Moen Mfg. Co., in making furniture springs; W. P. Guy and Guy Bros., 1892-1893; Mason and Risch, for dry house purposes, 1892 and 1898-1899; John E. Lancaster in the manufacture of corsets, 1894-1898; Hatch and Barnes, December 18, 1896 to 1898; Prouty Press, 1897-1898; Globe Corset Co., John E. Lancaster, treasurer, 1898-1900; Vocalion Organ Co., 1900, for a dry house only. The building was sold to John E. Lancaster in 1900 and is now occupied by Massachusetts Corset Co. and American Narrow Fabric Co. 19 Union Street was leased to Loring-Blake Co., organ builders, from July 1, 1877 to 1887. The lease was extended to July 1, 1892, and the building was occupied by this company until December 1, 1896. It was purchased by the National Mfg. Co., March 5, 1897. In 1916, that company was acquired by the Morgan Spring Company.

The Summer Street building across the railroad track connected with 15 Union Street was leased to the E. W. Vaill Company from October 1, 1880, to October 1, 1890, and was occupied successively by Mason-Risch Company, September 1, 1889-1898; Vocalion Organ Co., 1889-1903; Worcester Loom Company, Multiple Woven Hose Company. The building was sold to John E. Lancaster, Treasurer, December 1, 1904, and is at present occupied by the Worcester Loom Company.

16 Union Street, built by Stephen Salisbury, Jr., was occupied by Jacobs & Clarke in 1882-1883, later

by G. L. Brownell, and Logan, Swift and Brigham, and was sold to The Wire Goods Company, March 1, 1892.

25 Union Street was leased to Monroe Organ Reed Company from January 1, 1880, to January 1, 1890; Porter and Gardner, last manufacturers, July 1, 1890-1895; S. Porter & Company, Inc., from then to the present time. In 1896 it was occupied by the last named and Rawson and Ramsdell Company and the Decker Company. The building was sold to G. L. Brownell, July, 1903, and at the present time is occupied by S. Porter & Company, last manufacturers, and H. L. Hanson, metal stampings.

The building, 49 Union Street, corner of Market Street, was built in 1882 for the Worcester Barb Fence Company at a cost of fifty-five thousand, seven hundred and nineteen dollars. I remember that I made the arrangement with Mr. Salisbury, Sr., who wrote the lease in his own hand, as was his custom. For some time the Monroe Organ Reed Company leased the top floor for the Vocalion business. The building was leased to the Washburn & Moen Mfg. Co. from April 1, 1883 when that company acquired the Worcester Barb Fence Co., to 1893, and was occupied by them more or less of the time until 1898, when it was occupied by G. L. Brownell, who purchased it March 18, 1908.

20 Union Street was built by Stephen Salisbury, Jr. It was leased to The Wire Goods Company from October 15, 1884, and was bought by that company March 1, 1892.

All these factories were built by the late Henry W. Eddy.

The means thus afforded to individuals with limited capital to begin manufacturing unencumbered with an expensive plant, making it possible for a small business to be conducted with profit, is one of the chief causes of

the diversity of industries which makes Worcester uniformly prosperous, and creates a thrifty and permanent class of working-people.

In striking contrast are some other New England cities, confined almost entirely to a single industry, and with a large unsettled population of mill operatives, the business conducted by corporations, owned by non-resident stockholders and under a non-resident management. With such conditions, the prosperity of the community is uncertain, largely a matter of chance. In good years the dividends declared are not invested where they are earned, while in bad years the immediate community suffers, want soon overtakes the working-people and crime follows in the wake of cold and hunger.

It is true that there are corporations in Worcester, but they are, almost without exception, the outgrowth of individual enterprise; the stockholders are many of them residents, and in many cases, employees; the dividends are largely invested in real estate, in business blocks, in tenements, in factory property, while the fortunes accumulated have founded our hospitals, homes for the aged and infirm, have built our churches and endowed our schools.

While there are few large fortunes here, measured by modern standards, there are many small ones. There is, perhaps, less of luxury and display than in some communities, but more of thrift.

To properly take advantage of the opportunities here offered, an intelligent people was needed. Enterprise and sagacity have always been characteristics of the business men of Worcester, early manifested in appreciation of the importance of communication with the sea-board, and secured by the building of the Blackstone Canal, and evidenced later in the building of the rail-

roads, and always recognized in the high reputation enjoyed throughout the country by our manufactures.

But there is better evidence than this of the wisdom and foresight of the men who laid the foundation of Worcester's prosperity.

A desire for opportunities for education was manifest at a very early day. About 1819 a number of young mechanics, who had been active in reforming the schools and establishing a lyceum and temperance society, made an attempt to form a mechanics' association. This failed; but November 27, 1841, a public meeting was held to consider the question. Ichabod Washburn was chairman, and Albert Tolman secretary of this meeting. A committee was chosen, consisting of Anthony Chase, William Leggatt, Henry W. Miller, William M. Bickford, Putnam W. Taft, Levi A. Dowley, William A. Wheeler, Rufus D. Dunbar, John P. Kettell, James S. Woodworth, Albert Tolman, Hiram Gorham, Joseph Pratt, Henry Goulding and Edward B. Rice, to consider the formation of an association having for its object "the moral, intellectual and social improvement of its members, the perfection of the mechanic arts and the pecuniary assistance of the needy."

The first meeting of the subscribers was held February 5, 1842. William A. Wheeler was elected president, Ichabod Washburn, vice-president, Albert Tolman, secretary, and Elbridge G. Partridge, treasurer. Steps were taken to establish a library and an annual course of lectures. The first lecture was delivered by Elihu Burritt (then a resident of Worcester), and was upon the importance of educating the mechanics and working men of the country. From that time to the present the Mechanics Association has provided a course of lectures every winter.

Another object in forming the association was the holding of an annual fair for the exhibition of the mechanical products of the city. The first fair was held in September, 1848, and was very successful. The reports of the judges were printed and their circulation created a wide knowledge and consequently large demand for the products of Worcester mechanics. In July, 1854, in commenting upon the association and its work, the statement was made: "Notwithstanding the inadequate supply of water-power, which is everywhere deemed so essential for the successful development of the mechanic arts, without the aid of a single act of incorporation, mechanical business has increased in this city by individual enterprise alone more than tenfold. The mechanics as a class are more enlightened and better educated than formerly; their course is onward and upward; they are not only increasing in numbers, but continually expanding in influence and usefulness. Instead of being a small fraction of the population of a town of two or three thousand, as they once were, they are nearly a majority of the population of a city of twenty-two thousand; are the owners of nearly or quite half of the taxable real estate, and are producing from their workshops more than six millions of dollars annually. Their reputation for variety, excellence and finish on all labor-saving machines and implements extends far and wide through the land. Their products, branded with the name of some enterprising firm in Worcester, may be found in the shops, mills and factories and on the farms of every State in the Union."

In 1850 an act of incorporation was obtained from the State, and May 4, 1854, Ichabod Washburn offered to give ten thousand dollars toward the purchase of land and the erection of a Mechanics Hall, provided an equal sum should be raised by the association. The offer was

accepted and the condition complied with. In addition to the twenty thousand dollars thus raised, the association issued bonds to the amount of fifty thousand dollars, secured by mortgage upon the property, and further sums were raised as the work advanced, of which amount nearly forty-four thousand dollars was taken and paid for by two hundred and fifty-six members of the association. Ground was broken July, 1855, and on the third of September the corner-stone was laid, the day being observed as a holiday. The building was completed in 1857, and was dedicated March 19 of that year. The cost including the land, was about one hundred and forty-eight thousand dollars.

Another and striking illustration of the interest taken by the manufacturers and mechanics of Worcester in educational affairs is found in their generous contributions toward the building and endowment fund of the Worcester Polytechnic Institute.

For many years, indeed as late as 1850, the common school, the academies, high schools and colleges were the only instrumentalities of education in this country.

But it must not be thought that the need for a different training had not been early recognized. It was pointed out as early as 1830 that instruction in natural science could only be found in the colleges which were designed to educate those who were intended for the professional life of the ministry, the bar and medicine, and regret was expressed that no educational training had been provided for those who proposed to occupy themselves with practical affairs. The inventive faculty of our people had already been at work. John Fitch, Oliver Evans and Robert Fulton had long since demonstrated that steam was to be the great motive force for land and water vehicles.

Amos Whittemore had produced the carding machine; Eli Whitney, born in Westboro, had invented the cotton gin. Thomas Blanchard, of Millbury, had invented, among many other ingenious and useful devices, a lathe for turning irregular shapes. Erastus B. Bigelow, born in West Boylston, invented, before he was fourteen, a hand loom and machine for making piping cords and the first power loom for making counterpanes, coach lace, Brussels and Wilton carpets and wire cloth, and laid the foundation of the prosperity of the neighboring town of Clinton. Elias Howe, of Spencer, invented the sewing machine, and Morse had invented the electric telegraph.

In view of all these and scores of other inventions, it is not surprising that the attention of thoughtful men was directed to the fact that the development of our industrial enterprises was a matter of prime importance to the prosperity of the country, and that some special training should be provided for those who were to engage in such occupations. It is true that under the patronage of our colleges, scientific schools had been established through the generosity of private individuals. Joseph E. Sheffield, of New Haven, endowed the Sheffield Scientific School of Yale in 1847. Abbott Lawrence, of Boston, founded the Lawrence Scientific School at Cambridge in 1848, and Abiel Chandler, of Walpole, New Hampshire, endowed a separate department of Technology at Dartmouth in 1852. These schools, however, all taught pure science. It was left for the Polytechnic School, as later developed, to teach applied science. Such, in a general way, were the conditions in 1860.

July 2, 1862, Congress passed a bill granting to each state thirty thousand acres of land for each Senator and

Representative in Congress for the purpose of endowing institutions for teaching such branches of learning as are related to agriculture and the mechanic arts, and this, too, at a time when the failure of the peninsular campaign against Richmond had left the people of the country in a state of deep depression. This gave a great impetus to the cause of technical education.

The Massachusetts Institute of Technology was opened to students in 1865.

The foundation of our own school came about in this way. In the year 1865, John Boynton, of Templeton, in this State and County, placed in the hands of his former partner, David Whitcomb, the sum of one hundred thousand dollars for the endowment of a school, which was to be located here if the citizens of Worcester should provide the land and suitable buildings. This condition was complied with by a gift of the land and of sixty-one thousand, one hundred and eleven dollars, contributed by two hundred and thirty-two individuals and from twenty shops and factories. The Institute was incorporated May 9, 1865, under the descriptive, but perhaps prolix title of Worcester County Free Institute of Industrial Science, which was changed in 1887 to the name which it now bears, Worcester Polytechnic Institute.

December 2, 1865, Ichabod Washburn offered to establish a machine shop as one of the departments of instruction at the Institute.

The selection of the location of the school was an appropriate one. Worcester, then a city of thirty thousand, had long been famed for her industries and for the intelligence and public spirit of her citizens. Her industrial growth had taken place since 1830, prior to which time her manufactures had been of the most primitive sort. The Rev. Edward Everett Hale, whose life work was so

productive of good to his fellowmen, once told me that Judge Merrick, an old resident, meeting Samuel Slater, the pioneer cotton manufacturer, on the street in Worcester, said to him:

"We shall never be a manufacturing town because we have so little water power."

Mr. Slater replied:

"Judge Merrick, you may live to see the time when Worcester will need all the water of Mill Brook to provide the steam for her steam engines."

This conversation must have occurred at some time prior to 1835 and perhaps about 1830.

Eight or ten years before the founding of the Institute, Ichabod Washburn had discussed with the Rev. Dr. Sweetser the feasibility of establishing a school, in connection with the Mechanics Association, for giving scientific instruction to mechanics in the fundamental principles of Mechanics and Chemistry. It was expected that funds for the enterprise would be contributed by the prosperous mechanics and manufacturers of Worcester. The financial panic of 1857 prevented the execution of this plan, and Mr. Washburn later decided to carry out his earlier conceived purpose in connection with the Institute.

Fortunate, thus in its foundation and its location, the Institute began its life under the happiest auspices. In one particular its scheme for education was unique in combining with the studies ordinarily pursued in technical schools, manual labor in a shop, run upon a commercial scale and producing articles to be sold in the market.

Unsuccessful experiments in thus combining the practical with the theoretical had previously been made in Germany and Austria.

At this point I am led to inquire just what sort of a school this was in 1865, and what its founders expected of it. I understand that in the definition of the present day a trade school aims to give the pupil a thorough, practical knowledge of some handicraft. In the manual training school, instruction is given in various kinds of work with tools for educational discipline. In the technical or engineering school the sciences are taught in their practical application to the various industries.

Mr. Boynton, in his letter of gift, which was prepared under the advice of the Rev. Seth Sweetser, of Worcester, and Judge Emory Washburn, of Cambridge, adopted in most comprehensive form the curriculum of the scientific school as then known, with the addition of some subjects not ordinarily included.

Mr. Washburn's final letter of gift and instruction dated March 6, 1866, discloses a purpose to establish a trade school as we now understand it, excepting that in addition to learning a trade the apprentice was to be instructed in the principles of science.

Dr. Charles O. Thompson, the first president of the faculty, of brilliant accomplishments and magnetic personality, in his inaugural address delivered at the Institute November 11, 1868, said, among other things:

"Add to these considerations the fact that boys whose faculties are kept constantly alert by the training of the school are in a condition to learn faster than others the practical application of science and that the time spent in the shop will serve the double purpose of instruction and physical exercise and it will be admitted that this form of a manual labor school is at least an experiment worth trying."

The late Senator George F. Hoar, one of the charter members of the Board of Trustees, in addressing a committee of the Massachusetts Legislature, February 11,

1869, urging an appropriation of $50,000, said, among other things:

"You cannot find an instance of a boy who has been educated in the Scientific School at Harvard College going back to the bench of the workman or the farm, and so of the Institute of Technology. Theirs will be a different, and in many particulars a higher education than ours . . . You will not find there any boys who, having studied for two or three years, are going back to work in the shop . . . and there they will work their way up from the journeyman to the foreman and then the Master Mechanic."

All this testimony leads, I think, to the conclusion that the Institute in 1865 was what would now be considered a combination of a scientific school and a trade school, and of a grade not so high in some respects as either the Scientific School at Harvard or the Institute of Technology in Boston.

It was frankly admitted that it was an experiment and attention was called at the time to the fact that at Berlin the workshop connected with the school had been tried and abandoned twice. But the experiment succeeded here, and the combination has now taken the permanent form of an engineering school of the first rank, peculiar in this respect, that the practice not only illustrates the scientific principles taught in the school, but also gives the students considerable experience in the use of tools and a practical knowledge of the workings of a commercial shop.

An examination of the records discloses the fact that at one time or another, and for longer or shorter periods, four hundred and sixty-one of the graduates of the Institute have been at work in the industrial field in Worcester. Edward K. Hill and Edward F. Tolman, of the class of 1871, the first class graduated, were prominent

in the Wheelock Engine Co. Many, in the earlier days, were with the Washburn & Moen Mfg. Co., now the American Steel & Wire Company, conspicuous among whom was the late Fred H. Daniels, chief engineer of the works; many with the United States Envelope Company, several with the Wyman-Gordon Company, of which H. Winfield Wyman and Lyman F. Gordon were the founders; several with the Rockwood Sprinkler Company, of whom George I. Rockwood was the founder; many in the loom business, of whom Clinton Alvord is president of the Worcester Loom Company; over twenty with the Reed and Prince Co.; several with the Morgan Construction Co., among whom are Paul B. Morgan, the president, and Victor E. Edwards, the vice-president; a considerable number with the Norton Company, among whom is Aldus C. Higgins, secretary and general counsel. John W. Higgins is the proprietor of the Worcester Pressed Steel Company and R. Sanford Riley is the president of the Riley Stoker Co. Harry R. Sinclair was the proprietor of the W. & S. Mfg. Co., now known as the Worcester Stamped Metal Co. Charles Baker is treasurer of the Baker Box Co. and Harry S. Whitney an owner of the Whitney Mfg. Co.

About two hundred and seventy-five of the graduates are at present in the city of Worcester, actively participating in the maintenance and extension of her industrial interests. Many of them fill positions of great responsibility, and the majority of them are closely in touch with, and in large measure responsible for, the material progress of the city. It is difficult to estimate even approximately the value of these men.

An interesting statement made some years ago in an address by James M. Dodge, then president of the American Society of Mechanical Engineers, revealed the fact

that the average annual salary of the technical trained man was over $2,150, and for the non-technical, but trade-trained man, $790, so that the gain in average annual income due to a technical training was estimated to be over $1,360. This amount capitalized at 4% gives to a man receiving a technical training a potential increase in value of $34,000. There are now engaged, as already stated, in active life in this city two hundred and seventy-five graduates of the Polytechnic, who represent directly and indirectly a wealth creating power measured by a capitalization of approximately $9,350,000. This represents merely a capitalization of the increased earning power of the graduates and takes no account of the enterprises which they have developed and which they direct, which would easily make the pecuniary measure of the contribution to the city's assets a much larger sum.

The same spirit in the community which made possible the Polytechnic in 1865, led to the formation of the Boys' Trade School on Grove Street at Armory Square, which was dedicated February 8, 1910. Ichabod Washburn's original idea in creating The Washburn Shops was to teach a trade and with it give the apprentice an education. I have already traced the development of that idea in what I have said of the Polytechnic Institute. Milton P. Higgins was superintendent of The Washburn Shops for many years and a close student of the system of giving mechanical instruction in a commercial shop. He was a strong advocate of the "Half-Time School."

He had the half-time school idea in his mind as long ago as 1888 or 1889, when he went South to establish the Mechanical Department of the Georgia Institute of Technology, but it first received wide public attention at the time he read his first paper before the American Society of Mechanical Engineers in 1899. He was asked

by the Society to enlarge on this idea and subsequently an entire session was devoted to the presentation by him of a later paper and further discussion.

In 1905 Governor Douglas appointed a Commission to investigate the subject of Industrial Education for Massachusetts. As a result a permanent Commission was authorized on June 21, 1906. Mr. Higgins was called into consultation with this Commission and was active in framing the law giving authority for establishing trade schools under boards of trustees, independent of the regular public school system.

When Mr. Higgins advanced his idea of the half-time school he thought it was practicable for the trade school to operate in connection with the local high schools, the pupils spending alternate days in a commercial shop and in the public school. As he studied the situation and worked with the Douglas Commission, and afterward as a member of the Commission on Industrial Education, he became convinced that the academic part of the trade school should not be separated from the practical commercial shop.

The important principles that he stood for and was largely instrumental in securing in the Massachusetts scheme were, first an independent Board of Trustees; second, practical commercial shops, whose main object should be the training of the boy through the manufacture of salable products; and third, academic and practical training all in one school.

Mr. Higgins was appointed a member of the Commission on Industrial Education in January, 1907, and at once began work with the Worcester City Government, and through appeals to the various civic organizations, created such a demand for this trade school that the City

Council passed the ordinance authorizing its erection and equipment.

Upon the appointment of the Board of Trustees—which was selected from among the business men of Worcester—Mr. Higgins became the president of the board.

The first group of fifty-two boys started February 9, 1910, on a four year's course, some to learn the pattern maker's and cabinet maker's trade and others the machinist's trade, spending one-half their time in the shop and one-half in the school rooms.

Instruction is offered in machine work, tool making, carpenter work, cabinet making, pattern making, power plant engineering, drawing for the machine and building trades, printing and interior decorating.

The day school is free to boys between fourteen and twenty-five years of age. It is preferred that they should be graduates of the grammar grades, but other boys who show distinct mechanical aptitude may be admitted. During term time boys may enter on probation until the beginning of the next term when they will be assigned to the class for which they have shown themselves fit.

The school is operated under Chapter 471 of the Acts of 1911, which provides that any city or town may establish an independent industrial school under the direction of its school committee or an independent board of Education, and that if the school is approved by the State Board of Education the City shall be reimbursed to the extent of one-half its net cost of maintenance.

Under this law the City furnishes land, buildings, and equipment and pays the entire cost of maintenance. From this gross cost of maintenance all income from tuitions and sale of product is deducted and then the State repays one-half of that net cost to the City.

Meantime the schools of the city have increased in number and efficiency. No child, however poor, need be deprived of a thorough education, free of any cost for instruction, and in the public schools being even relieved of the expense of buying books.

Up to 1840 manual labor was, for the most part, performed by Americans. Worcester naturally attracted boys from the country, and the farmers' sons became our mechanics.

About this time Irish immigration commenced and, as the heavier kinds of manufacture were introduced, the Irishman became an important factor in our industrial development and indispensable to our material progress.

Since 1880 a large Scandinavian population has been added to Worcester. The last available figures show that in 1910, when the population of Worcester was 145,986, there were included in it eight thousand, five hundred and ninety-nine born in Denmark, Norway and Sweden, of which number eight thousand and thirty-six were born in Sweden.

They are a thrifty, industrious, capable and law-abiding people, who have come to make this country their home. They are found in most of our shops and are employed exclusively in some of them. They support several churches, in some of which their own language is spoken. In 1915 there were two thousand, seven hundred and sixteen Scandinavian children in our public schools. Our present mayor, Honorable Pehr G. Holmes, is native-born, but of Swedish parents.

Another race in our population, I wrote in 1888, is the Armenian, of which there were then about four hundred in Worcester, the larger number from the province of Harpoot. Very few of them had any mechanical training, having been engaged in their own country in

agricultural pursuits, either as peasant farmers or as laborers for farmers. This occupation afforded scarcely more than a bare subsistence, the wages being from twenty cents to thirty cents per day.

Conditions, of course, have changed somewhat since the above was written in 1888.

The following table gives a classification of the population of Worcester in 1910, which was then 145,986:

Native white—native parentage	41,421
Native white—foreign or mixed parentage	54,751
*Foreign-born, white	48,492
Negro	1,241
Indian, Chinese and Japanese	81

*Foreign-born, white: *Born in—*

Austria	362
Canada—French	5,010
Canada—Other	3,377
Denmark	205
England	3,113
Finland	1,452
Germany	580
Ireland	10,535
Italy	2,889
Norway	358
Russia	8,767
Scotland	870
Sweden	8,036
Turkey, in Asia	2,056
Turkey, in Europe	413
Other foreign countries	469

	Males	Females	Total
Native-born	47,401	50,012	97,413
Foreign-born	25,948	22,544	48,492
	73,349	72,556	145,905[1]

[1]Does not include Indians, 10; Chinese, 65; Japanese, 6. Total, 81.

In the census of 1915 the figures are as follows:

[1]Native born	110,108
Foreign born	52,589
	162,697

	TOTAL	MALES	FEMALES
TOTAL FOREIGN BORN	52,589	27,089	25,500
Austria, exclusive of Austrian Poland	188	88	100
British Possessions	8,239	3,933	4,306
Canada, n. o. c.[2]	6,020	2,978	3,042
New Brunswick	515	196	319
Newfoundland	65	31	34
Nova Scotia	1,339	595	744
Prince Edward Island	270	120	150
All other	30	13	17
France	105	51	54
Great Britain	14,457	6,491	7,966
England	3,512	1,738	1,774
Ireland	9,928	4,249	5,679
Scotland	993	491	502
Wales	24	13	11
Germany, exclusive of German Poland	537	277	260
Greece	678	600	78
Italy	3,985	2,400	1,585
Norway	368	179	189
Poland	5,741	3,354	2,387
Austrian	198	103	95
German	53	24	29
Russian	5,467	3,214	2,253
Poland, n. o. c.	23	13	10
Portugal, including island possessions	33	16	17
Russia, exclusive of Russian Poland	7,259	3,759	3,500
Russia, n. o. c.	4,629	2,396	2,233
Finland	1,712	846	866
Lithuania	918	517	401
Sweden	8,150	4,073	4,077
Switzerland	19	6	13
Turkey	2,422	1,619	803
Armenia	912	612	300
Syria	735	416	319
Turkey, all other	775	591	184
West Indies	19	9	10
All other	389	234	155

[1]This total includes persons born in the island possessions of the United States, persons born at sea of American parents, and persons of unknown country of birth.

[2]N. o. c. means not otherwise classified.

The evening schools are invaluable in giving our large foreign adult population an opportunity to acquire sufficient education to become useful and intelligent citizens. An examination of the records in 1888 showed that out of six hundred and ninety-one who attended the evening schools, one hundred and sixty-five were Irish, one hundred fifty-five Armenians, one hundred and fifty-three Scandinavians, one hundred and eleven French, forty-five English, thirty-one Americans, fourteen Poles, twelve Germans, three Mexicans, one Scotch, and one Portuguese.

These schools were maintained at a cost for each pupil of $11.68 for the year.

It is an interesting fact that no Scandinavian had up to that time made application to attend evening school who could not write his name.

In 1915 the nationality of the twenty-three hundred and fifty who attended the evening schools was as follows:

Jews	271	Turks	16
Swedes	181	Scotch	16
Lithuanians	176	Germans	13
Italians	158	Austrians	3
Poles	113	Chinese	2
Irish	112	French	2
Armenians	99	Norwegians	2
Greeks	72	Portuguese	2
French Canadians	71	Bulgarian	1
Russians	38	Dane	1
English	36	Dutch	1
Albanians	35	Macedonians	1
Syrians	32	Roumanians	1
Finns	30	Swiss	1

In 1915 these schools were maintained at a cost for each pupil of $19.57 for the year.

At the evening drawing-schools opportunity is afforded to learn free-hand drawing and drafting, of which our intelligent mechanics are quick to avail themselves. The average attendance during the year 1888 was one hundred and thirty-nine, and during the year 1915 was one hundred and seventeen. This decrease is no doubt due to the fact that there are now wider opportunities for instruction in the Trade School and elsewhere and not to any falling off in the number receiving instruction.

The census of 1885 showed that there were seven hundred and seventy-two establishments engaged in manufacturing and mechanical industries in the city of Worcester; the total capital invested, $18,344,408; value of stock used in a year, $15,016,756; total value of goods made and work done, $28,699,524, the different industries standing in the following order:— Metallic goods, other than iron; boots, shoes and slippers; iron goods; wood and metal goods; building material for building and stone-work; textiles; food preparations; miscellaneous clothing and straw goods; woolen goods; paper and paper goods; leather; printing and publishing; paints, colors, oils and chemicals.

June 30, 1885, there were employed in manufacturing and mechanical industries 16,566 people—13,413 males, 3,153 females—of which 2,475 were under twenty-one, and 14,091 twenty-one and over; 10,512 of these worked by the day, and 6,054 by the piece.

The total amount paid in wages in the census year was $7,060,755.

In 1913, a year nearer normal than 1914, which was one

of abnormal depression, just as 1916 was a year of abnormal inflation because of the war, the

Number of establishments was	448
Capital invested	$75,474,918
Value of stock and material used	$50,453,169
Amount of wages paid during the year	$19,887,759
Average yearly earnings	$625.38
Wage earners employed:	
Average number, males	24,317
Average number, females	7,484
Average number, both sexes	31,801
Smallest number	26,892
Largest number	36,275
Value of product	$89,707,793

Worcester has developed from a country town to a great manufacturing city in less than ninety years. The population in 1830 was a little over four thousand and today is probably one hundred and sixty thousand.

Within that time the steam-engine, the railroad, telegraph and telephone and commercial use of electricity have enormously increased the productive power of labor. The improvement in the condition of the laboring classes is no less marked; contrary to the opinion once held, the introduction of labor-saving machinery has advanced instead of lowering wages; has reduced, instead of extending the hours of labor. The laborer receives a constantly-increasing proportion, the capitalist a constantly-decreasing proportion in the division of gains. Many of our mechanics own their homes, and are naturally deeply interested in the welfare of the city. Avenues for advancement are always open to the capable and industrious. From their ranks will come the leading business men of the next generation, upon whom the continuance of prosperity will depend.

It is worthy of note that the causes of Worcester's prosperity are found within and not without. No abnormal conditions have prevailed, a change in which can bring disaster. No Government works or patronage of any kind have contributed to her advancement. We need not fear the natural advantages of other sections of the country, for there must always be conducted here the manufacture of the finer grades of goods, requiring intelligent and delicate manipulation. As we review the past and forecast the future, we can but feel that Worcester is worthy of her civic seal,—

THE HEART OF THE COMMONWEALTH.

INDEX

The publishers have been fortunate in securing the co-operation of Mrs. Mary R. Reynolds of the staff of the American Antiquarian Society in the preparation of the index. The work has been most adequately done and adds greatly to the value of the book for reference purposes. C. G. W.

C

E

I

J

*Lucius J. Knowles was elected on March 1, 1917, to succeed Charles H. Hutchins as President of the Crompton & Knowles Loom Works.

M

P

T

*A recent investigator has located the mill on the present site of the Salisbury Mansion or near there. See Proceedings American Antiquarian Society, October, 1916, map opp. p. 276.

Y

ERRATA

Page 38. Fifth line from bottom, *woolen*, not wollen.

Page 43. Fifth line from top, *manufactures*, not manufacturers.

Page 45. Seventh line from bottom, S. S. *Jr.*, not Sr.

Page 79. Fourth line from bottom, F. *L.* Ruggles, not F. G.

Page 93. Seventh line from top, F. *P.* Knowles, not F. B.

Page 115. Twelfth line from bottom, *Slocomb & Stickel*, not Slocum & Stickels.

Page 135. Eighth line from top, A. *B.* Barnard, not A. P.

Page 198. Ninth line from top, *Rheutan*, not Rheuton.

Page 236. Seventh line from bottom, *Child*, not Childs.

Page 238. Second line from the bottom, *C.* S. Goddard, not D. S.

Page 288. Fourth line from top, *Gardiner*, not Gardner.

Page 290. Ninth line from top, E. *E.* Cunningham, not E. D.

Page 291. Ninth line from top, *E.* Newton, not D.

Page 293. Fourth line from bottom, *Dixie*, not Dixon.