AMERICAN TEXTILE MACHINERY:

ITS EARLY HISTORY, CHARACTERISTICS, CONTRIBUTIONS TO THE INDUSTRY OF THE WORLD, RELATIONS TO OTHER INDUSTRIES, AND CLAIMS FOR NATIONAL RECOGNITION.

By JOHN L. HAYES, LL.D.,

SECRETARY OF THE NATIONAL ASSOCIATION OF WOOL MANUFACTURERS.

REPUBLISHED FROM THE BULLETIN OF THE NATIONAL ASSOCIATION OF WOOL MANUFACTURERS.

CAMBRIDGE:

UNIVERSITY PRESS, JOHN WILSON AND SON.

1879.

AMERICAN TEXTILE MACHINERY:

ITS EARLY HISTORY, CHARACTERISTICS, CONTRIBUTIONS TO THE INDUSTRY OF THE WORLD, RELATIONS TO OTHER INDUSTRIES, AND CLAIMS FOR NATIONAL RECOGNITION.

By JOHN L. HAYES, LL.D.,
SECRETARY OF THE NATIONAL ASSOCIATION OF WOOL MANUFACTURERS.

Republished from the Bulletin of the National Association of Wool Manufacturers.

CAMBRIDGE:
UNIVERSITY PRESS, JOHN WILSON AND SON.
1879.

CONTENTS.

AMERICAN TEXTILE MACHINERY:

ITS EARLY HISTORY, CHARACTERISTICS, CONTRIBUTIONS TO THE INDUSTRY OF THE WORLD, RELATIONS TO OTHER INDUSTRIES, AND CLAIMS FOR NATIONAL RECOGNITION.

THE value to a nation of its possession of a perfected textile industry is but feebly expressed by the number of operatives it employs, the money value of its products, or the sum of comforts — if it were possible to calculate them — which the people of a nation derive from an abundant and cheap supply of domestic textile manufactures. The census of 1870 shows that the cotton and woollen manufacture of the United States, with their branches, the worsted, carpet, hosiery, and print industries, employed 264,122 hands, and produced a total value of $449,514,619.

The operatives directly employed were but about $\frac{8}{5}$ of 1 per cent of our total population of 38,558,371, and the value of the product about $10\frac{3}{5}$ per cent of our total manufacturing industry, namely, —$4,232,325,442, and but about $18\frac{4}{10}$ per cent of that produced by the single industry of agriculture, $2,447,538,658.

When we look at the comparatively small proportion which the textile manufactures bear to our total productive industry, the question naturally arises, why it is that the textile industry is the first object of acquisition and encouragement by all

civilized nations, and that the interests of the spindle and loom have been the first consideration in the economical legislation of modern times. A moment's reflection will show us that the national value of the textile industries consists less in the direct sources of employment and production of values which they furnish, than in their relations to other industries, — to the agriculture, which supplies the raw material, and food for operatives; to the multiform industries which furnish its supplies and work up its products; to the vehicles of domestic commerce, which transport its raw material and fabrics; and to the trade of the great cities of which the textile industries are the chief aliment. But even these important relations are insignificant, compared with the influence of the textile industry, as the chief source of that tremendous development of labor-aiding mechanical power, in application to all industries, which is the miracle of the century now closing.* To illustrate the position here affirmed, and to show, by the history of the development of American textile machinery, the part which this country has taken in the grandest of all conquests, — the subjugation of the forces of nature to the control of man, — is the leading object of this essay.

RESTRICTIVE LAWS OF ENGLAND.

While to the British Stamp Act of 1765 we may attribute our emancipation from foreign political dominion, to another British statute of the same decade we may no less justly assign our industrial independence. The legislation to which we refer is so characteristic of the jealous watchfulness with which Great Britain has always guarded her industries, it has had so marked an influence upon our own industrial development, and has been so rarely referred to, that we may properly recount it with some detail.

The new career in the cotton manufacture, which was to raise Great Britain to such a height of wealth and power, com-

* This point was briefly though forcibly presented, by Mr. George C. Richardson, in his speech at the Wool Trade Dinner at Boston, April 10, 1877. — *Bulletin*, vol. vii. p. 183.

menced, about 1770, with the introduction of the water-frame or roller spinning by Arkwright, and, what was of vastly higher moment, his creation of that Briareus of modern industry, the factory system. The immediate success of his enterprise in the county of Derby, in association with Jedediah Strutt, attracted public attention. One of those happy inventors whose results were equal to his predictions, he did not fail to proclaim the vast advantages which the country would derive from his inventions. A contest as to the validity of his patent gave greater publicity to his improvements. The attention of Parliament was thus aroused to the prospective importance of the cotton manufacture, and to the desirableness of preserving its processes and machinery as the exclusive possession of England.

In the year 1774, the statute was enacted by Parliament, instituting the restrictive system as to textile machinery, which was continued for seventy-one years. The notes which follow were taken from the original statutes. The act, 14 Geo. III., cap. 71, was entitled "An Act to prevent the exportation to foreign parts of utensils made use of in the cotton, linen, woollen, and silk manufactures of this kingdom."

The preamble recites: "Whereas, the exportation of the several tools or utensils made use of in preparing, working up, and finishing the cotton and linen manufactures of this kingdom, or any or either of them, or any other goods wherein cotton or linen or either of them are used, will enable foreigners to work up such manufactures, and greatly diminish the exportation from this kingdom; therefore, for preserving as much as possible to his Majesty's British subjects the benefits arising from these great and valuable branches of trade and commerce, it is enacted," &c.

Stringent provisions are then made against the putting on board of any ship, vessel, or boat, which shall not be bound to some port or place in Great Britain or Ireland, "of any such tools or utensils as are commonly used or proper for the preparing, working up, or finishing of the cotton or linen manufacture," under penalty of forfeiture of such tools, &c., and a fine of £200. Similar penalties are imposed for having in

possession, with intent to export the same out of the kingdom, any tools or implements used in the woollen or silk manufacture.

The provisions of this statute were either not sufficiently stringent, or the rapidly increasing importance of the manufactures demanded a more rigid restriction, for in the year 1781, another statute [21 Geo. III., cap. 37] was enacted, explaining and amending the former act, and prohibiting the exportation of "any machine, engine, tool, press, paper, utensil, or implement whatever, which now is, or may at any time be, used in or proper for the preparing, working, pressing, finishing, or completing of the linen, cotton, wool, or silk manufactures of this kingdom, or any other goods wherein wool, cotton, or silk is used, or any part of such machine, &c., or any model or plan of any such machine." To the forfeiture of the machine, &c., and fine of £200, as in the previous statute, is added imprisonment for the space of twelve months.

In the year 1825, upon a general revision of the custom laws, the above statutes were repealed, but in the new act for the regulation of the customs which was thereupon passed [6 Geo. IV.], it was provided that certain articles should be absolutely "prohibited to be exported." Among those mentioned are "any machine, engine, tool, press, paper, utensil, or instrument, used in or proper for the preparing, working, pressing, or finishing of the woollen, cotton, linen, or silk manufactures of the kingdom, or any other goods wherein wool, cotton, or silk is used, or any part of such machines, &c., or any model or plan thereof" (except wool-cards, and spinners' cards, not worth above 4*s*. and 1*s*. 6*d*. per pair respectively). To this list was added utensils used in cotton printing.

It will be seen that in the list of articles prohibited the precise language of the statute of 1781–2, is retained. A revision of the customs tariff was made again in 1833, and in the table of prohibitions of exportation the same list occurs [statute 3 & 4 William IV., cap. 52].

This prohibition remained in force, it would seem, for twelve years, although it may have been less rigidly enforced, or the

means of evasion were greater with the increased facilities of intercourse with England, than at an early period.

From a letter in our possession, it appears that when, in 1839, Sharp and Roberts, of Manchester, England, after obtaining a patent in this country for their self-acting mule, desired to introduce it here, their partner in this country, Mr. Bradford Durfee, of Fall River, was compelled to smuggle the patterns for castings to be made here, through France. In the volume on machinery in the "Encyclopædia Metropolitana," published in 1845, there is an earnest argument in favor of the repeal of the laws prohibiting the exportation of textile machinery, upon the ground that "England is in a position to supply the whole world with machinery at an evident advantage to herself and her customers." A report to the same effect was made by a committee of Parliament. These arguments were not without avail, and in the act of Parliament for the general regulation of commerce, passed on the 4th of August, 1845, machinery for the cotton, wool, linen, and silk manufacture is for the first time omitted from the list of prohibited exports, the act of 1833, before referred to, being at the same time repealed.

These laws were not mere statute menaces. They were rigidly enforced, and very rarely evaded. In the earlier periods, no perfect textile machines were even smuggled into this country, and such models as were surreptitiously imported were imperfect. The patriotic Tench Coxe, the able coadjutor of Alexander Hamilton in the Treasury, entered into a bond with a person in London, who engaged to send him complete models of Arkwright's patents. The models were completed and packed, but were detected and forfeited. Even so late as 1832 the model of a roller for calico-printing, to be used at Lowell, could be obtained only by concealing it in the trunk of a lady returning from England to this country.* Thus, for seventy-one years, this country, in its efforts to introduce the textile arts, was compelled to rely wholly upon her own resources. Deprived of English machinery, which she would have contented herself

* Mr. Batchelder's personal statement.

with importing, if permitted, instead of the one industry which she aimed to acquire, she attained two, and one infinitely higher than that which she sought; viz., the industry of manufacturing machinery, the power of creating mechanical force, and of placing its labor-aiding power at the command of every national industry. Forced to be self-reliant, our textile arts and our machinery are as original and characteristic as our indigenous plants, and, we may add, as noble and symmetrical as our native elms. Thus did England's policy of restriction overreach itself and build up the rival which she now most dreads.

INTRODUCTION TO THE UNITED STATES.

Let us now consider the first efforts in this country to introduce the textile manufactures, or such operations as are carried on by the use of machinery driven by water or steam power, or by other means than the direct application of human labor.

First unsuccessful efforts. — When intercourse with England had been restored, after the peace of 1783, a few intelligent men in this country became aware of the improvement and extension in the manufacture of cotton which had been made in England by Arkwright and others during our revolutionary war. Tench Coxe says that he first "became acquainted with the fact that the labor-saving spinning machinery of Great Britain was considerable, in 1786." His efforts and failure to procure models of this machinery have already been adverted to. In the same year (1786), before the adoption of the Constitution, the Legislature of Massachusetts set the example of the protective policy which she has since so persistently demanded from the nation. But, before reciting the action of Massachusetts, let us briefly recur to the events which led to it.

Colonel Hugh Orr, of Scotch birth, was at this period settled in the town of Bridgewater. Before the Revolution, he had been engaged there in the manufacture of fire-arms, and at the commencement of that war made the first cannon, by boring the solid castings. Having doubtless continued his intercourse with Scotland, he had obtained information that two of his

countrymen, Robert and Alexander Barr, were familiar with the new machinery for carding, roving, and spinning cotton. From motives of patriotism, as it would appear, rather than of interest, he invited them to come from Scotland to construct the new machinery at his works in Bridgewater. The association of the manufacture of textile machinery with that of arms, we shall find often repeated in our history.

On the 25th of October, 1786, the Legislature of Massachusetts appointed a joint committee "to view any new invented machines that are making within this Commonwealth, for the purpose of manufacturing sheep's and cotton wool, and report what *measures are proper for the Legislature to take to encourage the same.*" The committee reported that they had examined "those very curious and useful machines, made by Robert and Alexander Barr, for the purpose of carding and spinning cotton;" and, in accordance with the report, a resolve was subsequently passed, granting the sum of £200, to enable them to complete the machines.

From the descriptions left of this machinery, which it is unnecessary to recite, it is the opinion of Mr. Samuel Batchelder — a most competent authority — that, although very imperfect, it included Arkwright's roller-spinning and other patent improvements, and was the first introduction of that machinery in the country. It was not used for manufacturing purposes, but rather for models to diffuse information, as the Legislature provided that public notice should be given "that said machines may be seen and examined at the house of Hon. Hugh Orr, in Bridgewater, and that the manner of working them will be explained."

The building of this machinery through encouragement of the State was, however, of permanent value, as it led indirectly to the employment of Mr. Slater, and to the events which mark the period of the successful introduction of the cotton manufacture into this country.

We must pass over with but slight notice the establishment of the cotton factory at Beverly between the years 1787–9, although it was the earliest enterprise undertaken and carried into exe-

cution in this country, and received liberal encouragement from the Legislature of Massachusetts. Its machinery was driven by horse-power. Its spinning mechanism consisted of four jennies, which were little else than the union of a number of spindles in the same machine, operating in the same manner as on the one-thread wheel by hand. These having been soon generally displaced by the roller-spinning machine, a manufacture conducted by this method had but little influence upon the progress of textile machinery in this country. These jennies, there is reason to believe, had been built from models furnished by one Thomas Summers, who was enabled to complete them through a grant of £20 from the Legislature of Massachusetts. They were possibly not without influence upon the important events to follow in Rhode Island. Besides, from the jennies just mentioned, as well as from the models in Beverly, jennies were built in Providence, which probably formed a part of the modest establishment to be next mentioned.

About the year 1788, a spinning-frame was built at Providence, after a draft obtained at Bridgewater. It was purchased by Moses Brown, of Providence, who, with William Almy, Obadiah and Smith Brown, "did a small business in Providence at manufacturing on lathes and jennies driven by men." The frame, however, was very imperfect, and made very uneven yarn. The failure to make it work successfully would seem, from the correspondence preserved, to have only stimulated the ambition of the proprietors to accomplish here the great results known to have been produced in England by the roller or water-frame spinning.

As Fisher Ames wrote of the country at this period, "the spirit of enterprise has of late been uncommonly ardent." While Massachusetts and Rhode Island were vainly stretching out their arms to grasp the new enterprise which was enriching England, Pennsylvania, always stepping unconsciously with these two New England States, had founded a society for the encouragement of the useful arts, whose efforts were no less eager to acquire the new textile industry. A reward offered by this society for a machine to make cotton rollers (roller-spinning),

published in a Philadelphia paper, reached the eyes of one who was to become the Jason of America, and to carry to her a boon transcending that which the Argonaut bore to Greece. We now approach the first great epoch in the history of American textile machinery.

Samuel Slater's enterprise. — Samuel Slater is commonly spoken of as the introducer of the cotton manufacture to America.* We think he has an equal if not higher claim to distinction as the founder of the manufacture of textile machinery in America. Up to the time of his advent in this country, with the exception of the rude saw-mill, grist-mill, and fulling-mill, some rolling and slitting mills, foot-lathes, a few rough carding machines and spinning-jennies, there were substantially no machines in the country; no steam-engines, no engine lathes, no machine tools, no artificer's shops with power.† The trade and name of machinist were unknown. The workmen in cold iron were called whitesmiths. In the city of Pittsburg, even so late as 1807 there was but one machinist and whitesmith. The bills for making the jennies we have described are extant. Their metal work was made by coppersmiths and clock-makers, and the spindles were wrought in the blacksmith's forge. From the date of his advent, at first as the direct, and later as the incidental, consequence of his enterprise, there has been an increase, in a constantly ascending ratio, of special artificers of machinery, until the census of 1870 enumerated 54,755 machinists.

Without attempting a biography of Slater, we cannot do justice to our subject without dwelling briefly upon the traits of personal character and circumstances of position which made him, if not the author of the new mechanical revolution in America, at least the pivot upon which it turned.

Jedediah Strutt, the son of a Derbyshire farmer and maltster,

---

* The principal authorities for the sketch which follows are the very interesting Memoir of Mr. Slater, by George S. White, and personal communications from Mr. H. Nelson Slater.

† Eli Terry, the founder of clock-making by machinery in Connecticut, in 1793, used a hand-engine for cutting the teeth of the wheels and pinions of his clocks, and a foot-lathe for the turned work.

had been led to embark in cotton-spinning through his invention of a machine for making ribbed stockings. In 1771, he had become a partner of Arkwright. In 1775, he erected cotton works at Belper, and afterwards at Milford, in Derbyshire, in which Arkwright had an interest; applying the machinery of the latter with such success that the manufacture carried on by him, and subsequently by his sons and grandsons, raised the family to great wealth, and to such high consideration, that, in 1856, the head of the family was elevated to the peerage, under the title of Lord Belper. In 1866, a grandson of Lord Belper, and the Marquis of Lorne visited this country as travelling companions. The social influence of the textile industry is significantly illustrated by its placing the descendant of the Derbyshire maltster on an equality with the representative of the proud line of MacCallum More.

William Slater, the father of the subject of this sketch, a respectable freeholder, tilling his own land, and carrying on the business of a timber merchant and land agent, being a near neighbor of Jedediah Strutt, was his confidential agent for the purchase of timber and land. The elder Slater being thus favorably known to Mr. Strutt, who, as his own sons then showed no adaptation for the pursuits, was seeking for a promising young man to be trained for the superintendence of his work, Mr. Strutt urged the elder Slater to place one of his sons in this position; and Samuel, the fifth son, a boy of fourteen, who "wrote well and was quick at figures," entered Mr. Strutt's employment as an apprentice in the "art of cotton-spinning," remaining with him upwards of eight years. Uncommonly well educated by an excellent schoolmaster, Mr. Jenkins, — whose letters attest the interest he continued to take in his former pupil, — and having a natural aptitude for mechanics, the young man became something more than a cotton-spinner. He lived in the family of his master, and was his confidential clerk. His first important service as a boy was the invention of a valuable device for enlarging the capacity of the bobbin to hold the yarn, the drawing of which is preserved, and for which his master gave him a guinea. He soon, as his biographer says, "became an

excellent machinist, as he had opportunities of seeing the latest improvements." To use his own words, in notes found among his papers, "during four or five of the late years, my time was solely devoted to the factory as general overseer, both *as respected making machinery* and the manufacturing department." His last employment was the superintendence of the construction of the new works erected by Mr. Strutt. It has been asserted that there were not five men in England so familiar with every branch of the cotton manufacture as young Slater. The point which we wish to bring into prominence is, that it was his accomplishments as a machinist, rather than as a mere cotton manufacturer, which fitted him for the important work before him.

A few months before his apprenticeship expired, seeing copied in a Liverpool paper the Philadelphia advertisement before referred to, he resolved to seek his fortune in America. His old schoolmaster, Mr. Jenkins, who regarded the "western world as the seat of patriotism and independence," was probably not without influence upon this decision. Endowed with that power of permanently impressing the outlines and relations of material objects on the brain, which is the highest evidence of mechanical genius, he at once began the process of fixing, without note or memoranda, all the forms of machinery and the processes of manufacture, in his *mind*, — that treasury which, in the words of Tristram Burgess, "could not be rummaged and pillaged by custom-house regulations." To master his subject more thoroughly, after the term of his indentures had expired, he continued his work of supervising the new factories of Mr. Strutt with the last improvements, and then in the guise of a farmer, keeping his object secret, even from his family, without a single model, draught, or memorandum, he embarked for New York. Arriving there in November, 1789, he spent a few weeks in a small establishment where cotton-spinning was carried on by means of jennies. This did not suit his purpose, for his "intention was to erect a perpetual card and spinning" (meaning the Arkwright patents). Learning, from the captain of a Providence coaster, of Moses Brown's attempts in this direc tion, he entrusted to the friendly captain a letter to Mr. Brown,

which brought back Mr. Brown's request that he should visit him in Providence. When Slater saw the old machines, he said, "These will not do. They are good for nothing in their present condition, and cannot be made to answer." Finally a contract was made between Almy and Brown, the associates of William Brown, and Slater, for the latter, "to direct and make a mill in his own way, which he did." The place selected by Moses Brown for the new enterprise was Pawtucket, Rhode Island, then a hamlet with a dozen houses, the site for the new machinery being an old fulling-mill with water-power. Happily, our adventurer found his first home in the house of an American mechanic, Oziel Wilkinson, whose daughter he soon married. Tristram Burgess thus speaks of Wilkinson and his sons: "They were blacksmiths, whose hands were as skilful as their minds were intelligent and persevering. I have often thought," he continues, "that divine Providence directed Slater, and brought him to lay his project before the Wilkinsons, because He had not fitted any other men in this country with minds and abilities either to see and at once comprehend the immense benefit of it, or to understand and perform what must be understood and performed to bring this scheme into full and perfect operation."

Though greatly aided by the Wilkinsons in the adaptation of the imperfect mechanical instruments at command to his work of construction, Slater made most of the machinery, which was completed and put in successful operation at the end of fourteen months, with his own hands. He had to construct his own tools. He had not even a turning-lathe at his command. In order to turn his iron rolls, he was compelled to construct a contrivance turned by a crank; an old Indian named Prime, whose name should be preserved in the roll of the early machinists, being employed for this purpose.

When the machinery was completed, operatives had to be engaged; and the following incident shows from what a low condition the introduction of textile manufactures has uplifted our laboring population. A man by the name of Arnold, with his wife and a dozen children, living a mile or two distant in

the woods, seemed to offer a favorable source for the supply of the needed hands. They lived in a den of which two rocks composed the sides, and rough slabs formed the roof and doors. The woman, when applied to by Mr. Slater to leave her wretched shelter, and work with her children in the mill, consented, upon the express condition that she should be provided with as good a house as she then lived in.*

Extension in Massachusetts and Rhode Island. — It is unnecessary to pursue farther the career of our pioneer. We find, in 1790, the industry of cotton-spinning, and of the production of machinery by which it is effected, firmly planted in America. At the commencement of the war with Great Britain, a little over twenty years from this, there were in the States of Rhode Island and Massachusetts, within thirty miles of Providence, fifty-three cotton factories, with 48,030 spindles. These establishments can be directly traced to Slater's enterprise, and justify his quaint and modest reply to General Jackson. The latter, visiting him at Pawtucket, said to him, "I understand you taught us how to spin, so as to rival Great Britain in her manufactures." "Yes, sir," said Slater, "I suppose that I gave out the psalm, and they have been singing to the tune ever since."

Before tracing Slater's relations to the further extension of textile machinery, we will consider the character of the soil upon which the seeds of mechanical power, brought from across the Atlantic, whose first sowing we have above described, were scattered. There were two favorable elements in this soil, — the spirit of enterprise, always so characteristic of New England, especially maritime New England; and the ingenuity of its laboring population. This population was composed principally of farmers: as a rule, all had been taught by the common schools to read, write, and cipher. Either from inherited ingenuity, custom, or necessity, the farmers of New England are characteristically "handy," or apt in mechanical work. In former times, more than at present, they made their own imple-

* Personal communication from Mr. H. Nelson Slater.

ments, constructed their own buildings, and conducted mechanical trades in conjunction with their agricultural employment. It was wholly from this class — for the first factories were not built in the cities — that the machine shops in this country continued to be supplied with workmen for some forty years. It was from this class that Mr. Slater obtained the workmen in his mills, and upon his machinery.

In accordance with the invariable laws which attend the propagation of industries, "several of his workmen, who had become acquainted with the construction of his machinery, left his employment, and commenced the erection of mills for themselves or other parties." A factory was erected at Cumberland about 1801, by Benjamin S. Walcott, who had been employed by Mr. Slater in the construction of his first mill. Another of his workmen commenced a mill in New Ipswich, N. H., in 1804, the first cotton mill in that State. Another employé in the early mills in Pawtucket, B. S. Walcott, in 1807 or 1808, built the first cotton mill in Oneida County, New York, and subsequently, in conjunction with Benjamin and Joseph Marshall, erected the original factory of the "New York Mills," the establishment which has since become so celebrated for the excellence of its fabrics. Mr. Samuel Batchelder * informed the writer that his associates in building the second mill in New Hampshire in 1808, Nason and Holton, were machinists who had been employed in the Providence cotton mills. In answer to the inquiry of the writer how the early machinists of New England acquired their art, he replied that "they grew up in building machinery for spinning, in Pawtucket and Providence."

As we have before observed, until the manufacture of textiles by power had been successfully established in this country, the

---

* In the course of the preparation of this paper, the writer enjoyed the privilege of two long interviews with Mr. Batchelder, about a month before his decease, and was permitted to take notes of his recollections of the early stages of the American cotton manufacture, to which no one then living had so much contributed. At the time of these interviews, Mr. Batchelder, at the age of ninety-five, was in the perfect possession of his remarkable mental faculties.

industry of manufacturing machinery, as a distinct business, had no existence in this country. The factory system and the movement of textile machinery by power demanded the construction of great numbers of pieces of machinery of the same dimensions, and also the construction of works of nice mechanism, which the mere handcraftsmen could not supply in sufficient number, nor with requisite precision of construction. The application of power to the production of machinery, and the creation of machine tools, and therewith of the special art of the machinist, were the necessary result of the introduction of the factory system.

The first important independent machine shop of which we can find trace, though there may have been others, is that erected by David Wilkinson, the brother-in-law of Slater. He was the inventor and introducer of the first self-acting engine lathe known in this country, the earliest of that series of inventions which have substituted the iron arm for the weak and uncertain human hand, and have caused, at least in the manufacturing world, the file, the plane, the chisel, the auger, the drill, in the hand of man, to disappear, except for the most trivial purposes.

The relations of Wilkinson with Slater sufficiently establish that the dawn of this revolution was coeval with that of the introduction of the factory system. The time, however, had not arrived for the successful introduction of the independent machine shops. At this period, and indeed for many years subsequently, the machinery for new mills was generally constructed by workmen directly employed by the mills, and the shops attached to the mills were established in the basements of the factory building, and were moved by the motive-power of the factory. The successful establishment of the independent machine shops did not take place until the second great epoch in the history of our textile manufacture.

Introduction of Woollen Machinery. — In the household fabrication of woollen cloth, — the only domestic source of supply in this country until about the commencement of the present century, — the greatest defect was caused by carding the wool

with hand-cards, without proper care in sorting and mixing the wool, for which reason the different parts of the cloth would shrink unevenly upon being fulled and dressed. This defect was not obviated until the adoption of machine carding, which mixed and carded the wool so perfectly that the different parts of the cloth would receive a uniform finish. Therefore the use of the carding machine may be considered the first step in the introduction of the woollen manufacture proper, or the fabrication by means of machinery. In giving the history of the introduction of the carding machine, and consequently of the woollen manufacture of this country, we can only repeat the facts collected by our accomplished associate, Mr. Royal C. Taft, of Providence, R.I., published at length in a previous volume of our Bulletin.*

"On the 24th of March, 1793, John Scholfield with his family, and Arthur, sons of Arthur Scholfield, who lived at Standish-foot, in Saddleworth, Yorkshire, England, sailed from Liverpool for the United States, where they arrived at Boston in the May following, and took up their residence in Charlestown, near Bunker's Hill. Here they remained until August, making some preparations and constructing some machinery for the manufacture of woollen cloth. Having introduced themselves to Mr. Jedediah Morse, author of "Morse's Geography and Gazeteer," as being manufacturers, and well skilled in the most approved method of manufacturing woollen goods in England, they were by him introduced to some persons of wealth in Newburyport, who, availing themselves of the knowledge which they possessed, at once put up a factory at Byfield, in the vicinity of Newburyport, under the immediate supervision of *John and Arthur Scholfield, and they there constructed the first* carding machine that was put in operation in the United States. This was constructed and first operated by hand before the factory was ready to receive it. When all of the machinery was constructed according to their direction, the factory went into operation, and John Scholfield was employed as an agent, and the business was conducted prosperously. This was the first factory erected and conducted advantageously in the United States, all previous attempts having been rendered unprofitable by reason of imperfect machinery."

* "Introduction of the woollen manufacture into the United States."—*Bulletin of the National Association of Wool Manufacturers,* vol. ii. p. 479.

In 1798, John Scholfield hired a water-power at Montville, Conn., and built a factory, where he continued until 1806. Arthur Scholfield remained with his brother at Montville about three years, when he removed to Pittsfield (1801), and built a carding machine, and went to carding rolls and manufacturing. In 1804 he made the first broadcloth fabricated in this country. In 1806 we find him advertising as follows: "Double carding machines, made and sold by A. Scholfield, for $253 each, without the cards, or $400, including the cards. Picking machines at $30 each." Arthur Scholfield appears therefore to have been the first manufacturer in this country of wool machinery as a distinct business.

We must not omit to notice that Mr. Samuel Batchelder, in some memoranda upon Mr. Taft's paper, published in Vol. IV. of our Bulletin, suggests that two other persons are entitled to share in the credit of contributing to the first steps in our woollen manufacture. He states, as would appear from verbal information, which he admits to be "always liable to inaccuracy, particularly as to dates," that two men by the names of Lees and Taylor came to this country in 1794. Lees soon after returned to England and purchased carding machinery, which was shipped to Boston as *hardware*. This card machinery was received at Boston by Taylor and put in operation by him at Byfield, about 1796. Lees afterwards went to Leominster in 1800, and set up wool-carding there. Mr. Batchelder intimates "that it may be inferred that such machinery as was capable of being operated by hand while the mill was building, and was made by inexperienced workmen at Newburyport, could not have been so complete as the carding machines imported by Lees." It is possible that the Scholfields may have been assisted by Lees and Taylor; but this cannot detract from the credit due to them as the first suggesters and founders of wool-carding machinery, and due also to the first successful wool manufacturers of the country.

The introduction of the wool-carding machine did not lead immediately to the establishment of woollen factories as now constituted. For many years the carding machines formed an

important part of the fulling-mills of the *clothiers* of the early part of the present century. As late as 1810, the trade of the clothier was as distinct and general as that of the hatter, although both industries have disappeared. In New Hampshire, nearly every township of two hundred or three hundred families had a carding and fulling mill; the carding and fulling machinery being moved by power. There were about one hundred and forty fulling and carding mills in that State, of which the average cost was $1,500. In Vermont there were one hundred and sixty-three fulling-mills. Every farm-house in these States had one or more spinning-wheels, and every second house, at least, a loom. The wool was carded into rolls to be spun in the households, at a cost of about seven cents a pound; and the cloth, after being woven in the families, was fulled and dressed by the clothier. In Vermont, in 1810, 1,040,000 yards of cloth and flannel, besides the fabrics of cotton and flax, were woven in families, and were dressed in the mills.*

The application of power to spinning and weaving wool did not take place until several years after its application to cotton. This was due to two causes. While there was an abundant supply of cotton, there was a scarcity of fine wool for merchantable or *boughten* cloth, the only kind which then could be advantageously made in a mill, as the coarse cloths were all home-made; and again, in the early attempts at spinning woollen yarn adapted for the making of fine fulled cloths by power, it was found that, in power spinning, the machinery could not be sufficiently controlled to preserve the looseness necessary for effectual fulling. For the same reason the power-loom for weaving woollen yarn into cloth has been of comparatively recent introduction.

Of the early stages of the introduction of wool-spinning machinery in this country, we have to admit that our knowledge is greatly deficient. Studious researches, and inquiries by letter addressed to our oldest manufacturers, fail to give us the desired light. Spinning jennies had been built by Arthur Scholfield in

* Bishop's *History of American Manufactures*, vol. ii. p. 150.

1806. The "Pittsfield Sun," in 1809, publishes the following: "These machines (the spinning jennies) go with from twenty to thirty spindles, upon which a single woman can spin from twenty to thirty runs of fine yarn per day, in the best manner. A few of them are already in operation in this vicinity, and can be conveniently worked in a private family. The cost of them is about $50, and one of them is sufficient to do the spinning for a number of families, who can join in the purchase." From another contemporaneous notice, it appears that these jennies were operated by a crank, moved by hand.

It would seem from this that wool-spinning by power was not known in one of the oldest wool-manufacturing centres of Massachusetts, even as late as 1809.

In the history of the oldest wool-manufacturing establishment in Rhode Island, the Peacedale Company,* founded in 1800, by Rowland Hazard, it appears that in the early years, spinning and weaving were carried on by hand. "In 1819, Isaac P. Hazard and Rowland G. Hazard, sons of Rowland, took charge at Peacedale, and in the year following started a spinning jack of fifty-two spindles." This is the first record which we can find of the application of power to spinning wool in this country.

From the history above referred to, we learn that, in 1812, a resident of Peacedale, Thomas R. Williams, the inventor of the felting machinery to be referred to hereafter, invented a power-loom for weaving saddle-girths and other webbing. This loom was put into successful operation by Mr. Hazard in 1814, but was not used for ordinary woollen goods, — kerseys and other wide goods being then woven by hand until 1828, when the power-loom for weaving broad goods was introduced.

Cloth-weaving by power was introduced earlier in Pittsfield. Mr. Thaddeus Clapp, an authority in relation to the industrial history of Berkshire, says, "I have always heard that the first power broad looms were started here about 1826, and were

* *Awards and Claims of Exhibitors at the International Exhibition of* 1876, p. 145.

built at Williamsburgh, Mass." Bishop fixes the date of the introduction of the power-loom in Berkshire County at 1825, and states that flannel woven by water-power in Massachusetts, and exhibited at Brighton Fair, in November, 1824, "gave great satisfaction."

The period of 1830 we may fix upon as that of the completed and successful introduction of the woollen manufacture in this country, substantially with the principal appliances and machinery of the present day. This was the date of the erection of the Middlesex Mills of Lowell, whose history, it has been said, "covers the entire life of the successful woollen industry of this country," and whose machinery and products are recognized types of the perfection we have attained.

Second epoch in the history of American textile machinery. — Introduction of the power-loom. — Until 1814, the operation of the cotton factories in this country had been confined to the production of yarn, which was woven in the hand-loom, generally in the families of the country people living in the vicinity of the spinning-mills, the proprietors of which supplied yarn and procured the weaving to be done by piece. Mr. Batchelder informed the writer that, from yarn produced in his mill in New Hampshire, he had caused the production of three hundred tons of cotton cloth woven in hand-looms in the manner described. We cannot fail to be impressed by the fact that the household fabrication of cotton cloth on so extensive a scale was conducted under the direction of a manufacturer who has lived to our own times.

During the years of restrictions upon importations of 1809–11, and the war of 1812, the profits of manufacturing, even upon hand-looms, were so great that the inquiry was never made whether any improvement could be made in machinery, but how soon such as was already known could be turned out by the machine shops. In 1811, the movements then being made in Scotland and England to introduce the power-loom attracted the attention of a novice in manufactures, but of rare mechanical and mathematical genius, Francis C. Lowell, of Boston, then temporarily residing in Great Britain. He returned to this

country in 1813, bringing with him a better knowledge of the manufacturing operations of Great Britain than was possessed by any other person in this country. He at once found associates to undertake with him the new system of manufacture at Waltham. One of these associates, not more eminent as a merchant than as a manufacturer, a legislator, political economist and philanthropist, Mr. Nathan Appleton, has left a history of this enterprise,* which, familiar as it is to so many of our readers, cannot be properly omitted, even in the merest outline of the history of American machinery.

"In starting the enterprise at Waltham," says Mr. Appleton, "the first measure was to secure the services of Paul Moody, of Amesbury, whose skill as a mechanic was well known, and whose success fully justified the choice.

"The power-loom was at this time being introduced in England; but its construction was kept very secret, and, after many failures, public opinion was not favorable to its success. Mr. Lowell had obtained all the information which was practicable about it, and was determined to perfect it himself. He was for some months experimenting at a store in Broad Street (Boston), employing a man to turn a crank. It was not until the new building at Waltham was completed, and other machinery was running, that the first loom was ready for trial. Many little matters were to be overcome or adjusted before it would work perfectly. Mr. Lowell said to me that he did not wish me to see it until it was complete, of which he would give me notice. At length the time arrived. He invited me to go out with him and see the loom operate. I well recollect the state of admiration and satisfaction with which we sat, by the hour, watching the beautiful movement of the new and wonderful machine, destined, as it evidently was, to change the character of all textile industry. This was the autumn of 1814.

* "Introduction of the Power-loom and Origin of Lowell." This account having been published in the perishable form of an unbound pamphlet, is now rare. Fortunately, all the important statements was embodied by Hon. Robert C. Winthrop in his appreciative memoir of Mr. Appleton, prepared for the Massachusetts Historical Society, and are permanently preserved, among other precious muniments of the Commonwealth, in the volume of that society for 1860–62.

"Mr. Lowell's loom was different in several particulars from the English loom, which was afterwards made public. The principal movement was by a cam, revolving with a centre eccentric motion, which has since given place to the crank motion, now universally used. Some other minor improvements have since been introduced, mostly tending to give it increased speed.

"The introduction of the power-loom made several other changes necessary in the process of weaving. The first was in the dressing, for which Mr. Horrocks, of Stockport, had a patent, and of which Mr. Lowell obtained a drawing. On putting it in operation, an essential improvement was made, by which its efficiency was more than doubled. This Waltham dressing machine continues in use, with little change, from that time. The stop-motion for winding on the beams for dressing was original with this company.

"The greatest improvement was in the double speeder. The original fly-frame, introduced in England, was without any fixed principle for regulating the changing movements necessary in the process of filling a spool. Mr. Lowell undertook to make the numerous mathematical calculations necessary to give accuracy to these complicated movements, which occupied him constantly for more than a week. Mr. Moody carried them into effect by constructing the machinery in conformity. Several trials at law were made under this patent, involving, with other questions, one, whether a mathematical calculation could be the support of a patent. The last improvements consisted in a more slack spinning on throstle spindles, and the spinning of filling directly on the cops, without the process of winding.

"From the first starting of the power-loom, there was no hesitation or doubt about the success of this manufacture. The full capital of four hundred thousand dollars was soon filled up and expended.

"Mr. Lowell is unquestionably entitled to the credit of being the first person who arranged all the processes for the conversion of cotton into cloth within the walls of the same building.

"He died in 1817, at the early age of forty-two, beloved and respected by all who knew him. He is entitled to the credit of having introduced the new system in the cotton manufacture, under which it has grown so rapidly. For although Messrs. Johnson and Moody were men of unsurpassed talent and energy in their way, it was Mr. Lowell who was the informing soul, which gave distinction and form to the whole proceeding."

Mr. Batchelder's invaluable book,* and his recent personal communications to us, furnish some supplementary facts as to this enterprise in its relation to the development of machinery.

Machinery at Waltham. — Mr Moody, the constructor, and at least the joint inventor, of most of the new machinery at Waltham, which was made in a shop attached to the mill, was an accomplished mechanic. He had obtained his knowledge of machinery in constructing and directing nail machinery in Amesbury, where he had the benefit of suggestions from the celebrated Jacob Perkins, the most eminent machinist of his time, one of whose devices — the drop wire — he applied to effect the stop-motion in the warpers constructed at Waltham. Moody was not only ingenious, but had a remarkable faculty of turning to practical account the suggestions of others. Speaking accidentally to his brother of the difficulty he encountered in casting the rollers for his dressing frame, he said, "I intend to try soapstone," — meaning for a mould. His brother, misunderstanding him, replied, "Well, I should think soapstone would make a very good roller." Mr. Moody made no answer, but took the hint, and made the rollers of soapstone, which has come into general use for the purpose.

When spinning was first commenced at Waltham, the filling and the warp were made on the same machine, and the filling had to be wound off on another bobbin. Failing to purchase on reasonable terms a patent then existing for the purpose, on the challenge of Mr. Lowell, Moody invented the filling frame which spins the filling separately, a machine still in use where the filling is not spun on the mule. The dressing frame invented by Mr. Moody, when seen by English manufacturers, was admitted to be greatly superior to any used in Manchester or Glasgow; and, according to Mr. Batchelder, is superior to any of the modern processes for effective work, although the latter may cost less.

Mr. Moody's genius was subsequently evinced by one of the

---

* *Introduction and Early Progress of the Cotton Manufacture in the United States.*

most characteristic of American improvements, — the use of leather belts instead of iron gearing for the transmitting motion to the main shafting of the mills having been first introduced by him at the Appleton Mills, in Lowell, in 1828.*

Mr. Moody is still spoken of as "that prince of mill organizers," † and must be placed in the first rank of the creators and introducers of American textile machinery. All the inventions and improvements in machinery made at Waltham, including the loom, roving frame, or double speeder, warper, dressing frame, and filling frame, were patented, — a conclusive proof, under our system of examination, of their originality. The very fact that they were made by men who had had no previous practical experience in manufacturing, gave freshness and originality to the inventions. They were the first emancipation from the English methods, which had been hitherto servilely followed, and continued to be followed to a considerable extent in Rhode Island, where they were first introduced. Even the high price at which the Waltham patents were held stimulated invention in other quarters, and the introduction of more recent foreign improvements. Three years after the cam power-loom had been successfully operated by Lowell, the crank loom, introduced by Gilmore, was constructed by him and David Wilkinson, in Rhode Island; and the tube-speeder, for making the roving, was invented by Danforth to take the place of the Waltham patented speeder, and was applied in the mills of Rhode Island, and subsequently, to a considerable extent, in Great Britain.

The complement of the Waltham enterprise was the founding of Lowell subsequently by the same promoters. The starting of the Merrimack Mills in Lowell, in September, 1823, completed the introduction of the cotton manufacture into the United States. From this period we can follow the subsidiary industry, — the manufacture of machinery, — for only a brief

---

* "The practice of high speeded shafts and the entire substitution of belting for gear wheels belong essentially to this country." — *Machine Tools*, by William Sellers & Co., p. 185.

† *Proceedings of the New England Cotton Manufacturers' Association*, No. 9, p. 10.

period, until the stream is lost in the sea of industries which from this time began to spread over the American continent.

Machinery at Lowell, and factory repair shops. — The first work of the projectors of the enterprise at Lowell was the building of a machine shop. The right to all the patented machinery at Waltham, and the use of all the patterns, was acquired, and the machine shop was placed under the charge of Mr. Moody. The original machine shop was made exactly the size of the most approved factory buildings, with the idea that, when all the mills were supplied with machinery, there would be no farther use for the machine shop, and the building could be converted into a cotton factory.

In 1825, the "Proprietors of the Locks and Canals" became owners of all the land and water-power in Lowell, as well as the machine shop. They continued to supply all the machinery for each of the mills constructed, until 1845, when the machine shop was sold to a separate corporation, which has continued the production of machinery with increased activity. Mr. Burke, the present accomplished superintendent of the Lowell Machine Shop, who was brought up in the Nashua Machine Shop, established about the same time, informs us how the machine shops of Lowell and Nashua obtained their workmen. Ira Gay, the superintendent of the Nashua shop, who invented and constructed a self-acting mule as early as 1828, was the son of a New Hampshire farmer. He learned his trade in Pawtucket, and therefore grew out of the early Rhode Island machinists. All the workmen in Nashua and Lowell, and, indeed, in all the early shops, according to Mr. Burke, were native Americans, taken from the trades and farms, — often men with families, who came into the shops wholly unskilled in the special trade of machinists. They received higher wages than were paid at that time for farm labor, — according to our recollection about fifty cents a day. According to a memorandum left by Mr. Boot, in 1828 the average wages paid to the machinists were about ninety cents; but he says, "As a large portion of the work is done by contract, and done by apprentices, many of them make even from four to six dollars a day." Thus an

intelligent class of men was attracted from the farms to the machine shop, who learned the powers and principles of machinery, and were able to apply them, not only to textile, but all other industries; and thus the early textile machine shops became the great schools of American invention.

Establishment of independent machine shops. — The Lowell Machine Shop became independent of the factories in 1845. In this year, the celebrated works of Mr. Mason were established in Taunton, being, as asserted by him, the first independent establishment erected in the country for making cotton machinery, with all accessories, foundry, &c. Until this period, as Mr. Mason has observed to us, there was scarcely a mill without a machine shop under it. They have been gradually withdrawn from the factories; and the manufacture of textile machinery, as a distinct and exclusive business, has become one of the most important and characteristic of our industries. The change has been of great benefit to the textile manufacture. The construction of machinery being the first, and not the secondary, object of the establishment, it commands all the resources in skill and enterprise of the proprietors, and the work is more perfect, as in all specialization of industry. There is a more extensive use of machine tools, and a more extended appreciation of the American "interchangeable system," with the use of special tools for even the most minute parts of the machinery, thus effecting the utmost economy of production. Machinery being made by contract, the cost of stocking a mill may be exactly calculated, while competition has brought prices down to a mere living profit.

Our machine shops, — it would be invidious to specify examples, — it is believed, compare favorably with any in the world, in their mechanical appliances, the material worked up, and the skill of their native workmen.* Such establishments are the first necessities of a manufacturing nation, and the most important of securities for industrial independence.

* Mr. Harris Gastrell, in his report to the British Government, says: "The machine shops of the United States are well equipped, organized, and managed; and certain establishments not only rival European, but even in some respects excel the best in England."

Although machine shops are now severed from the mills, they are placed in the midst of the great centres of manufacture, having easy access to many mills. As in all other cases, the advantages of the consumer and the producers of machinery being placed near each other are incalculable. They are found, not only in the saving of transportation, facilities for selection and purchasing, but especially in the opportunities afforded for the adaptation of machinery to the special wants of the manufacturer. The owners of the mills and machine shops, without being partners in profits and losses, are united in one object, — the perfecting of the manufacture. The advantages of this contiguity are illustrated by some notes furnished us by a large manufacturer of woollen machinery, whose establishment is easily accessible to the mills of Andover, Lawrence, and Lowell. It is the system in this establishment, as it is doubtless in others, to encourage the workmen to suggest improvements in machinery. For slight improvements, the proprietors offer a hundred dollars, for instance, to the workman suggesting an improved device, and pay the expense of getting out a patent. For important improvements much more is paid, one mechanic having received for his various improvements over $25,000. If a workman conceives of an improved device, — say an improvement in spinning, — and desires to test it in a neighboring mill, the proprietor arranges with the spinner selected by the workman to test the new device, to pay for his extra time, or loss of time, as the spinners work by the piece. The spinners, who are usually proud of introducing improvements, readily try the experiment.

"There are many great advantages," says the same intelligent informant, "in having the machine shops near the mills. Many of the suggestions of the improvements that are needed come from the mill operators. They say, 'We find a difficulty, and you machinists must set yourselves to work to overcome it.' Within the last ten years, the mill operators complained that one of their greatest evils was that they were subject to men employed as jack spinners, who were generally foreigners, and had brought with them the disorderly habits of English workmen. Often on a Monday morning, half of them would be absent from the mill in consequence of the Sunday's dissipation. This retarded

all the operations of the mill. The mill-owners said, 'We need a self-operating machine, which can be run by a boy, and will make independent of the unreliable class of workmen we were compelled to employ.' The response to this demand was the construction, by four different American inventors and machinists, of as many self-operating adjustments which could be added to the jacks. These came into extensive use; and when the jacks with these attachments were worn out, they were replaced by self-operating mules. The self-operators are found now in every woollen mill of any pretensions. They had been tried in England with but little success. The machinery of the first self-operators in successful work in this country was of American invention and construction.

"Another reason why American woollen machinery is preferable for our own mills is that machinery should be adapted to the special wools consumed here. California wool requires different machinery from Ohio wool, and Mestiza wool different from either."

CHARACTERISTICS OF AMERICAN TEXTILE MACHINERY.

Omitting, for the present, all considerations of ingenuity or special adaptation to the purposes in view, we may mention some of the general characteristics of American machinery which entitle it to favor. The raw materials of the machine manufacture are iron and steel; and the domestic products of these materials are to our machinists what the superior fibre of our own wool and cotton are to our textile manufacture. American iron and steel are universally recognized by our machinists as superior to any imported. Formerly it was the custom to import Scotch pig, to be mixed with our own harder irons, in order to give the requisite softness for turning and planing the castings. American pig irons are now used, which require no mixture. The superior strength of American iron enables our machinists to make their work materially lighter than the English, and at the same time equally strong. Besides the general lightness of American work from the cause just stated, in American machinery the weight of iron is placed just where the strength is required, while — perhaps on account of the former greater cheapness of iron in England — their machinists put in the weight without reference to the parts where it is most desirable.

Gracefulness of proportion and superior finish of all the parts — the frames as well as the working parts — are marked characteristics of American machinery. None of our machinists, we believe, will regard it invidious for us to say that no one has contributed so much to the artistic construction of American machinery, as the veteran machinist, Mr. William Mason, of Taunton, who in early life hesitated whether he should be an artist or machinist. He has proved to be both. The graceful form of the present American locomotive is due to his artistic models. Following his example, our machinists long ago anticipated the lessons of the recent English art-writers, to combine, even in the most common utensils, the beautiful with the useful. It has been often observed, that the first work of American machinists, in adopting the model of an English machine, is to take out the dead iron, place it where it will be of use, and give grace and proportion to the whole structure, and finish all its parts. The artistic spirit of the workmen is shown in all our machinery, conspicuously in locomotives and fire-engines, — nothing like them in perfection of exterior finish being known abroad, — and had its crowning illustrations at our Centennial Exhibition, in the Corliss engine, which foreigners recognized as hardly less a triumph of mechanism than of art. This artistic construction of machinery is not without its practical uses. It causes greater care on the part of the workmen operating the machinery, thus keeping it in better working order, and encourages the cleanliness and order which have become distinguishing features of American mills. Another characteristic of American machinery is the more extensive use here than abroad of special tools, and the application of the idea first suggested by an American mechanic, still living at Springfield, Massachusetts, of making each of the several parts of an indefinite number of smaller machines interchangeable; a system by which a machine tool, moved by power, is adapted for each operation, one tool, for instance, cutting ten thousand slots, another drilling ten thousand holes, and so on. By this means, there is attained not only extraordinary precision, but the utmost economy of production. Although British officers of engineers, shortly after the Crimean war, visited our

armories for the special object of studying this system, it has not been adopted abroad; and for this reason, chiefly, as we are informed, are we enabled to export a type of textile machinery purely original with us, — our sewing-machines, — to all parts of the world.

Still another peculiarity of our machine shops is, that all parts of the machinery are made in one establishment, and under the direction of one controlling mind. In England, on the contrary, in cotton machinery especially, the work of construction is divided among different establishments, — one, for instance, making the rolls, and the other the spindles. By this system the work is done much more cheaply, but, as is obvious, much more imperfectly than here. The enormous scale upon which English cotton machinery manufacture is conducted, — it being made for exportation as well as home use, and England, according to M. Reybaud, manufacturing 45,000 spindles every week to supply the filatures of the world, — admits of this division of work, and permits the employment of the cheapest class of labor. It is this cheap labor, and not greater skill, which makes the ordinary cotton machinery, such as that used in spinning, cheaper than in this country. The higher classes of machinery, such as fine steam-engines, locomotives, and machine tools, which require uncommon tools and high-priced workmen, are dearer in England than in this country.

To conclude this branch of our subject, we quote the answer of an accomplished engineer,* unconnected with the manufacture of machinery, to our question, "What is the necessity of importing machinery?" His reply was: "There is not the least; our machines are more nicely fitted, as the English, our only competitors, are not so far advanced in special tools. With scarcely an exception, every machine built in the United States will perform its work more accurately than any machine which can be imported for the same purpose."

There may be what Herbert Spencer calls a "prejudice of patriotism" in these commendations of American workmanship.

---

* Colonel Samuel Webber, of Manchester, N. H.

There could be no such bias in the observation of a recent French writer on the "Marvels of Machinery," who, speaking of America, says, "*Là les ingénieurs sont des savants, les savants sont des ingénieurs.*" The scientific construction of our textile machinery, we cannot doubt, has largely contributed to the eminence thus accorded to our mechanics, in science, and to our men of science, in mechanics.*

---

* A few other foreign testimonials may be added.

Mr. Brassey, the eminent member of Parliament, — better known to us by his cruise around the world in the yacht "Sunbeam," so charmingly described by Mrs. Brassey, — said, in a recent lecture in England, "It would at first sight seem incredible that our engine builders should have been beaten in a neutral market with no hostile tariff. Anyhow, it would have been expected that, if we were beaten, it would have been by Belgians or German makers, who command an ample supply of labor at comparatively low rates. The contrary, however, has happened; and it is a country where labor is paid at rates unknown in the old world which has supplanted us. We have been conquered by the mechanical skill of the employer in devising labor-saving machinery, and by the industry and energy of the workmen, who, if they have earned high wages, have worked longer and more industriously than many among our own mechanics have been disposed to do."

In a discussion upon a paper of Mr. Mundella, at the "Statistical Society" of England, Mr. J. B. Brown said, "from his own experience he had found that English workmen generally, when employed in an American workshop, were inferior in expedition to an American, and that American machinery, on the whole, was superior to the English, quite as well made, generally more ingenious, and more successful in saving manual labor."

Mr. H. D. Pechin, in the same discussion, said, "There was a time when our (the British) workmen were equal to any workmen in the world, but anybody acquainted with the facts would know that, in certain classes of machinery, we are outdone by the Americans."

Mr. Mundella would not allow the superiority, but admitted the equality, of the American with the English workman. He regarded both superior to the workmen of all other nations.

The reporter to the London *Engineering*, from the Paris Exposition of 1867, referring to one of the outgrowths of our machine shops, the American wood-working machinery, regards America as "the natural home and native land of this kind of machinery, since the United States had furnished the first models of the most important wood-working tools in general use in Europe, and since these tools, however modified in details, still preserve their distinctive principles just as they were transmitted to us across the Atlantic."

Says the London *Ironmonger*, "In a country like ours, which boasts of some of the finest engineers in the world as makers of machinery, it is a bold venture on the part of our 'cousins' to settle in our midst with the very goods in which we consider we stand pre-eminent. Yet we have firms established in London whose dealings are confined entirely to American machinery and tools."

CONTRIBUTIONS TO THE TEXTILE INDUSTRY OF THE WORLD.

I. COTTON MACHINERY.

We will next consider the contributions which American inventors in machinery have made to the textile industry at home and abroad, taking our examples first from machinery applied to the manufacture of cotton.

Cotton gin. — First in this list, of course, is the invention of the cotton gin, by our countryman, Whitney; conceived in 1793, and patented in 1794, at a time when Slater obtained all his cotton in the West Indies. Previous to this invention, a hand would gin about four and a half pounds of cotton a day. With Whitney's machine he could gin seventy pounds a day. Later improvements of American invention have brought up the ginning of cotton from 70 pounds a day to 400 pounds an hour. This invention carried the export of American cotton to England, from 150,000 pounds in 1791, to 15,000,000 pounds, ten years later.

Before this invention, whatever might be the demand for cotton, there was a physical limit to the supply. "Thus," says President Barnard, "the creation of the automatic machinery by which the production of cotton fabrics, early within the last century, rose to a hundred-fold what it had been at the close of the last century, and by which, in the year 1860, it had been brought to a thousand-fold at least, was a direct consequence of the invention of the cotton gin."

Card-setting machine. — Next in order of time was an invention which has contributed equally to the cotton and wool manufacture, — the card-setting machinery of Amos Whittemore, — patented in this country in 1797, and in England in 1799, — machinery by which, without essential improvement, all the card clothing of the manufacturing world is now made. No mechanism ever attracted more admiration. When the question of the renewal of the patent was under discussion in Congress, John Randolph said, "Yes, I would renew it to all eternity, for it is

the only machine which ever had a soul." It is a singular fact, illustrating how slowly even the most meritorious inventions extended in the earlier periods of the manufacture, that a mere prejudice against machine-made cards prevented their introduction into Lowell until 1826, when they were introduced by Mr. Batchelder into the Hamilton Mills. So great now is their use, that a single card-manufacturer in Massachusetts consumes annually 30,000 sides of leather in constructing machine-made card clothing.

Other inventions will be mentioned without order of date or importance.

Arnold's compound gear. — One of the most important contributions to the cotton manufacture of the world was the invention of the compound gear, or differential-box applied to the roving, to regulate the variable velocity requisite for winding the slender filaments of cotton on the bobbin. By means of a train of bevel wheels, the number of rotations per minute of the bobbin are altered, so that its gradually increasing surface shall always move with the same relative velocity to the speed of the flyer-nose which delivers the bobbin. This was the invention of Aza Arnold, of Rhode Island, and was put in successful operation in that State in 1822, and patented in 1823. The English law permitting a patent to the introducer of an invention, a patent for the precise device invented by Arnold, was taken in England in 1826, by one Houldsworth, — who by some means obtained possession of Arnold's model, — and became known as Houldsworth's differential or equation box. Dr. Ure, in referring to this invention, which he supposed to be of English origin, says, "It may be considered the most ingeniously combined apparatus in the whole range of productive industry." Elsewhere he says, "It is only since these improvements of Mr. Houldsworth were introduced, about eight or nine years ago, that excellent cotton yarn has been turned off with increased uniformity of speed, so as to extend the trade by lessening the cost of producing a superior article. The good yarn formerly made required prodigious pains in the first adjustment of the machine; and its graduating could not be altered to suit a new

market without extraordinary exertions on the part of the mechanics as well as the spinners of a factory."

Batchelder's stop-motion. — Our patriarch in the cotton manufacture, Mr. Batchelder, was more fortunate. His invention of the stop-motion in the drawing frame, whereby the breaking of any of the four or more ends which are engaged and united in the operation instantly stops the machine, is referred to by Mr. Montgomery * as one of the notable American improvements. The inventor allowed it to go into public use in this country, but obtained a patent in England which gave him a handsome remuneration. No machinery is now built, either in England or this country, without this improvement.

Speeders. — The Taunton speeder or tube frame of George Danforth, invented in 1824, — a cheap machine, well adapted for making coarse goods, — was patented in England and used to a considerable extent in that country. Another cheap machine for making roving — the "Eclipse" speeder of Gilbert Brewster, patented in 1829 — was also introduced into Manchester in 1835, being manufactured by the celebrated machinists, Sharp and Roberts.

Danforth's cap spinner. — Few improvements in the cotton manufacture have made more sensation in England than the Danforth or cap spinner, invented by Charles Danforth, of Paterson, New Jersey, in 1828, which was introduced in England and other European states in 1830. Dr. Ure, in his history of the cotton manufacture, devotes several pages to the description of "the American throstle," as he terms it. "The throstle," he says, "is a machine so simple in its construction, and seemingly so perfectly adapted to its purpose, that for many years after its introduction few persons thought of altering it or improving it in any respect, until about the year 1829 an invention appeared in the United States of a very singular character. Mr. Danforth was its author." He shows that in an excellent cotton mill, where the common throstle spindle

---

* *Cotton Manufacture of Great Britain and America*, by J. Montgomery, Glasgow, 1840.

turned off three and a half hanks of yarn in a day, the American throstle turned off five and a half. "The latter covered better in the web, and was therefore more economical in the manufacture of certain kinds of calico cloth." "The invention," he continues, "is not more remarkable for its own success than for the excitement it occasioned among spinners, and the number of new throstle devices to which it gave rise." This invention was much more extensively adopted in Europe than in the home of the inventor, and would, it is said, have become universal for spinning warp for print cloths, if the self-acting mule had not about this time appeared.

Ring spinning. — The Danforth cap frame has been revived in this country for worsted spinning, with an increase of fully 50 per cent in the velocity of the spindle, and a consequent increase of production over former methods of spinning. This invention is more important, however, as the foundation of ring spinning, one of the most valuable of American improvements.

The first conception of the ring spinner was due to John Thorp, of Providence; and it was first tried about 1830, at Providence, in a building where horse-power was used. The device, however, did not operate advantageously until improved by Mr. Mason, who claims to have constructed at Killingly, before the erection of his works at Taunton, the first ring frame which was operated with success. The gain in the use of the ring frame over the old throstle frame is a production of double the yarn with the same power. The production of the same quantity of yarn requires less than half of the power of the old Waltham frame. The system of ring spinning is applied so advantageously to the production of all warps that no new mill in this country would use any other system for making warp. It is used advantageously for all filling of coarse yarns, usually known as domestics, numbers from 8 to 16. There is no subject to which the minds of inventors are so earnestly directed as to the adaptation of ring spinning to the finer numbers of yarn for filling, so as to do away with the mules for spinning the finer warps. And it is claimed that by a recent improvement

the problem of spinning, on ring frames, yarns for filling up to number 50, has been fully solved. In ring spinning there is a gain of space over the throstle of 20 per cent, and of 50 per cent over the mules. The displacement of the mule, moreover, would get rid of the most troublesome class of operators in the mill. The excellent cotton goods sent of late to England, the evenness of the goods, and the softness of the fabric, have attracted attention there to our machinery and methods of manufacture. Ring spinning is recognized as one of the great features which are giving prestige abroad to our cotton fabrics, and its adoption in European mills is regarded as only a question of time.*

Spindles. — By modern American inventions, spindles have been reduced in weight from twelve or fourteen ounces down to five or six. The average speed has been increased from about five thousand to six thousand revolutions per minute; and for one spindle an average speed of seven thousand revolutions is claimed. Of the modern spindles, four forms are in high repute: the Sawyer spindle, of which more than a million are said now to be running in this country, having a short tip and frictional support to the bobbin, in which, by means of an elongated bolster, the lower half of the bobbin is permitted to drop over the bolster so as to bring its centre of gravity about at the point of support; the Pearl spindle, having a short taper tip with a high-chambered bobbin, holding by friction on the spindle; the Garsed spindle, having a short, straight tip, with a square clutch at its bottom, giving a positive motion to the bobbin; and the Rabbeth or self-oiling spindle, which may be run six weeks without oiling. The saving in power by these spindles is from 30 to 40 per cent, already included in the saving of power effected by ring spinning. No opinion is intimated as to

* In a paper recently had before the Scientific and Practical Society of Manchester, England, it is declared that "the advantages to be derived from the ring frame are increased production, saving in power, saving in wages, and saving in wear and tear." And that within the limits of the numbers 40 and 10, "the success of the ring frame in America is complete." Its universal introduction into English mills is earnestly and unqualifiedly recommended.

the relative merits of these devices by the order in which they are mentioned.*

Mules. — The invention of the self-acting mule is claimed by the English for Roberts, of Manchester. Mr. Mason, of Taunton, and Mr. Roberts were independent inventors of the automatic disengagement, the principal feature of the present self-actors. A mule operating as a self-actor was invented by Ira Gay, of the Nashua Machine Shop, in 1827, and some were built and put in operation by Pitcher & Brown, of Pawtucket, in 1828. The first self-acting mules operated in this country, whose use is still continued, were devised and constructed by Mr. Mason about 1837. The English mules were not brought here until several years afterwards. The Mason mule, which runs at least 40 per cent lighter than the English mule, is largely used in Rhode Island and Southern Massachusetts and elsewhere, although the English pattern of American construction is more extensively used.†

Cards. — The Woodman and Wellman self-stripping card, an American invention of universal use in this country, as it saves one-third of the cost of carding, has been patented abroad and largely introduced in England. The Americans have simplified the carding machines and made them lighter. An American card costs about $120, while an English card costs about $275; and, although the former makes more waste, this

* The modern spindles run like a top when it is said to be asleep; the apex of the spindle travelling exactly in the line of its gravity. In a recent test of the Garsed spindle, a gentlemen came in to see the operation of the frame, and stood for some time looking at it; he at length turned to the man who had the frame in charge and inquired why he did not start up the frame. The spindles were then running at the rate of about eighty-three hundred revolutions per minute, but were running so steadily that the inquirer was not aware that they were in motion. For full descriptions of the spindles named, the reader is referred to numbers 10 and 14 of the *Proceedings of the New England Cotton Manufacturers' Association.*

† Reports of competent engineers, giving dynamometer tests, show the power consumed by the Mason mule, compared with English mules under the same circumstances, to be as 47 to 100 in the most favorable report, and as 56 to 100 in the least favorable. Where steam power is used this saving would amount to $750 to $1000 per year on every 10,000 spindles, according to the price of fuel.

is not a material defect with us, as our manufacturers sell the waste for a lower fabric.

Eveners, shears, openers, warp spoolers. — Hayden's railway evener, to equalize the sliver of the cotton as it comes from the card, before going to the roving, giving an equal size to the sliver whatever the number of the cards, is universally used here, and to a considerable extent in Europe, and is indispensable for making the highest quality of yarn.

The application of helicoidal shearing to prepare cotton cloth for market, by clearing it from all knots and loose threads as it comes from the loom, now in universal use here and abroad, was first made by Milton D. Whipple in Massachusetts.

Among the more recent valuable American improvements may be mentioned the cotton opener of the Kitson Machine Company, and that of Jillson & Palmer, as improved by Whitehead & Atherton, which, opening the cotton better than by previous methods, and at the same time with less injury to the staple and with great saving of power, are, one or the other, used in our principal establishments.

Another quite recent improvement is a bobbin holder, to facilitate the spooling of the warp yarn from the quill bobbin, used generally in ring spinning, to the spool used in warping. This effects a saving of the help formerly required to tend the spoolers, which formerly cost about as much as the help tending the spinning frame.

Looms. — Our improvements in fancy looms will be referred to hereafter. All our looms for cotton weaving are of American construction, none, substantially, being imported. An important change made in the plain loom in this country is the adoption of the parallel motion picker staff with a leathern cushion attached to the end of it in place of the cumbrous rawhide picker sliding on a rod and moved by a strap or string attached to the picker staff, the construction in use abroad.

An American improvement early applied to the loom was the device of the self-acting temples, now invariably used for keeping the cloth extended to the width of the warp, which was introduced at Waltham in 1825, and was a novelty in England

as late as 1850. The first self-acting temple was invented by Ira Draper in 1816. His family have continued to manufacture them for over fifty years. Of an improved form, — the Dutcher's temple, patented in 1863, — they have sold over 200,000 pairs. Even this indisputable improvement was introduced at Waltham only by a stratagem of Mr. Patrick Jackson. The weavers persisted in preferring the old hand-temple which had to be adjusted by hand. Having at length induced one of his weavers to try the new device, Mr. Jackson said to his overseer, "John, the weaver makes the self-acting temple work, and you mustn't be beaten by a common hand." The overseer accepted the challenge, and the new device was soon applied to every loom.

A valuable American improvement in the machinery of weaving, of later date, is the "tension let-off motion" for looms, the object of which is to secure automatically a uniform tension of the warp in weaving. The principle of "holding, at the beat," first applied by Mr. Bigelow in carpet and gingham looms at Clinton, has been successfully applied to all kinds of cotton weaving, thick and thin, coarse and fine, plain and fancy, — thus relieving the weaver from the exercise of the skill and labor required to regulate the tension of the warp, and enabling him to tend more looms, and at the same time to make the cloth more uniform in quality and appearance.* Another invention of Mr. Bigelow, applicable to power-looms generally, is that of the friction-brake stop mechanism, whereby the movement of the loom, when thrown out of gear, is suddenly arrested without a shock, and held in position. This important invention rendered it possible to largely increase the speed of all power-looms, and is now generally adopted, not only in this country, but in England and on the Continent.

A vivid picture of the changes effected by American improvements in weaving cotton fabrics is given in the following communication, kindly furnished to us by the well-known expert in making and using cotton machinery, Mr. George Draper, of Hopedale, Mass.

* For a full account of this invention, see *Proceedings of New England Cotton Manufacturers' Association*, 1870, No. 8, p. 22.

"In 1832 I was employed in the Crown and Eagle Mills at North Uxbridge, Mass. At that time they made sheetings No. 38 warp and No. 42 filling, with about 80 picks to the inch. Their looms were of the ordinary pattern of that day, but, like most of the machinery, were made in a shop connected with the mills. Those for yard-wide cloth were run 70 picks per minute. One half of the weavers tended two, the other half three looms each. These looms had an intermittent take-up motion, and the tension of the warp was regulated by friction on the yarn beam. They had pickers and picker rods and picker strings. The looms are now replaced by others running on substantially the same goods at the rate of 130 to 140 picks a minute, each weaver tending five or six. The new looms stop when the filling is out; the old ones did not. The new looms have a take-up motion to make the cloth a given number of picks to the inch; the old ones had no such device. The new looms have a tension let-off motion to give the cloth a uniform strain in weaving; the old ones did not. The new looms have a parallel shuttle-motion; the old ones did not. The new looms are provided with shuttle guards to keep the shuttles from flying out; the old ones had no protection. This shuttle guard has been almost universally adopted, and is a very useful American invention. It saves the eyes of operatives, as well as money in various ways."

Of the other machinery in this mill Mr. Draper says: —

"To open the cotton they had whippers, with walnut sticks. They had 18-inch cards stripped by hand, Waltham speeders, line spindle flyer frames to spin warp yarns, and box organ hand-mules to spin filling, and drop-wire warpers on which the yarn was warped directly from the spinning bobbins to the section beams.

"The old 18-inch cards are now replaced by modern self-strippers. The modern cards have railway heads with Hayden's eveners; the old ones had neither; the old drawing has given place to new, with improved stop-motions; the old Waltham speeders, with their headed bobbins, to the modern fly frames with compact roving and headless bobbins. The flyer spinning is replaced by ring frames having Sawyer's spindles; the box-organ hand-mules, by self-operators. The cradle warpers have long gone by. A modern warper is now used, having improvements too numerous to mention; and a new slasher, built in this country, takes the place of the old dressing frame. This presents a true picture of some of the changes in the manufacture of cotton cloth during the last forty-five years in a single mill, than which, in 1832, there were few better in this country."

Calico-printing machinery. — In mechanical means applied to calico-printing, American improvements are second only to that of the cylinder printing which made the fortunes of the famous Peel family in England. The great obstacle to the extension of calico-printing was the enormous expense of engraving the copper rollers. Our countryman, Jacob Perkins, caused a complete change in the mode of engraving, by the invention of the roller die and transfer process, first applied to bank-notes, in which a design on an engraved and subsequently hardened steel die is impressed into a copper cylinder in repetition to any extent. By another American improvement, the number of cylinders which may be applied to each web is increased from one to twelve. Finally, the rotary pentagraph machine, invented by Milton D. Whipple at the Merrimack Mills in Lowell, in 1843, replaces all other methods of engraving, except for small designs.* This is a system by which a design previously drawn on paper is transferred, by a series of diamond points, to a copper roller covered with a resinous varnish. A few moments' immersion in nitric acid eats out the tracing to the proper depth. A design may be reduced from five to nine times from the original tracing, making it, when executed on the copper, very perfect, and the work may be done by any bright girl. By this machine, the cost of engraving for calico-printing is enormously reduced, — rolls which cost $23 to engrave by the old system, being executed for $2.25, — while the system permits the execution of designs so large as to be almost impracticable with the former methods.†

* Whipple's pentagraph, after being introduced at the Merrimack Mills, was carried to Dover, N. H., and put in use at the Cocheco Print Works. An English engraver, named Rigby, employed there, seeing the advantages of the machine, quietly made sufficient sketches of the machine for his purpose, and, returning to England, introduced it under his own name, where, with some modifications, it is still in use.

† In the preparation of the statements respecting inventions in cotton machinery, we have had the privilege of consulting Colonel Samuel Webber, C. E., one of the judges on cotton machinery at the Centennial Exhibition, Mr. George Draper, a well-known expert on machinery and the cotton manufacture, and others, to whom we beg to express our obligations. Mr. Batchelder's book has also been freely used. Many inventions worthy of notice are omitted. But the list is long enough to establish the point in view.

Results. — Mr. Burke, in a paper read before the New England Cotton Manufacturers' Association, shows from precise data furnished by the Boott Mills and Jackson Company, engaged in the manufacture of drillings and standard sheetings, that the number of pounds of cloth produced by each operative an hour at the former mill, in the year 1838, was 1,012. In the year 1876, the production of each operative for the same time had raised to 3,333 pounds. In the Jackson Mill, the production in 1838 was .9852, and in 1876 2,275 pounds, to each operative per hour. Mr. Burke attributes this increased production principally "to improvements in the construction and workmanship of machinery and many important inventions and attachments to save labor and perfect work," and continues: "I will note some of the principal ones, — the Wellman card-stripper, the use of lap-heads (so called), where double carding is practised, eveners on railway heads, the stop-motion on drawing frames, great improvement on mules, the introduction of the ring and traveller spinning-frame, also of the 'slasher'* for sizing yarn, and the filling stop-motion on the loom. . . . The number of looms a weaver is now able to tend has more than doubled. . . . By improvements on fly frames and speeders, we double at least the length of roving laid on a bobbin, and thus enable a spinner to tend more spindles. We double the length of yarn laid on a quill or bobbin, we wind three times as much weight of yarn on a section or slasher beam, and we double at least the number of cuts or pieces on the warp beam for the loom." We feel justified in adding that these improvements, with scarcely an exception, are the results of American ingenuity, and have been effected by machinery of American construction. "It is of interest to remark," says Mr. Harris Gastrell, in his report to the British Government, "that the improvements in the cotton machinery of the United States are mostly of American origin;" and he very sensibly adds, "May not, in addition to the usually assigned causes, the better system of patents in the United States have had something to do with

* The "slasher" is of English introduction, although the machines with American improvements are now constructed here.

this result?" He omits to mention the still more effective cause, — the restrictive laws of England, referred to in the earlier pages of this paper.

II. WOOLLEN MACHINERY.

Helicoidal shearing machine. — Among the contributions of our inventors to the wool manufacture of the world, we are authorized by the highest French authority to place first in time the introduction of the method, now universal, of cutting off at an equal height all the filaments of wool on the surface of the cloth developed by napping. The principle of the machines now used for shearing cloth is the adoption of a cylinder, provided with a knife arranged in a helix, more or less projecting, very sharp, and taking the form of a screw, with its threads very acute, turning tangentially in contact with a fixed knife, and the stuff upon which this knife rests. This invention, according to Alcan, under the name of a machine for shearing cloth with helicoidal shears, was introduced into France in 1812 by George Bass, of Boston, but did not come into use until the principle was adopted in 1817 by John Collier, a machine builder in Paris. The same principle was subsequently adopted in the Lewis machine used in England.*

Mr. Alcan ranks this invention, which he distinctly admits to be of American origin, among the most important of those which have brought the woollen manufacture of the world to its present condition, the saving effected in France in one year by its introduction being estimated by him at ten thousand francs.

Goulding's endless roving, or American card. — The most important of all contributions to the card-wool industry of the world during the present century was the invention of what M. Alcan calls the "spinning, or American card." This was the invention of John Goulding, of Massachusetts, who, born in 1793, was for many years a workman in the machine shops

* We have been unable to find any other reference to this invention than that of Alcan.

of Worcester, the original patent having been granted in 1826. Before his invention, the rolls or roving 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 a painful hand process, or by a machine called the billy. A part of what the American invention accomplished is judicially recited by Mr. Justice Clifford, as follows: —

"Goulding aimed to dispense with the billy altogether, and sought to accomplish with four machines what had previously required the use of five; and the evidence shows beyond controversy that the invention enabled manufacturers to produce yarn from wool at much less cost, of better quality, and in greater quantity than was produced by the old process. His purpose, also, was to dispense with short rolls, and to introduce the long or endless roll in its place. Years were spent by him in experiments to accomplish these purposes; but the result was that he was successful. He dispensed altogether with the billy, and, by a new combination of old devices, he obtained the endless roll, and so perfected his machinery that he could use it successfully from the moment the roving left the delivery end of the first breaker, till it was converted into yarn fit to be manufactured into cloth."

M. Alcan recognizes this invention, which had been extensively introduced into France between 1840 and 1844, as the most important in the card-wool industry of that period. It prevails now however wool is carded and spun by machinery. In the progress of the wool industry of the world, it was, in the words of one of our most eminent manufacturers, "not a step, but a flight."

Burring machinery. — The principle of all the machines for burring wool used here or abroad, viz. striking the burr from a card, or toothed cylinder, by means of a rapidly revolving guard or blade, was first applied to a machine about 1833, by Mr. Michael H. Simpson, of Boston. Samuel Couillard, a native of France, first made the attempt in Boston to strike the burr from a solid roller with a leather belt running over it; but the plan was soon abandoned, as the staple of the wool was too much injured, and the burrs were imperfectly removed. The originality and value of the invention are

shown by the fact that the rights to the invention in England were sold for £10,000. Other burring machines, as those of Mr. Parkhurst, Mr. Sargent, and the Belgian machines, have become famous; but this was the germ of the invention. Chevalier, in his introduction to the History of the French Exposition of 1867, refers to burring machines as among those which have largely contributed to the woollen industry of Europe. They are indispensable for working the Mestiza wools, so largely used in Belgium and France.

Felting machinery. — The modern manufacture of felted cloths and carpets, and the processes and machinery by which it is effected, were of American origin. M. Koeppelin, a French expert, speaks thus, in the "Annales du Génie Civil" of 1869, of this fabric: —

"In spite of the simplification of its fabrication, and in spite of the antiquity of its origin, felting was for a long time abandoned to the lesser industries. It is only within thirty years that the mechanical fabrication of felted cloths has been essayed. Many fruitless attempts in this direction were made in France and other countries; and it is only to the spirit of invention of two Americans, Wells and Williams, that we owe the processes now in use, which have not been materially modified since the epoch of their discovery."

The invention of making felted cloth of *commercial length*, and its machinery and processes, are due to Thomas Robinson Williams, of Newport, R. I., having been made about 1820, and introduced into England in 1824. Wells was associated with Williams only in making hat bodies. The English felt carpets made by his invention, so popular from their cheapness, are exported in great quantities to all parts of the world.*

Fancy and Carpet Looms. — The American inventive power and constructive skill in machinery have been most signally displayed in original automatic appliances for weaving and knit-

* Important improvements in felting machinery were made at the Middlesex Mills, in Lowell, by Milton D. Whipple, before named, who also invented and introduced there a machine for twisting the fringes of woollen shawls, by means of which the cost of twisting a fringe was reduced from 16 cents to about 2 cents.

ting. "The greatest part of your own invented machinery," says the highest German authority, Professor Grothe, in a letter to an American correspondent, "is superior to the English, German, or French machinery, especially your looms for finer work, your looms for cotton goods, cassimeres, carpets, and heavy work."

First in the list, in the order of invention and extent of use abroad, is the loom of William Crompton, with the improvements added by his son, George Crompton. The elder Crompton, born in England, worked about 1836 as a machinist in the machine shop attached to the cotton factory of Crocker & Richmond in Taunton, Mass., — the birthplace of so many inventions. His employers desiring to introduce fancy-woven fabrics, Crompton undertook the construction of the machinery which afterward expanded into the loom which has made his name famous. The invention, though made by a native of England, has always been declared by him to have been American in its conception and inspiration. A patent was obtained for the loom as first adapted for cotton fabrics in 1837, both in this country and in England; and a cotton factory in England was filled with looms of his pattern.

In 1840, Mr. Samuel Lawrence, who had seen a sample of fancy cassimere, a fabric which had lately been invented in France, applied to Mr. Crompton to adapt his loom for weaving fancy woollen fabrics. This was successfully accomplished, and was a marked event in the woollen industry of the world. "For," says Mr. Lawrence, "not a yard of fancy woollen fabrics had ever been woven by power-loom in any country, till done by Mr. William Crompton, at the Middlesex Mills in Lowell, in 1840." It was affirmed, before the Committee on Patents of the United States House of Representatives, in 1878, that "upon the Crompton loom, or looms based upon it, are woven every yard of fancy cloth in the world." The writer was assured by his associates from Sweden, Austria, and Germany, in the group of judges on wool and woollens at the Centennial, that the specific Crompton loom, with its recent improvements, is in use in all the principal establishments on the Continent of

Europe. The value of this contribution to the industry of the world can be appreciated only by remembering that at least three-quarters of all the woollen cloths now worn are woven upon fancy looms.

As we have elsewhere said, the arts succeed each other by a true generation. Idea begets idea; and the invention of to-day gives birth to the invention of to-morrow. While the first conception of automatic fancy-weaving is due to Crompton, his loom has made for itself formidable American competitors. Prominent among them is that more recent marvel of ingenuity and mechanical skill, the open shed fancy loom of L. J. Knowles & Brother, first patented in 1863, which won from the eminent judges, Messrs. Hulse, Hermann, Lockwood, and Webber, an award "for originality of invention; substantial and good construction of machinery; smoothness of working; facility for effecting changes and for manipulating; economy; quality and variety of work produced," — an award which we quote at length, because it typifies the qualities which are characteristic generally of American machinery. The several looms of the Thomas patent, for weaving a variety of fabrics; the Wood loom; the Lyall positive-motion loom, the first loom in the world which dispensed with throwing the shuttle, equally adapted for weaving goods of unprecedented width or of the narrowest dimensions, — are other illustrations of American excellence in this department of machinery.

Our object is rather to present the inventions which have received foreign recognition, and have been epochs in the textile industry of the world. Conspicuous among these inventions is the power carpet-loom. In 1844, the hand-loom, both in Europe and in this country, was universally used for making carpets. The system was revolutionized by an American invention, which marks the period of its introduction as the most important era in the whole history of the carpet manufacture. Mr. E. B. Bigelow, of Boston, Mass., in 1842 conceived a series of devices for making the carpet loom automatic, so that the costly labor of man might be dispensed with, and the whole process of weaving might be conducted by women and boys.

This was first successfully applied to the weaving of ingrain carpets. Subsequently, his inventions were successfully applied to the weaving of Jacquard, Brussels, and Wilton carpets, and his patents, purchased for a large sum by English manufacturers, were applied in England. The report of the jury at the World's Fair in London says, "The honor of this achievement [substituting steam power for manual labor in the manufacture of Brussels carpets], one of great practical difficulty, as well as of great commercial value, must be awarded to a native of the United States." Says the "London Morning Chronicle," in noticing the exhibit, "At the eleventh hour, power-loom manufactured Brussels was deposited in the American division, the merit of the invention and application of this important discovery being due to Mr. E. B. Bigelow, of the United States." It has been carefully computed that, in consequence of this invention, "one woman can weave as much Brussels carpeting by the carpet power as ten men, assisted by ten boys, can weave by the hand-loom. To weave by the hand-loom, the carpeting that is now woven by the carpet power-loom in its various applications would require the labor of fourteen thousand more persons than are now employed." For a wonder, this invention did not have its birth in a machine shop, but in the closet of a young medical student. Even his genius might have been unproductive, without the stimulus of the genial atmosphere of invention emanating from the machine shops of New England.*

The power-loom for making Axminster carpets, invented and perfected by Alexander Smith, of Yonkers, N. Y., attended

---

* The carpet power-loom is generally supposed to be a mechanical unit, capable of weaving the various kinds of carpets in common use. This is an error. The carpets to which Mr. Bigelow's inventions are applied consist of three classes; *viz.*, 1st, two-ply and three-ply ingrain carpets; 2d, Brussels and Wilton carpets; 3d, tapestry Brussels and tapestry velvet carpets. These three classes of carpets are essentially different in their structure, and, although the looms to weave them have some devices in common, their organization and construction are very unlike. They are, in fact, three distinct inventions. A loom adapted to weave tapestry carpets will not weave Brussels carpets, and a loom adapted to weave Brussels carpets will not weave ingrain carpets, and *vice versâ*.

by one competent girl, will produce in a day an amount equal to the product of ten English or French hand-looms, attended by as many men. The invention, although made in 1856, was not at first appreciated. Within the last year, the right to use this invention has been purchased for large sums by several manufacturers in France and England. It will be remembered, as an illustration of the instability of human felicity, that the inventor died but a month or two after receiving this foreign recognition, and on the very day of his election to Congress, in appreciation by his own countrymen of his enterprise and high personal character.

Knitting machines. — Without considering in detail the American inventions in knitting machinery, we may notice that power was applied to knitting frames by Egbert Egberts, at Cohoes, in 1832, while it was not applied to knitting in England till 1851. The circular knitting machine, invented by John Pepper in 1851; the machine for the same purpose of Messrs. Aiken, — father and son, — both making ribbed work, a marked feature of American hosiery; the machines of the Messrs. Kilbourn, declared to be the only completely automatic machinery for making fashioned hosiery goods in the world, — so successfully applied in New Brunswick, New Jersey, and New Britain, Conn.; the Lamb machine, so extensively used for family fabrication; the Marshall knitting machine, making cardigan jackets for three cents each, which would cost on the English hand-frame fifty-eight cents; the Shaw stocking loom; and the Nelson machine, recently invented and constructed in Illinois, which literally completes a stocking at a cost for labor of one-sixth of a mill per pair, — these, all of American conception and construction, are some of the inventions which have brought up our products of hosiery from a value of one million dollars in 1850 to over eighteen millions in 1870.

Worsted machinery. — It will be observed that we have cited no inventions of machinery adapted to the worsted manufacture. In this department of the textile industry, we have exhibited less originality of invention or construction, and have contented ourselves with copying or importing English

and French machinery.* It is not difficult to see why our invention seems to have failed in this department. The worsted industry has been developed to any extent in this country only since 1845, and therefore since the restrictions against the exportation of English machinery have been removed. With the facility of obtaining worsted machinery abroad, there has been no stimulus to invention and construction at home. We thus see how much the originality of our cotton and card-wool machinery is due to the compulsory self-reliance imposed, in the early period of our cotton and wool manufacture, by English restrictions.

General auxiliary machinery. — We must pass by the machinery in other departments of textile industry, — the cordage, linen, and silk manufacture, — although instructive illustrations might be drawn from them, and can but hint at the machines which are auxiliary to all departments of the textile manufacture. Among the machines of this class we may mention the Corliss engine, effecting the economy of using two tons of coal in place of six and three-quarter tons used for other engines at the time of its introduction, so justly recognized by the Rumford medal of the American Academy; the Batchelder dynamometer, used by the best engineers here and abroad for measuring power; the improved turbines of several inventors, cast directly in a single piece, and producing, as shown by tests made at the Centennial Exhibition, a net result of over 80 per cent of the theoretical power of the water; the self-adjusting hangers for shafting, giving efficiency to the machine for transmitting motion, — often the largest one in an establishment, — a distinctly

* An important exception is a wool-combing machine, invented by Samuel Couillard, before named, and applied by Mr. Michael H. Simpson, at Boston, in 1835, — an invention which was the first step in the introduction of the worsted manufacture in the United States. At the time of this invention, hand-combing was in universal use in Europe. The famous comber of Heilmann, of France, was not invented until 1844. Mr. Simpson, by improvements added to Couillard's comber in 1854, and patented in 1857, increased its productive power more than five-fold. This comber, as improved, is in universal use in this country for preparing the wool for carpet worsteds, and is indispensable for this manufacture, it being the best machine known for combing the class of wools known as "carpet-wools." It will be seen that the original invention was made at a time when the English restrictive laws were in full force.

American invention, displacing the rigid bearings which are still used in Europe; the spooling and winding machinery, used for cotton and silk thread; and, above all, the sewing-machine, of Massachusetts origin, which, besides its household work, has created an entirely distinct industry, the ready-made clothing manufacture.

Without adopting Horace Greeley's estimate, "that if to-morrow this country were blotted out of existence, with all its people, the outside world could well afford to pay a billion of dollars for what we have added to its production by American devices and inventions," we may derive, from the achievements of our textile machines thus faintly outlined, satisfactory assurance that this country has at least done its part in contributing the enginery for the industrial progress of the present century.

RELATIONS TO OTHER INDUSTRIES.

Having shown the direct influences of our textile machinery, let us consider its indirect but no less positive influences in its relations to the development of other industries. Our proposition may be stated very simply. The shops attached to our early textile factories were the first practical schools in this country in which the principles of mechanics and the methods of constructing machinery were taught. They were the nurseries of a distinct class of artisans in machinery, and thus rendered it practicable to extend the application of machinery to various departments of industry. Besides this obvious proposition, a few illustrations may be permitted of the manner in which this extension — so limited at the commencement of this century, and now so universal — has taken place.

Manufacture of machine tools. — The first necessity in the factory repair shop was the creation of machine tools, and the engine lathe came into existence in Rhode Island. So indispensable became the special tools, with the increasing demand, at first for textile, and then for general, machinery, that the manufacture of machine tools, or of automatic apparatus to produce machinery, was established as a distinct industry. The pioneers in this exclusive manufacture were Messrs. Bancroft & Sel-

lers, a house established in Philadelphia, in 1848, and now known throughout the engineering world as William Sellers & Co. The senior partner of the original firm, Mr. Edward Bancroft, had been engaged in the manufacture of textile machinery in Providence, R. I., and had there invented his celebrated self-adjusting hanger for shafting.* He was one of the men produced from the Cadmian seed sown by Slater and Wilkinson, and the achievements of the house which he established belong to the history of the American textile industry. Mr. John Anderson, LL.D., C.E. of the Woolwich Arsenal, Great Britain, the writer of the award indorsed by the judges at the Centennial, says of the exhibit of William Sellers & Co., —

"This exhibit [of machine tools for working metals] is probably without a parallel in the past history of international exhibits, and, taken as a whole, is worthy of the highest honor which can be conferred. Besides, it is thoroughly national in its characteristics, and pre-eminently worthy of the United States and the grand occasion of the Centennial Exhibition. Every single machine, tool, or piece of apparatus that is displayed in this vast collection, would for itself command the strongest recommendation for an award, even if it stood alone as a unit; but here every unit is surrounded by thirty-three distinct machines, each one being of the highest standard in its peculiar class."

This award is but a confirmation of those previously given at Paris and Vienna, accompanied by the bestowal of the gold medal and diploma of honor, and in the Vienna award by the declaration that "the pre-eminent achievement in the invention and construction of machine tools of the Messrs. Sellers have been adopted as patterns by the constructors in all countries." The Messrs. Sellers, it need not be said, are not without able rivals; and it is worthy of notice that the house of one of the most eminent of their rivals in Philadelphia, Messrs. Bement & Dougherty, has in one of its partners a representative of the textile machine shop of Lowell. There is no need of enlarging upon the mechanical power diffused by these machines in every department of productive industry.

* The other partner, Mr. Sellers, was educated in a textile machine shop in Delaware.

Locomotives. — Our textile machinists have been important auxiliaries in the introduction and perfection of the railroad enginery of the United States. Dr. Bishop, in his "History of Manufactures," thus connects the first successful builder of locomotives in this country with the textile industry, —

"Messrs. David H. Mason and Matthew W. Baldwin, manufacturers of improved book-binders' tools, in Philadelphia, commenced about this time (1822) the first engraving of cylinders for calico-printing in the United States. The establishment of print works on a large scale at Taunton, Fall River, Lowell, Dover, &c., within a few years, gave them a prosperous business. . . . The invention and manufacture of tools and machinery adapted to their use led to the construction of calico-printing machines, drying and calendering for cotton, silk, &c., stationary engines, and machinery in general. This business was soon followed by the construction of locomotives for railroads, of which Mr. Baldwin was one of the first builders in the United States."

The Baldwin Locomotive Works, founded by him, has turned out, even in this year of hard times, a locomotive for every working day of the year; and its locomotives are sent to all parts of the world.*

The Lowell Machine Shop, founded by the cotton manufacture, supplied the first locomotives for New England, and continues their fabrication on an extensive scale. The ingenuity and skill of Mr. Mason, developed in constructing cotton machinery, was early applied to the locomotive, of which he greatly improved the form; and the manufacture of locomotives, concurrently with cotton machinery, is extensively carried on by his establishment in Taunton. While the manufacture of cotton has declined in Paterson, N. J., that city finds its recompense in the locomotive manufacture which sprang from its original cotton industry. The Danforth Locomotive Works originated in the first machine shop built in New Jersey, about 1800; first occupied in making carding machines for country work. At a later period it was developed by building the

* Viz., to Brazil, Peru, Cuba, Nicaragua, Russia, Norway, Italy, Australia, and New Zealand.

famous cap-spinning frame of Charles Danforth, referred to in previous pages. The construction of locomotives, now the principal work of this eminent establishment, was afterwards added. The Rogers Locomotive and Machine Works, distinguished for many important improvements which it originated, was founded by Thomas Rogers, — originally a builder of looms, — for the purpose of building cotton, woollen, and flax machinery. To the five establishments above mentioned, all the outgrowths of the textile industry, is due in a large degree the perfection of the most characteristic and national of our achievements in mechanical engineering. It is not without a sort of paternal satisfaction that we have read, in a late number of "Harper's Magazine," a comparison of the characteristics of the English and American locomotive, proposing the inquiry, which is to be the engine to span the continents, which thus concludes: "All that the English engine can do, on a perfect road, the American engine will do; and more than this, it will do good work on any road, however rough or cheap. There can be no question which one of these tools is best for the world's work." *

Steam fire-engines. — The researches of Professor Tillman, of the American Institute, have shown that the steam fire-engine, the modern artillery of fire extinction, was of American origin. No establishment has contributed more to the perfection of this invaluable machine, which, besides its proper work of fire extinction, has extinguished the most fertile source of riot and disorder in our great cities, than the machine shop of the Amoskeag Manufacturing Company, an establishment founded upon a cotton mill erected in 1809, near the location of the present company, and therefore, according to Mr. Batchelder, by the aid of the early machinists of Providence and Pawtucket.

---

* The relations of textile machinery to locomotives are seen in Europe as well as in this country. As we write, the foreign papers announce that Richard Hartmann, of Chemnitz, the "king of the Saxon machinists," has just died. In 1837, he set up as a manufacturer of cotton-spinning machinery. In 1847, he added a locomotive factory to his establishment. In 1869, his workshops were fifty in number, and he employed two thousand six hundred men.

This company, besides constructing and putting into operation for themselves mills containing 138,000 spindles and 4,500 looms, building in their own shops and foundry every thing required, have constructed since 1859 524 steam fire-engines, and, besides supplying the principal towns of the United States, have sent these magnificent trophies of American skill to England, South America, China, Japan, and Australia.

Firearms. — The resources of mechanical power created by our machine shops came conspicuously in play during our late war: first, in furnishing arms; and, secondly, in supplying machines which took the place of men required for the field. "When the late war came suddenly upon the nation," says Mr. Goulding,* "it found it unprepared to make the arms wanted to supply the patriotic volunteers who flew to the defence of its flag. The cotton machine building shops, more than any or all others, came to the rescue with capital, skill, and tools, and in a surprisingly short time supplied the government with all the arms it needed, and in their construction brought into use improved tools and methods which have been thought worthy of introduction into the armories of Europe. At the time of the breaking out of the Rebellion, the cotton machine building shops were least employed, because most interfered with by the cutting off of the cotton supplies for the mills. From these shops came the men and skill which filled our public and private armories.† One shop alone in Massachusetts (Whitin's, at Holyoke) furnished three hundred men to the Springfield Armory; and the rapid increase in the force of that armory from about two hundred men at the beginning of the war to twelve hundred men at its close, was drawn mainly from the cotton machine shops." Besides supplying workmen for the national works, the proprietors of several of our textile machine shops converted their own establishments into armories. Four of these establishments made for the government 246,000 muskets, $200,000 worth of gun-making tools, and $100,000 of gun

* Statement to Congress, in 1872.

† The first Union soldier killed in the war, at Baltimore, was a workman from the Lowell machine shop.

appendages. The largest of these contributors, Mr. Barton H. Jenks, of Bridesburg, Pa., who furnished 110,000 muskets, signed a contract to supply the government with guns, on the same day that a similar contract was signed by the Colt Fire-arms Company, who had a well-appointed armory filled with skilled men and tools. Mr. Jenks pitched his tent in the grounds of the Springfield Armory, made drawings of the special tools required to fabricate the Springfield muskets, took them to Bridesburg, made the tools, and turned over a thousand finished muskets before Colt Firearms Company had finished their guns. The tools he afterwards sold to the French government, and some that were left he altered to make "Garsed" spindles. It is an interesting illustration of the line of evolution in the mechanical industries which we have undertaken to trace, that the establishment of Mr. Jenks was founded by his father Alfred Jenks, who had been a pupil and colaborer with Samuel Slater in Pawtucket, and who removed to Pennsylvania in 1810, furnished the machinery for one of the earliest cotton mills and the first woollen mill established in that State. Thus cotton, which caused the war, indirectly contributed the arms which quelled it.

The relation of cotton and textile machinery to the production of instruments for national defence had been shown in an early period in our history. In 1798, Eli Whitney had applied the mechanical knowledge acquired in the construction of his cotton-ginning machinery to the fabrication of arms for the national government, and, for the fulfilment of a contract to furnish ten thousand muskets, established the manufacturing of arms at Whitneyville, near New Haven, which is flourishing at this day. The buildings and machinery erected by him became the model upon which the national foundries were afterwards arranged; and many of his improvements, transferred by his workmen to other establishments, have become common property.

Agricultural machinery. — But the mechanical arts of the North, in the creation of which the textile industry had been so important a factor, were more potential in the great struggle than its arms. In all the former great wars of history, productive industry, and especially agriculture, declined. In the war

of the Revolution, no fruit trees were planted. Painters represent War by fields laid waste by contending armies; and Peace, by waving grain and reclining flocks. In the war of the Rebellion, productive industry and agriculture had a development beyond all precedence. While in the second year of the war there were issued 240 patents for implements of war, there were 490 patents for agricultural implements. The North was astonished at its own resources. It was unconscious of the marvellous mechanical revolution which had been going on in the preceding fifteen years. The tariff of 1842 had started factories upon every available water-power, and furnaces near every ore-bed. The old factory repair shops were too narrow to supply the demand for their products, and independent machine shops were established in all the centres of manufacture. The germs of industry have wings like the seeds of the maple and thistle. They "fall to earth we know not where." They were carried to the fertile fields of the West; and agriculture, always the last to receive improvement, partook of the inventive and constructive power invoked by manufactures. "Agricultural machinery," says Mr. Storrow, "as an important element, dates from about 1850. It was 1855 to 1858 before sowers, reapers, mowers, harvesters, and threshers became so distributed as to have any decided general effect."* When we see this coincidence of the development and extension of the independent textile machine shops, with the period of the introduction of agricultural machinery, we are warranted in regarding the modern labor-aiding mechanism of the farm as an outgrowth of the machinery of the factory. Mr. Bigelow, who is always cautious in his statements, estimates that the people of this country, assisted by labor-aiding inventions, have three times the productive power in proportion to number that they had a century ago. The illustrations we have given are sufficient to show how much this increased productive power is due to the industry first made auxiliary to the spindle and loom, and to justify the inquiry how this industry, so potential in the past,

* *Arguments before the Committee on Patents*, 1878.

shall be made to multiply and develop inventions and improvements in the future.*

CLAIMS OF AMERICAN TEXTILE MACHINERY FOR NATIONAL RECOGNITION.

Direct value of the industry. — Ignoring for the present the broader relations of this industry, let us look at the part which this manufacture occupies simply as one of our national industries. The latest returns in relation to this manufacture are some obtained by a committee of cotton machine builders in 1872, and published in a remonstrance to Congress against a diminution of the duty. Although these returns are incomplete and relate only to cotton machinery, they sufficiently show the importance of the industry. Out of 85 establishments in the United States known to the committee as engaged in the manufacture of cotton machinery, 53 stood as follows in 1871: —

Amount of capital employed		$10,822,000
Number of men employed		7,114
Largest number of men that could be employed with then existing tools and buildings		10, 670
Value of machinery produced excluding weaving machinery	$7,451,200	
Value of weaving machinery	913,100	
Total production		$8,364,300

* In attributing the present mechanical development of this country to the influence of the early textile machine shops, we may seem like the partial genealogist, who traces his family back to one favorite remote ancestor, and ignores the hundred or more progenitors whose blood flows equally in his veins. While it is true that every industry established upon our soil has contributed to our present mechanical advancement, in giving predominance to the one industry under discussion, we have but followed the example of historians, biographers, and even stock-breeders, who are wont to trace the characteristics of races and individuals to the prepotent influence of certain typical ancestors. Among the industrial establishments which have co-operated with the machine shops in their mechanical influence are the textile factories, which called them into existence; the iron furnaces, rolling mills, and foundries, and steel works, which have furnished the raw material of machinery; and the marine-engine works, like the "Novelty," the "Allaire," and the "West Point Foundry," which, although of later date than the textile shops, have been, like them, important schools of skill and invention.

Pig iron consumed, tons	25,736
Bar ,, ,, ,,	3,892
Steel ,, ,,	653
Coal ,, ,,	19,612
Moulding sand ,,	7,121
Lumber, feet	5,036,500
Other material consumed, value	$1,617,155

It was the opinion of practical men that the capital at that time in all branches of the production of textile machinery in the whole country amounted to $20,000,000, and that all the items above should be doubled, to cover the whole industry in the United States. This would make the value of the total production to exceed $16,000,000, the number of men employed to exceed 14,000, and the number capable of being employed to exceed 20,000. When we consider that the workmen in this manufacture are the most highly paid of all persons engaged in mechanical labor, we see that this industry is of the highest importance in its relation to the first object of every economical system, the profitable employment of the people. In this consideration lies the most direct and obvious claim of the textile machine manufacture for the favor which is extended to other branches of the domestic manufacture. How far it enjoys this favor will be the next subject of inquiry.

Present duty and its adequacy. — For the first seventy years of our existence as an independent nation the textile machinists of this country had no need of invoking national favor. Ample protection had been afforded to them unconsciously by England in its prohibition of the export of machinery. The beneficent effect of the English laws in developing our own production of machinery explains the otherwise anomalous fact that, while nearly every other American industry is directly mentioned or impliedly referred to in our tariff laws, the manufacture of machinery has been invariably ignored. Textile machinery, in our schedules of dutiable articles, always has been, and still is, without name or mention, and hitherto has been recognized in our tariffs only as among the "manufactures of iron and steel," and even then has been classed among the articles "not otherwise provided for." Of

all our industries, no one owes so little to our *own* national favor, although no one so well illustrates the beneficent effect of the restrictive policy in the abstract. At no time has the duty on "manufactures of iron," the only practical governmental protection of our own to machinery, been more than 35 per cent. The duty, beginning with a rate of 7½ per cent in 1790, was gradually increased to 35 per cent in 1816. In 1819 the duty was reduced to 20 per cent. Raised in 1825 to 25 per cent, it was from that period to 1842 reduced to 21½ per cent. In 1842 it was advanced to 30 per cent, and in 1857 reduced to 24 per cent. In 1861 it was advanced to 30 per cent, and in 1863 to 35 per cent, at which rate it has remained until the present time.

The duty on "manufactures of steel, or of which steel is a component part, not otherwise provided for," is 45 per cent. As steel is a component part of nearly all textile machinery, it might seem that machinery would receive the benefit of the higher duty. But, as the steel parts are generally small and easily detached, it is the custom of importers to have such parts sent in separate packages, so that machinery in the main is admitted at the 35 per cent duty.

It is maintained by the machine builders that this duty affords them less *net* protection than is given to any other great branch of our national industry. To the iron, steel, cotton, wool, and silk industries, a full and clear protection of at least 35 per cent, and in many cases more, is given. In the silk and cotton manufactures, the raw material is free of duty. In the woollen and clothing manufactures, and some others, besides the protective duty of at least 35 per cent, a further reimbursing duty is imposed, to offset the duty on the raw material. In the industry of machinery, the raw material, constituting at least half the cost, is iron and steel; and the duties on the grades used by the machine builders, it is alleged, amount to an *ad valorem* of 55 to 60 per cent. The fact, therefore, must be admitted that the protection, whether adequate or not, is far less than that afforded to other industries of the same importance.

The next question arising is whether the duty is adequate to

secure the national market for the national labor in this class of productions. It is admitted by the most ardent revenue reformers that, with raw material free, at least 25 per cent is required to offset the higher cost of labor, interest, and local taxation in this country, so that our manufacturers may compete on an equality with foreigners in our own markets. Allowing 25 per cent to offset the superior advantages of foreign manufacturers in labor, interest, and taxation, our machine builders have but 10 per cent to offset the duty of 60 per cent to which they are subject on their raw material. It is perfectly obvious, therefore, that the present duty is of itself utterly inadequate to maintain this industry, and that it holds its ground only because partially protected by cost of transportation, and because its roots have been so firmly planted by the unqualified protection formerly afforded by English laws.

Arguments for reduction of duty. — We are not aware that any movement is contempated by the American machine builders to increase the rate of duty on foreign machinery; nor, on the other hand, are we aware of any desire, on the part of the textile manufacturers, the consumers of machinery, to diminish the present duty. There is no popular demand for the reduction of the duty, as it does not affect general consumers. But a movement for the reduction, and even abolition of the duty, has come, and will come again, from foreign builders, or their agents in this country, who desire to gain freer access to our markets; and we have dwelt upon the real inadequacy of the present duty principally for the purpose of showing the unreasonableness of their demands. The tactics of the foreign builders or their agents has been to foment a sentiment in the South that the great industrial problem to be worked out by the cotton-producing States is the conversion of the raw material into *yarn* prior to export, which would, as alleged, double the exchangeable value of the cotton crop, "bringing in $400,000,000, instead of $200,000,000, now realized," "furnishing employment to hundreds of thousands of dependent persons," and thus "speedily repairing the losses of the war." It is urged that the first and essential step to this

new industrial career is the making of cotton machinery cheap and attainable by admitting it absolutely free of duty.

This specious reasoning has found some favor in the South, and demands a few words of refutation. There are two fallacies in this argument. Every practical cotton manufacturer knows that the whole scheme of making yarns at present in the South for export is a delusion. In the words of experts who have thoroughly studied this subject, "the question is not whether the South can compete with the North in the export of yarns. In the contest for the markets of the world for cotton yarns, the struggle is to be with the colossal establishments, the gigantic capital, the cheap and skilled labor, and the world-wide commercial facilities of England, or with the Continent, even more difficult to contend with in certain particulars. Into this conflict we are, neither North nor South, prepared to enter. We have in time past enjoyed a limited sale for cotton fabrics in a few foreign countries, the market being secured to us by the extraordinary excellence of the goods and by the relations of our trade with such countries.* But we cannot, either for yarns or cloths, yet compete on equal terms in the markets of the world with our transatlantic rivals, so as to build up a great business. We shall not be able to do this until our conditions and theirs as to capital, as to density of population, and cost of labor, become more nearly equalized. The hopes of our Southern friends, either with or without free machinery, could not be realized. The embarkation of large amounts of capital in the making of yarns for export would be a ruinous venture for them or for us."

The second fallacy is that machinery would be cheapened by the abolition of the duty. The error of this assumption is demonstrated by the whole history of our manufactures. The invariable effect of the introduction, through protective duties,

* Mr. Bigelow, in his "Tariff Policy," shows that in 1875 Great Britain exported cotton manufactures to the value of three hundred and fifty-eight million eight hundred and fifty-eight thousand dollars, while the value of the largest export of such manufactures in any one year (viz. 1877) by the United States, was only twelve million and eighty-eight thousand dollars.

of a domestic fabric, has been the immediate reduction of the price of the foreign competing article, and a still farther reduction through domestic competition. Cottons, hardware, glass, nails, screws, are palpable proofs of this proposition. Common sense and analogy show that free foreign machinery will not remain cheap a moment after it has ruined our own machine shops; and that it would ruin them, subject as they are to the extra expenses attending all American production, from which these foreign rivals are exempt, is too obvious for argument. We should have in machinery the same experience which we had in iron, when the tariff of 1846, shutting up our own furnaces and rolling mills, brought the prices of English rails from fifty up to eighty dollars a ton, and cost our railroads not less than thirty millions of dollars. A temporary cheapness, to be followed by excessive dearness, or a *tenter-board* movement of prices, is no benefit to consumers. Equable or gradually falling prices for a series of years is best secured by rates of duty which, while not prohibiting importation, preserve domestic competition in full activity. Every cotton manufacturer who has gone abroad to purchase machinery knows that the fulcrum of the lever which he applies to pry down foreign prices of machinery is the machine shop in his own country. He goes abroad with a knowledge of American prices, and forces the foreign builder to reduce his rates by showing him American schedules, and threatening to buy at home. Thus, it is the foreigner, and not the home consumer, who in fact pays the duty, or at least its greater part. Our experience under the Canadian Reciprocity Treaty, when for a time coal, barley, and wool were free, proved conclusively that the remission of the duty which the government lost inured to the benefit, not of the American consumer, but the foreign producer.

Assuming that the remission of the duty on cotton machinery would make it cheaper, of what especial benefit would this be to the South? At present, the competition of the South in the cotton manufacture is not with England, but with the States of the North. Machinery, if free to Alabama, would be free to Massachusetts. The former works up less than 3,000,000

pounds of cotton, against 140,000,000 pounds, more or less, worked up by the latter. Would the relations of the case be altered by cheap machinery? Would not Massachusetts grasp the added advantages as promptly and effectually as Alabama? Would not the eternal law, "To him that hath shall be given," give the new advantage to the section which is richest in capital, skilled labor, and experience?

The manufacture of machinery at the South to be encouraged. — The South, of all sections of the country, can least afford to have machinery free. She needs the diversified industry of which her former system of labor deprived her. Even more than the factory she needs the machine shop, the fruitful mother of diversified industries. She is unjust to her own capacity and her magnificent resources when she aims at any thing less than producing for herself all that is necessary for industrial independence. Her unsuspected capacity for mechanical improvement was shown, to our cost, by her productions in military enginery during the late war. In the possession of the raw material of machinery, she surpasses even Pennsylvania. Her coal-fields are inexhaustible. In the State most clamorous for free machinery, Alabama, the horseman may ride a hundred miles over beds of fossiliferous iron ore fifteen feet thick. Her metallurgic capacity equals her textile wealth, and has equal claims for development. No single industry, however stimulated, will suffice for the improvement of these resources, nor can overcome the inertia of labor of which the South complains. To triumph in the industrial race, she must rally every available industry, and harness them *all abreast*, like the steeds in the Olympic course. Let the South multiply her cotton factories, but let her have her own machine shops under or near them, even if at first they are as humble as the old repair shops of New England. Like them, they will expand into independent establishments, and become nurseries of mechanics, schools of invention, and fountains of labor-aiding power. Out of them will spring more modest single industries to occupy her people. Some will build pickers, others carding machines, others looms and spindles, others supplies for mills

of cotton and wool, card-clothing, reeds, harnesses, shuttles, bobbins, spools, belting, — accumulated special industries more important to the State than a few gigantic establishments.

Free machinery no boon. — The introduction of the material or supplies which can be produced at home, free of duty, for the encouragement of protected manufactures, is not a measure of free trade, but one of qualified protection, or rather a mongrel system, justified by the theories of neither school of political economy. The system is unjust, selfish, short-sighted, and time-serving, and, wherever practised, has retarded, instead of promoting, the national industry. This system has prevailed largely on the continent of Europe, many countries admitting English yarns free of duty for the benefit of the manufacturers of woven goods, who were defended by duties. It has prevailed to a marked extent in Austria, high duties being imposed upon cotton cloths, and none, or but slight duties, on yarns. The result has been that Austria still remains tributary to England and Switzerland for the yarns woven into her tissues; and it is now admitted by the Austrian manufacturers that "their industry would have attained a much greater importance and development than it now has, if it had been protected by the same duties as have been extended to woven goods."* Both the cotton and woollen manufacture of Germany have declined under the same system of admitting raw materials free. The German manufacturers now admit their mistake, and have formed a gigantic association, numbering thousands in the organization, who demand protective duties on every thing which can be produced in the German Empire. The most recent issue of the leading textile journal of Germany refers to the United States as an example to the world of the height to which a nation may attain by developing its own raw material of manufacture and making its industry thoroughly self-dependent.† The early cot-

* *Notes upon the Cotton Industry at the Vienna Exposition*, by Charles Grad. — *Bulletin of National Association of Wool Manufacturers*, Vol. V., p. 262.

† "The United States have, during the free-trade contest in Europe, closed their borders, and have established for themselves a great and powerful industry, built upon the firmest foundation; namely, their own production of raw material

ton manufacturers of New England were reconciled to the duty of three cents a pound laid on raw cotton in 1789, although at first regarded as "a very serious impediment to their rising manufacture." The wool manufacturers are reconciled to the duty on wool, which will soon make Texas the first sheep-producing State in the Union, and add wool to the list of Southern exports to foreign countries; and the South, it is hoped, in the benefit derived from her own manufacture of the machinery for her factories, may find a conclusive refutation of the sophistry of "free-trade in raw materials."

Slight burden of the duty. — As a final reason why at least the present measure of national protection to this industry should be preserved, we would observe that the burden of the duty, if it is a burden, which we do not admit, is much less than appears by its rate. Experts in the fabrication of machinery and construction of mills assert that the extra cost of transportation and freight of foreign machinery to the mills in this country, over the American, is at least 15 per cent, which, deducted from the 35 per cent duty, would leave but 20 per cent on the machinery as the advantage of purchasing abroad, or loss in being compelled to purchase at home. The cost of the machinery of a cotton mill they assert to be not half the cost of the whole plant. Assuming that, in a mill costing complete $100,000, the machinery made here costs $50,000, the tax upon the mill would be 10 per cent, or $10,000. Against this must be set off the superior adaptation of our machinery to the special wants of our own mills, and the skill of our operators, the facility of selection, and the admitted superiority of construction, while this 10 per cent is but a small premium to pay for preserving an industry which has hitherto been so fruitful in producing power.

CONCLUSION.

The history of the industry which we have reviewed refutes, as we conceive, on every page, the doctrine of free trade, — that

---

and means of subsistence (*der eignen Production der Rohstoffe und Nahrungs mittel*"). — *D. A. Polytechnische Zeitung*, Feb., 1879.

unlimited competition is the essential condition of the healthy industrial growth of a nation. We have seen a great manufacture planted in a new country by means of a system of restriction more rigorous than the strictest prohibitory tariff of our own could have been. We have seen this restriction (that it was involuntary on our part does not affect the question) — which was a virtual prohibition of foreign competing products — continuing during the first half century of our industrial career, and with what results? The sapling industry, thriving because no colossal overshadowing tree at its side intercepted the sun from its leaves, or covered the ground with roots extracting the nutriment from the soil, has expanded into a proportion and symmetry of which the glorious solitary elm of a New England intervale is a fit type. And this industry, the only one of all our manufactures which has been absolutely and effectually protected, like the elm, is the most grandly developed and perfectly proportioned of all our indigenous products. It is, with its outgrowths, the most original, characteristic, and distinctly American of all our industries, — the one whose eminence is most freely recognized by foreign nations, and the one whose overflow has most contributed to the productive power of the whole manufacturing world. Does not this example prove that it is restriction, and not unlimited competition, which favors the industrial development of nations, and especially the highest result of development, — the power of original creation? In an early number of this magazine, we attempted to show, in another connection, the beneficial influence of industrial restrictions in giving a national character to national productions by an analogy drawn from the physical world; and we now venture to reproduce the paragraphs tracing this view, as the most appropriate close of the history of an industry which singularly illustrates and enforces the analogy referred to: —

"In the physical world, it is the barriers of mountains, oceans, rivers, and uncongenial climates which have alone preserved the characteristic features of those regions which retain their peculiar types of animal or vegetable existence. These natural obstructions have given variety to the productions of the earth, and break up that drear monot-

ony which would have followed from the unimpeded sway of the strongest nations.

"So it is in the industrial world. In the economical competition of nations, it is not the best and fittest industries which survive: it is those of the strongest people. Unobstructed in their admission to India and Turkey, British cottons have supplanted the magnificent muslins of Hindostan; and the cheap dress-goods of Bradford have extinguished the precious mohair fabrics of Angora, just as the white-weed and Canada thistle take possession of the West, and the prolific and pugnacious English sparrows expel our native song-birds. They supplant, but they by no means replace. Protective barriers are to industrial nations what natural obstructions are to the animal and vegetable world. They secure to each country its native industries, and permit others to take root which in time acquire a national character, impressed by the peculiar genius of each people. The arts and products of each country overflow its borders, and spread into surrounding nations. The whole world is benefited by the variety, excellence, and cheapness which follow from the competition of many industrial countries, deriving their very power to compete from partial exemption from competition; and is relieved from the monotony, mediocrity, and dearness of production which are the inevitable results of a monopoly of industries by the strongest and wealthiest nation."