COTTON MANUFACTURE.

Cotton was known to the ancients as *tree-wool*, being mentioned by Herodotus, Pliny, and many others. It was introduced into Spain by the Arabs, and flourished as long as religious toleration existed in the peninsula, and from this land it reached the less civilized parts of Europe. When the best part of the inhabitants was expelled, when the University of Cordova became a thing forgotten in the peninsula, when the memory of Alhazen was lost, and the era of the Pedros and Philips commenced, then the cotton-plant too faded away, and all the industries growing out of this beautiful staple expired.

Cotton was, however, known to the Mexicans when discovered by Cortez. This man without a conscience sent of his stolen goods to Charles V. "cotton mantles, some all white, others mixed with white and black, or red, green, yellow, and blue; waistcoats, counterpanes, tapestries, and carpets of cotton; and the colors of the cotton were extremely fine."*

Although there are several native American varieties of cotton, our plant is a native of India, and it has formed the staple material of garments there from time immemorial.

Cotton goods were made in Manchester in 1641, of "cotton-wool brought from Smyrna and Cyprus." Cotton seed was brought to England from the Levant, taken thence to the Bahamas, and thence to Georgia in 1786. The first cotton mill in America was at Beverly, Massachusetts, 1787. Slater's mill was erected at Pawtucket in 1789. Slater was an apprentice of Strutt and Arkwright, and

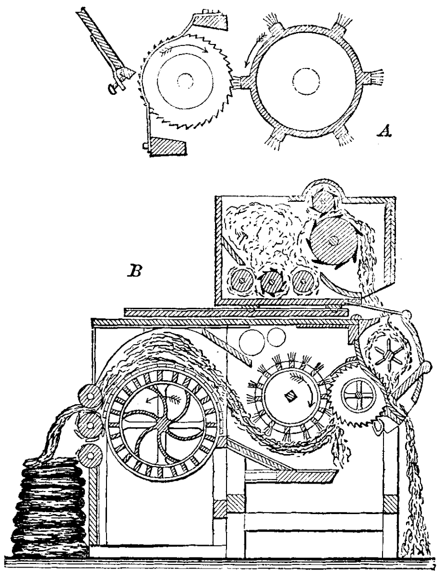
* Clavigero's *Conquest of Mexico.*

introduced into the United States the Arkwright system of associated and combined machines, being the founder of the New England factory practice. The success of these mills is referred to in the report of Alexander Hamilton, Secretary of the Treasury, 1791, who proposed to remove the duty on cotton, as it was "not a production of the country," and to "extend the duty of seven and a half per cent. to all imported cotton goods."

The beauty and softness of the goods made of this material, which was new to the people of Europe, recommended it to persons of means and taste, and the importation from India assumed large proportions. The names of *calico* and *muslin*, from Calicut and Moussoul, indicate clearly enough whence the market was supplied at an early day. The English manufacturers struggled against many difficulties, three of which may be named—the lack of suitable machinery; the opposition of the wool trade, which induced the authorities even to hang criminals in cotton garments to render the goods unpopular; and the lack of supply of cotton.

The cotton from the boll yields only from one-quarter to one-third ginned fibre, and the labor of removing the seed by hand seemed at this critical moment to set a limit to the production, or at least render it so expensive that the goods could not come into general use among the masses of the people, who were used to being tolerably well fed and housed, and could not live on twopence a day and support their families, like the Hindoos. It is true that in India a sort of roller-gin had been in use from time immemorial—one which pinched the fibre and carried it away from the seed, whose size prevented it from passing between the rollers; but this was comparatively slow, and does not appear to have been known in America, where the hand-picking was in vogue. Besides, it is only suitable for certain staples of cotton. The great need of the producer and the manufacturer was a machine to remove the cotton from the seed with rapidity and economy.

At this juncture appears Eli Whitney, of Massachusetts, who in 1794 patented the *cotton-gin*. The name *gin* is short for *engine*, and is a frequent curt expression for a handy machine. Whitney's *saw-gin* (A) comprises two cylinders of different diameters mounted in a wooden frame, and turned by a handle or belt and pulley so as to rotate in opposite directions, the brush cylinder the faster. The smaller cylinder carries on its circumference from sixty to eighty circular saws, and the larger cylinder a series of brushes. The teeth of the saws pass in between a number of bars, forming a grating. The cotton, as picked from the pods, is thrown into the hopper; the saws strip the fibre from the seeds, which fall through



WHITNEY'S COTTON-GIN.

the bottom of the hopper, while the wool is cleansed from the teeth of the saws, and delivered by a sloping table into a receptacle below. A more modern and complete form of the machine (B) is shown in our engraving.

The crop of cotton increased from 189,316 pounds in 1791 to 2,000,000,000 pounds in 1859. Whitney and his partner received $50,000 from the State of South Carolina, and a tariff of so much per saw per annum from the States of North Carolina and Georgia for a short term of years.

After the gin come the *opener* and *scutcher*, which separate the locks of cotton, remove the dirt, and convert the tangled fibre into a light and flocculent *bat* or *lap*. The machines of this stage of the process have a number of names, the marks of the rough humor of the Lancashire men among whom they originated. They were known as *willowers*, from the practice of beating with willow wands, or as *devils* and *wolves*, from their toothed drums, which tore the locks apart, the fibre passing from one to another, and the dust and dirt being carried off by a suction blast, or falling through the meshes of wire-cloth into a box beneath the machine.

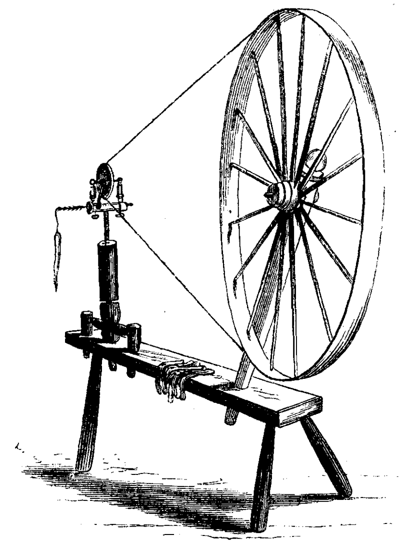
The *carding-machine* reduces the mass of cotton to a fleece or sliver, the fibres laid parallel, so that they may be drawn and twisted into a yarn. Hand cards were not superseded by machine cards until about 1770, although attempts had been made at carding-machines by Lewis Paul in 1748, and by Hargreaves in 1760. To the latter, to Arkwright, and to Mr. Peele, the father of the first Sir Robert and the grandfather of the statesman, the invention is ascribed. It was hardly possible that this necessary link in the chain of machines should long lack a discoverer.

Lewis Paul in his patent of 1748 had a number of parallel cards on a bed, or on a cylinder, with intervening spaces. It was used in connection with an upper card or a concave, and when the strips were full they were taken off, and the roving removed from each. Peele in 1779 introduced the cylinder. His machine had strips of card around the drum to give separate *slivers* or *cardings*, and a can, which rotated on its base, to give a slight twist to the rovings. This was perhaps the first *roving can*. The *card-sticking* machine was invented by Amos Whittemore, of Massachusetts, and patented by him in 1797.

Next in order of operation, though the first to feel the rising tide of invention, was the *spinning machine*. In ancient Egypt, Phœnicia, Arabia, India, Greece, and Rome the *distaff* and *spindle* were the means of spinning. The *spinning-wheel* may have originated among our cousins of Hindostan, as it was certainly known there at a somewhat distant period; it appears in our illuminated missals of the fourteenth century, but only among the lady population, being used by spinsters and matrons of rank. The great bulk of the spinning was by the distaff, which indeed is still used in many parts of the continent of Europe. Among English-speaking peoples it survived latest in the *flax-wheel*, in which a continuous thread was spun from a tussock of combed flax held upon a distaff at one end of the machine.

So far as we are concerned, the commencement of our century finds the spinning of cotton and wool in the condition of many previous ages and centuries; it was done upon hand spinning-wheels. This was true as to work done for the household and that which was done in the way of business, being distributed by the spinning masters of a neighborhood to the operatives, who did the work at their own houses. When Hargreaves invented the spinning-jenny in 1768 cotton and woolen mills were unknown.

The wool being carded into rolls in which the fibres were arranged in one direction, the spinner attached the end of one to the spindle, which was then revolved by whirling the large wheel, a band passing over the periphery of the latter and over a little pulley on the spindle. The left hand of the operator drew out the roll as it was twisted, the degree of its elongation and the hardness of the twist depending upon the distance it was pulled out and the number of revolutions. In practice, the spinner steps back a distance after setting the wheel a-whirling, and, when the twist is satisfactory, by shifting the yarn from the point to the shaft of the spindle, and reversing the direction of



SPINNING-WHEEL.

rotation, the yarn is wound upon the spindle, excepting the end of the yarn, which is left projecting from the point for the attachment of another roll. Another feature must also be noticed, as it has a very close bearing upon what was followed in the most perfect known spinning machine, the *mule*, of which more presently. The spinner, after drawing out the roll, giving the wheel a whirl, and walking backward from it, dropped the roving, and then, advancing to the spindle, took the roving between the finger and thumb; then, giving a rapid revolution to the wheel, she walked backward away, allowing the roving to slip through the grip with just such friction as would secure the required tightness of twist. This done, the yarn was wound upon the spindle, and the double process repeated with another carded roll.

This was the way with wool, and subsequently with cotton; but it was not until the rising demand for cotton yarn occurred that machinery was invented to supplement the individual exertions of the spinner. Machinery was first applied to silk, but the material was expensive, the demand limited, and the process essentially different. Lewis Paul led off in this line of invention in his patent of 1738, in which he introduced the idea of successive pairs of *drawing rollers* for elongating the roving, the speed of the consecutive pairs increasing so that each pulled upon the roving between it and the preceding pair, the eventual extension depending upon the relative rates of the increase of speed of the successive pairs. He also gave to one or more of the pairs of rollers a revolution in a plane at right angles to that of their individual rotation, so as to give a twist to the yarn. This invention is said to have originated with Wyatt, Paul being only a promoter; however that may have been, it was not successful, owing, doubtless, partly to want of skill in the making, and also to intrinsic difficulties, for the same invention, in a modified form, was patented in 1848, and had a fair trial on a large scale in Rhode Island before it was finally abandoned.

In 1758 Lewis Paul tried again to adapt machinery to the work. This invention was the precursor of the *bobbin-and-fly frame.* He seems to have been unfortunate in his combinations.

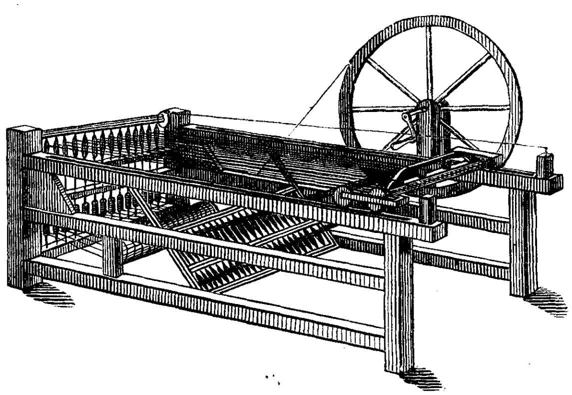
The cardings being attached endwise, are fed between rollers which deliver the long sliver to a bobbin, which takes it up faster as to length than it is delivered by the rollers, and so stretches it according to the quality required. There is an indistinct intimation of a *flyer* in the drawing of this machine in the stretch between the feed rollers and the bobbins. Had he put the *drawing rollers* of his former patent to the *feed rollers* and *bobbin* of his new one, he might, perhaps, have forestalled Arkwright.

Hargreaves's *spinning-jenny* was the direct outgrowth of the spinning-wheel, unlike the Paul *drawing head,* which had a radically different construction. Something had to be done to meet the increased demand for cotton yarn. James Hargreaves was the man for the occasion. It is said that the first suggestion in the right direction was caused by the upsetting of a spinning-wheel by one of his children. *It continued to run when the spindle was vertical.* Here was the solution. He had frequently tried to spin several yarns at once on as many spindles, but the latter being horizontal, the yarns interfered. He made a machine in 1764 with eight vertical spindles in a row, fed by eight rovings, which were held by a fluted wooden clasp of two parallel slats. The ends of the rovings being attached to the spindles, the wheel was revolved by the right hand, rotating the spindles, and the clasp which lightly clipped the rovings was drawn away from the spindles, paying out the roving, which was twisted by the rotation of the spindles, and stretched by the retraction of the clasp and the amount taken up by the twist. When the clasp reached the back of the machine the yarn was wound on the spindles, the clasp resumed its place near them, fresh rovings were pieced on to the ends of the former ones, and the work was repeated.

The clasp was, as it were, a long finger and thumb to hold a row of rovings, and the machine was eventually made to contain as many as eighty spindles. Hargreaves spun in secret so much yarn that the jealous workmen broke into his house and destroyed the machine. He deviated a little from his first design in drafting the specification for his patent of 1770. He there had a series of bobbins holding *slubs*—soft rovings having but little twist—which pass from thence to a row of spindles, all rotated from a common driving-wheel. Between the two, with divisions for the slubs, was a clasp, which was managed by the left hand, to bring such a pressure upon the roving as the required twist might warrant. A *presser-wire* regulated the winding of the yarn on the spindles in the intervals of spinning.

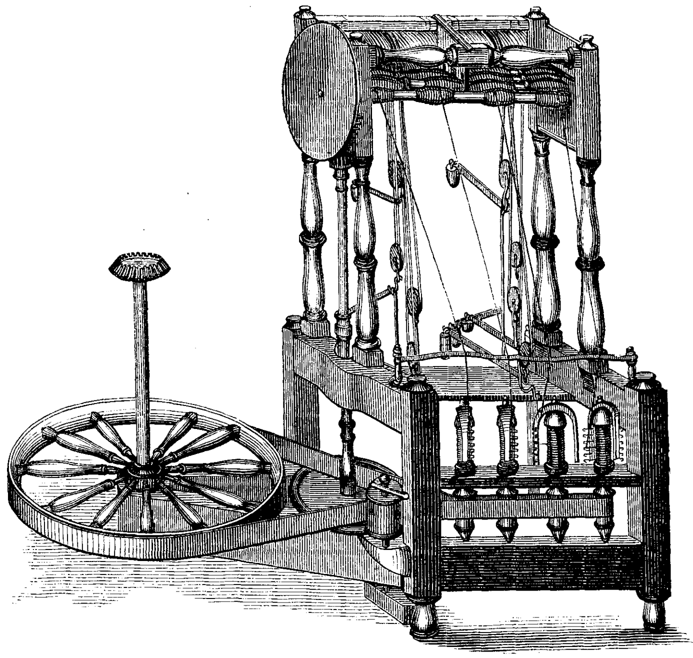
It being proved that he had sold several of his machines before his application for a patent, the latter was set aside, and he never was reasonably remunerated.

When the machine of Arkwright, which is next in order of date, came into use, the *spinning-jenny* of Hargreaves still held its superiority in yarn, the product being used for the *weft,* while the *water-twist* of the Arkwright *roller-machine* was used for the *warp.* Subsequently the principal features of the jenny were embodied with others selected from the Arkwright *drawing frame* to form what was playfully termed the *mule,* by which name it is universally known up to date. It was said also that until the invention of the Arkwright machine cotton yarn was seldom used for warp, owing to its softness and weakness, the jenny not giving a sufficiently hard twist to bear the strain of the loom. Goods were therefore usually made, at the period referred to, with a *linen warp* and *cotton woof.*



HARGREAVES'S SPINNING-JENNY.

Arkwright's invention for "making of weft or yarn from cotton, flax, and wool," patented 1769, was the most brilliant of its time and class. It was designed to be driven by horse-power, a band from a drum on the master - wheel shaft giving motion to the various parts. It was much improved in later years, and was driven by water-power after its success justified larger operations. This soon followed, and in 1785 steam - power was first applied to cotton spinning. The cotton rovings were wound upon large bobbins at the back upper part of the machine, and were drawn from them by four pairs of *drawing rollers,* which, moving with a graduated accelerated speed, elongated the rovings, and passed them to the flyers and spindles on the lower part of the machine. The four essential parts of this apparatus have not been dispensed with in ordinary spinning, and constitute the *bobbin-and-fly frame,* or *roving-frame,* which bids fair to hold its ground for spinning ordinary numbers to the end of time.



ARKWRIGHT'S SPINNING MACHINE (FROM THE ORIGINAL DRAWING).

The drawing rollers were suggested by the Lewis Paul machine of 1738; but the *flyers* and the general combination are of the highest order of merit, and are to be attributed to Arkwright.

Reference has been made in the introductory remarks to the factory system initiated by Arkwright in his cotton mills, 1768–1785. Arkwright was the first man to associate consecutively the various processes in cotton manufacture under the same roof. This series of machines for carding, drawing, and roving was patented in 1785, and from Arkwright's period we date the origin of the factory system. This was the year after the ratification by Congress of the definitive treaty of peace signed at Paris, and four years before Washington became President.

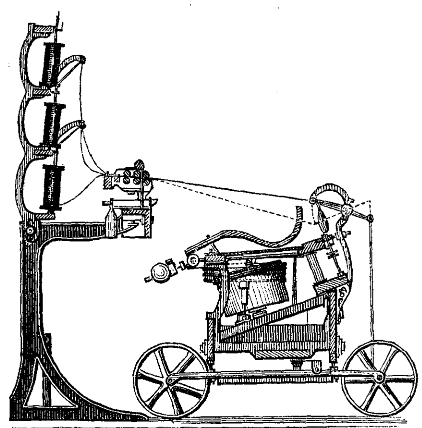
Thenceforward the system had but to grow and extend; to grow, in bringing other departments of the cotton manufacture, and eventually those of wool, flax, and hemp, into the same method; to extend, in respect of its boundaries, geographical and economical—the latter by the inauguration of parallel practices in other interests, such as the working of metal, leather, and wood.

The invention of cotton machinery was no exception to the general rule: Arkwright did best what had been attempted before. Arkwright had his Lewis Paul, just as Fulton had his Symington and Rumsey, and as Stephenson had his Trevethick and Hedley.

Many other improvements might be cited, such as Jenks's ring-and-traveler spinner, if we had the space. The list of spinning machines closes with the *mule,* and at present there is nothing better to offer. The perfected mule has been called the "iron man" from the wondrous skill with which it operates. Apparently instinct with life and feeling, it performs its allotted course as implicitly as a mere water-wheel, but the exquisite provisions for timing — what may be called the opportuneness of its movements —give it an air of volition and prevision. These features belong to the *automatic mule,* or the *self-acting mule,* as it also called. It was not thus in the original mule of Crompton. In this the main features were present, but were brought into and continued in action by the care and judgment of the operator.

Samuel Crompton was a young weaver when he applied his mind to the solution of the problem how to make a machine which should avoid certain faults present in the Hargreaves and the Arkwright machines. This he succeeded in doing in 1779. He placed his spindles on a traveling carriage, which backed away from the roving bobbins to stretch and twist a length of the rovings, and then ran back to wind the yarn upon the spindles. The immediate object was to deliver the roving with the required degree of attenuation, and twist it as delivered. The work of this machine was finer than any heretofore produced, and the improved self-acting mule still maintains its superior character. Even at the first it was called the "muslin wheel," as its yarns rivaled in softness the finer kinds from India. Crompton took no patent for it, but was rewarded with a Parliamentary grant of £5000 thirty-three years afterward. He died in 1827.

Previous to the invention of the mule few spinners could make yarns of 200 hanks to the pound, the hank being always 840 yards. The natives of India were at the same time making yarns of numbers varying from 300 to 400. By the best constructed mules yarn has been made in Manchester of number 700, which was woven in France. The illustra-



MULE SPINNER.

tion will give an idea of the machine, though it has not the complicated parts of the self-acting mule.

The mule of Crompton had only twenty to thirty spindles, and the distance traveled by the carriage was five feet. The distance traveled is now much greater, and some mules carry 1200 spindles.

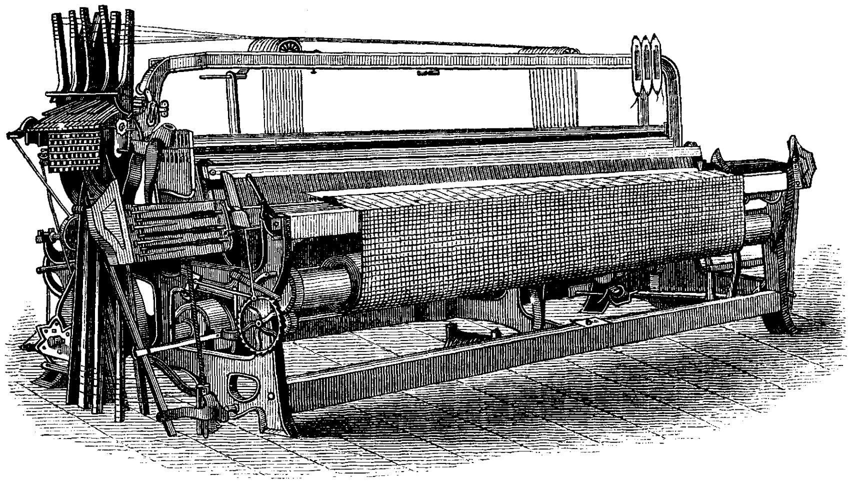
The drawing and stretching action of the mule spinner makes the yarn finer and of a more uniform tenuity than the mere drawing and twisting action of the *throstle*. As delivered by the rollers, the thread is thicker in some parts than in others; these thicker parts, not being so effectually twisted as the smaller parts, are softer, and yield more readily to the stretching power of the mule; by this means the twist becomes more equable throughout the yarn.

The mule carriage carrying the spindles recedes from the rollers with a velocity somewhat greater than the rate of delivery of the reduced roving, the rapid revolution of the spindles giving a twist to the yarn, which stretches it still farther. When the rollers cease giving out the rovings, the mule spinner still continues to recede, its spindles still revolving, and thus the stretching is effected.

When the *drawing, stretching,* and *twisting* of the yarn are thus accomplished, the mule disengages itself from the parts of the carriage by which it has been driven, and the carriage is returned to the rollers, the thread being wound in a *cop* upon the spindle as the carriage returns.

The specific difference between the action of the throstle and the mule is, that the former has a continuous action upon the roving, *drawing, twisting,* and *winding* it upon the *spindle,* while the mule *draws* and *twists* at one operation as the carriage runs out, and then *winds* all the lengths upon the spindles as the carriage runs in. The automatic disengagement is the invention of Roberts, in 1830, and of Mason.

The jenny and the drawing frame being fairly at work, the cry was now, "What is to become of the yarn? there will not be hands enough to weave it." The Rev. Edmund Cartwright set himself to the solution of the problem, and took out a patent for a power-loom in 1785, and a second in 1787. He was at great expense, and worked under the disadvantage of being a poor mechanic, having very little judgment in the proportion of parts or the convenient modes for the transmission of motion. One of the great difficulties in his way was in the fluffy and spongy character of the warp, and in the necessity for stopping the loom to dress a length of warp. This was avoided by the invention of the sizing and dressing machine of Radcliffe, of Stockport, in 1802, which took the yarns from the warping machine, carried them between two rollers, one of which revolved in a reservoir of thin paste, then between brushes, which rid the yarns of superfluous and uneven paste, then over a heated copper box, which dried them, and then wound them on the yarn-beam of the loom. The power-loom was only extensively adopted about 1801—the year of expiration of Cartwright's principal patent. He received £10,000 from Parliament. The justness of Cartwright's claim to the power-loom may be appreciated when it is stated that his loom, patented in 1787, has automatic mechanical devices to operate all parts. It was a memorable success for a man of letters, whose first attempt at a power-loom was made in 1784, before he had ever seen a loom. Eventually, by the exertions of Horrocks, of Stockport, in 1803, and the adaptation of the steam-engine to the work, the power-loom became fixed in use. Jacquard, of Lyons, France,



CROMPTON'S FANCY LOOM.

Roberts, of Manchester, England, and more lately Bigelow, Crompton, and Lyall, of this country, have brought the machine to a degree of perfection which is a marvel to the uninitiated, and an object of respect to those who happen to be a little better informed in technical matters.

It may be mentioned that the mill at Waltham, Massachusetts, erected in 1813, was the first in the world in which were combined machines for all the processes which convert the raw cotton into cloth. The mills of Arkwright, at Cromford, in Derbyshire, erected 1771–75, and that of Slater, at Pawtucket, Rhode Island, 1790, had no power-looms.

Crompton is a name twice famous in the history of the manufacture of fibre. His loom, represented in the accompanying cut, is not a loom for cotton, but a more complicated structure for figure-weaving, as in carpet-making.

The Jacquard loom is the most distinctively curious in the list of looms. Jacquard, of Lyons, is reported to have conceived the idea in 1790, and in 1801 he received from the National Exposition a bronze medal for his invention of a machine for figure-weaving, which he patented.

The appendage to the loom which constitutes the Jacquard attachment is to elevate or depress the warp threads for the reception of the shuttle, the action being produced by cards with punched holes, which admit the passage of needles which govern the warp threads. The holes in a card represent the warps to be raised for a certain passage of the shuttle, and the needles, dropping into the holes, govern the formation of the shed so that the required threads of warp come to the surface. The next card governs the next motion of the warps; and so on, the required color being brought up or kept up, as the case may be. For figured stuff, from the finest silk to the most solid carpet, figured velvets and Wilton carpets, we are indebted to the genius of Jacquard, who made it possible to do by machinery what was before an expensive operation requiring skillful hands.

While the art of the dyer is as old as Tyre, and the colors of antiquity are not, perhaps, excelled in lustre and stability, the variety has increased, and the modes have become more numerous and cheap. Dye baths and mordants were well understood in India two thousand years ago, as were also one or more styles of calico-printing, including chintz patterns and the resist process, which helped to make the fortunes of the Peele family.

Pliny refers to the skill of the Egyptians as "wonderful" in imparting to white robes a number of colors by steeping "with dye-absorbing drugs" (mordants), after which the goods take on several tints when boiled in a dye bath of one color. Cortez was met in Mexico by people who wore cotton dresses with Dolly Varden patterns in black, blue, red, yellow, and green.

These instances, which are but a tithe of what offers, show that calico-printing is old enough, and, indeed, it was practiced as a profession at Augsburg at the latter part of the seventeenth century, about which time it was introduced into England. Hand processes, however, were all that were known. Their nature it is not so easy to determine, but Robert Peele, a farmer of Blackburn, invented the method of *printing by blocks,* each cut out to correspond with its part of the pattern, and laid in apposition by means of *register pins.* This may have been about 1776, a year or two before his invention of the *mangle* and the *cylinder carding-machine,* the roller principle of which seems to have suggested the *calico-printing machine* (1785), which has its pattern engraved on the face of a cylinder, and which, with various improvements in detail, remains in use to the present day. The object he chose for his first attempt at hand-printing was a parsley leaf. The women of his family ironed the goods, and he was long called, without intentional disparagement, "Parsley-leaf Peele."

In this machine the pattern for each color is engraved on a cylinder which revolves so as to dip its lower surface in a trough of color; the face of each cylinder is scraped clean by a blade called a *doctor*, leaving the color only in the engraved lines; the cloth passes against the cylinders in turn, and receives a portion of its pattern from each. By an American improvement the number of cylinders which may be applied to each web is increased to twelve. The mode of engraving the cylinders has undergone a complete change since the invention by Jacob Perkins, of Massachusetts, of the roller die and transfer process, in which a design on an engraved and subsequently hardened steel die is impressed into the copper cylinder in repetition to any required extent.

Robert Peele was also fortunate in securing two very valuable processes, known as the *discharge* and *resist* styles. The latter he is said to have bought of a commercial traveler for £5, and to have made £250,000 by it. The *discharge* style is a process in which the cloth is printed with a material which prevents the mordant from becoming fast, so that when the dye is applied and the cloth washed, the dye is not fast at those places. The *resist* style is one in which the cloth has a pattern printed in paste, and is then dyed in indigo. The paste resists the coloring matter, and these parts are white on a blue ground when the cloth is washed.

The name of Peele, the self-taught dyer and mechanic, and his son and grandson, the two Sir Roberts, the latter being the statesman who was killed by a fall from his horse in 1850, are indissolubly associated with the cotton manufacture, and more specifically with the carding and the calico-printing.

WASHINGTON, D. C. EDWARD H. KNIGHT.