COTTON MANUFACTURE. We now arrive at the second of the three divisions into which it has been deemed desirable to group the information concerning cotton; namely, the manufacturing processes, in their history and their practice.

The use of cotton as a material for the production of woven fabrics, was known in India and China for many centuries before its introduction into Europe. The earliest mention of cotton by the Greek writers is by Herodotus (iii. 106) in his brief notice of the usages of the Indi: he calls it (iii. 47) by the significant name of tree-wool (εἴριον ἀπὸ ξύλου), apparently not being acquainted with the native name. In the reign of Amasis, B.C. 563–525, cotton was known in Egypt; but it must have been imported, for there is no reason for supposing it was then grown in Egypt. Cotton cloths were, according to Arrian, among the articles which the Romans received from India; and there is no doubt the manufacture had been carried on in many parts of Asia, long before any extant notice of that quarter of the world being visited by Europeans. The perfection to which the weaving of cotton had then been brought by the natives of many parts of India, notwithstanding their rude and imperfect implements, attests at once their patience and ingenuity. In China, this manufacture is supposed not to have existed at all before the beginning of the sixth century of the Christian era. The cotton plant was indeed known in that country at a much earlier period, but continued till then to be cultivated only as a garden shrub, and was not indeed propagated on a large scale until the eleventh century; at the present time nearly all the inhabitants of that populous empire are clothed in cotton cloths of home manufacture, made from cotton brought in part from India, but mostly of home growth.

Before the discovery of the passage to India round the Cape of Good Hope, cotton wool is said to have been spun and woven in some of the Italian states, the traders of which were the channels through which the cotton fabrics of India were distributed to the different countries of Europe. Becoming thus acquainted with these goods, and having near at hand the raw material of which they were formed, it was natural that they should apply to the production of similar goods the manufacturing skill they had long possessed.

Baines has shown ('History of the Cotton Manufacture,') that the cotton plant was extensively cultivated, and its produce manufactured, by the Mohammedan possessors of Spain in the tenth century. This branch of industry flourished long in that country. In the thirteenth century the cotton manufacturers formed one of the incorporated companies of Barcelona, in which city two streets received names which point them out as the quarter in which the manufacturers resided. The cloths made were mostly of coarse texture, and a considerable quantity was used as sail-cloth. The name *fustians*, from the Spanish word *fuste*, signifying "substance," was borrowed from the Spanish weavers, and is still used to denote a strong fabric made of cotton. The intercourse between the Mohammedan possessors of Spain and the Christian inhabitants of other European countries was so small, owing to religious prejudice, that the arts which long flourished among the former, did not extend themselves to the latter; the traffic of Andalusia was all carried on with Africa and the East.

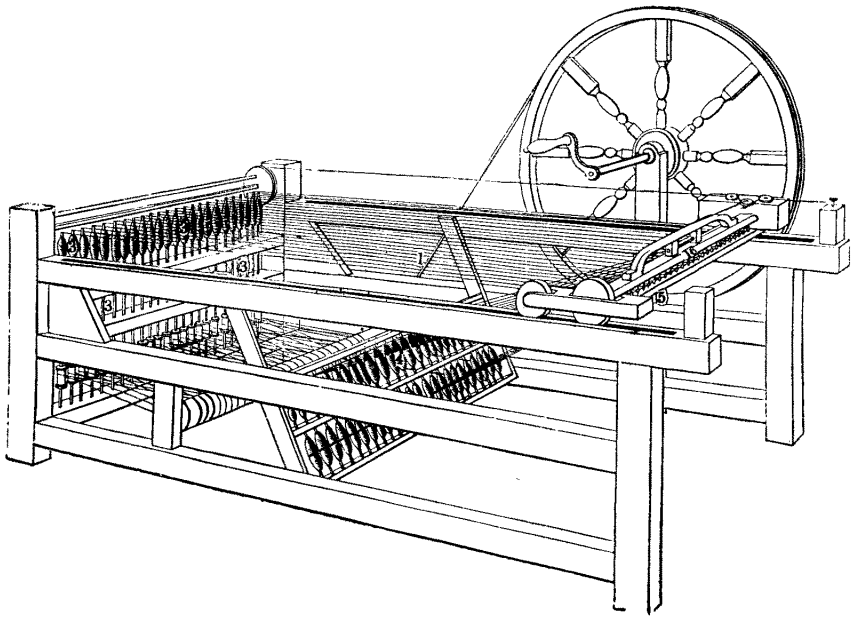
From Italy the cotton manufacture made its way to the Netherlands, and about the end of the sixteenth or the beginning of the seventeenth century was brought thence to England by protestant refugees. Lewis Roberts, in 'The Treasure of Traffic,' published in 1641, makes the earliest mention extant of the manufacture in England. He says, "The town of Manchester buys cotton wool from London that comes from Cyprus and Smyrna, and works the same into fustians, vermilions, and dimities."

There is abundant evidence to show that in the beginning of the sixteenth century, and probably before that time, cotton was cultivated and converted into clothing in most of the countries occupying the southern shores of the Mediterranean. The European conquerors of Mexico in their first invasion of that country found in use native manufactures of cotton, both unmixed and mixed with the fine hair of rabbits and hares. Some of these fabrics were sent by Cortes to Spain as presents to the Emperor Charles V. Cotton was cultivated and manufactured at an equally early period by different nations on the coast of Guinea, and it is stated by Macpherson in his 'Annals of Commerce,' that cotton cloths were imported into London in 1590, from the Bight of Benin.

It would be difficult to trace the introduction of the cotton manufacture in the different countries of Europe where it is now established but some notice of its recent progress and present state therein will be found in the next following article.

In England, previous to the introduction of the inventions of Arkwright, this manufacture was of small importance, as is evident from the quantities of the raw material then brought into the country. Arkwright's first patent for the mode of spinning by rollers was taken out in 1769; and between the years 1776 and 1780 the average annual consumption barely reached seven millions of pounds. The system under which this manufacture was long carried on was very different from that which is now pursued. It was the custom for the weavers who were dispersed in cottages throughout the district to purchase the material with which they worked, and having converted it into cloths, to carry their wares to market and sell them on their own account to the dealers; but about 1760, the merchants of Manchester began to employ the weavers—furnishing them with yarn for warp, and with raw cotton to be spun by the weaver's family into weft, and paying a fixed price for the labour bestowed in weaving.

The application of machinery to the preparation and spinning of raw cotton for weft preceded by some years the inventions of Arkwright. In the year 1760, or soon after, a carding engine not very different from that now used was contrived by James Hargreaves, an illiterate weaver, residing near Church in Lancashire; and in 1767 the *spinning-jenny* was invented by the same person. This machine, as at first formed, contained eight spindles, which were made to revolve by means of bands from a horizontal wheel. Subsequent improvements increased the power of the spinning-jenny to eighty spindles, and the wheel was placed vertically, as in the annexed cut:—where the rovings (1), clasped and drawn by the frame (5), are transferred in an attenuated state from the spindles (3) to (4). The saving of labour which it thus



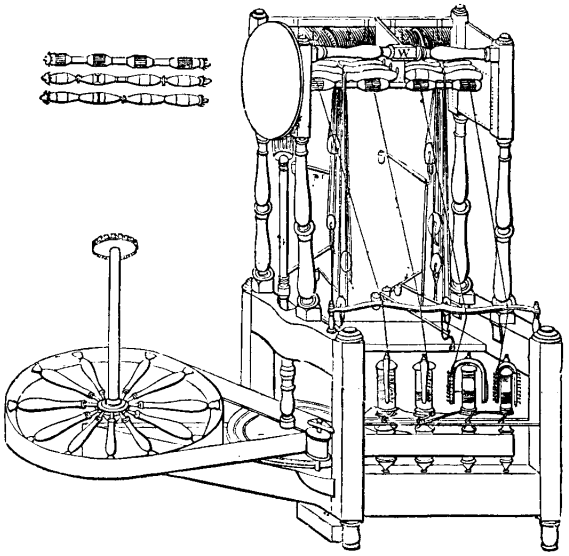
[Hargreaves' Spinning Jenny.]

occasioned produced considerable alarm among those persons who had employed the old mode of spinning; and a party of them broke into Hargreaves' house and destroyed his machine. The great advantage of the invention was so apparent, however, that it was soon again brought into use, and nearly superseded the employment of the old spinning-wheel. A second rising then took place of the persons whose labour was thus superseded by it; they went through the country destroying, wherever they could find them, both carding and spinning machines, by which means the manufacture was for a time driven away from Lancashire to Nottingham.

The cotton-yarn produced both by the common spinning wheel and the spinning-jenny, though suitable for weft or cross-threads, could not be made sufficiently strong to be used as warp or long-threads; and, therefore, linen-yarn was used for the last-named purpose. It was not until Arkwright's spinning frame was brought into successful operation that this disadvantage was overcome. Yarn spun with Hargreaves' jenny continued for some time to be used for weft. At first, the manufacturers of cloths composed of cotton only were subject to much annoyance from the determination of the revenue officers to charge them with double the duty paid upon calicoes woven with linen warp and printed for exportation; and also by prohibiting their use at home. With some difficulty an act of parliament was obtained for removing these obstacles to the development of the manufacture, which from that time was prosecuted with a great and continually accelerated rate of increase.

The earliest attempts at producing the finer cotton goods called *muslins* were made about the year 1780; but without much success, although India-spun yarn was substituted as weft for that produced by the spinning-jenny: the greatest degree of fineness to which yarn spun with Arkwright's frame had then been brought, was eighty hanks to the pound, and even this degree was not attainable by means of the jenny. This disadvantage was overcome by the invention of Samuel Crompton's machine, which came into general use about the year 1786, and which, partaking of the nature of both Hargreaves' and Arkwright's machines, was aptly called the *mule-jenny*. By means of this piece of mechanism, yarns were produced of a much greater fineness than had before been attained. Crompton's invention was made several years before it could be openly used, because of its interference with the patented invention of Arkwright; but when this patent was annulled, the mule-jenny was brought rapidly and exten-

sively into use. No less than 500,000 pieces of muslin were made at Bolton, Glasgow and Paisley, in 1787, with yarn of British production.



[Arkwright's Original Spinning Frame.]

Crompton did not secure to himself the benefit of his invention by taking out a patent; he carried on a spinning and weaving business on a small scale at Bolton, and worked his mule-jenny with his own hands in an attic. In a brief memoir of Crompton, Mr. Kennedy has stated, that about 1802 he, in conjunction with Mr. Lee, set on foot a subscription which amounted to 500*l.*: and that with this fund Crompton was enabled to increase his manufacturing establishment, and to set up several looms for fancy work in Bolton. In 1812 Crompton made a survey of all the cotton manufacturing districts in the kingdom, and ascertained that the number of spindles then at work upon his principle amounted to between four and five millions. The kind friends already named assisted him in making an application to parliament for some reward; and the great merit of his invention having been established before a Committee of the House of Commons, he received a grant of 5000*l.*, which was paid to him in full without any deduction for fees or charges. This money was employed by Crompton in putting his sons into business; but they proved unsuccessful, and he was reduced to poverty. Mr. Kennedy again interfered in his behalf, and raised a second subscription, with the produce of which a life annuity of 63*l.* was purchased. Crompton lived only two years to enjoy this small provision. The first mule-jennies consisted of not more than thirty spindles each, but the number has been progressively increased, and they now frequently contain from 600 to 1000 spindles each, or even a still greater number. The next great improvement in the construction of this machine was effected by Messrs. Sharp, Roberts & Co., machinists of Manchester. Their machines, which are called *self-acting mules*, do not require the manual aid of a spinner, the only attendance necessary being that of children, called piecers, who join such threads as may be accidentally broken. Self-acting mules were contrived at different times by Mr. William Strutt of Derby, Mr. Kelly of Lanark, Mr. De Jongh of Warrington, and others; but none of these were brought successfully into use, owing, no doubt, in some measure, to the inferior skill of the machine makers of those days.

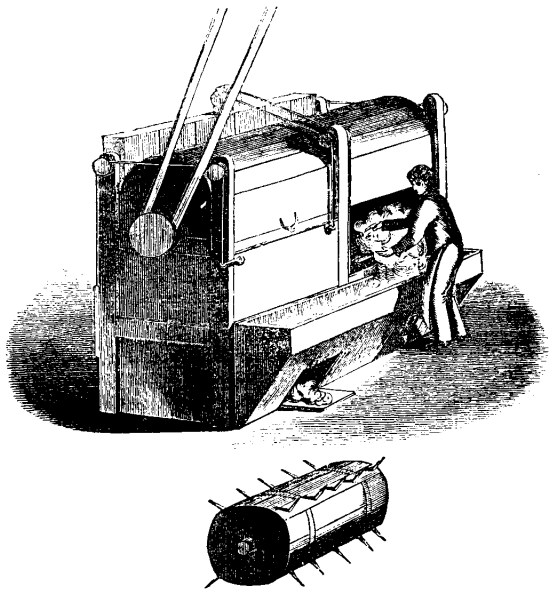
Another event which contributed to the rapid extension of the cotton manufacture, was the successful attempt to weave by means of machinery, made in 1785 by Dr. Cartwright, who secured the invention by patent. In a commercial point of view Dr. Cartwright did not draw any advantage from his power-loom; but in 1809 he obtained from parliament a grant of 10,000*l.* as a reward for his ingenuity. Mr. Monteith, of Pollokshaws, Glasgow, who fitted up 200 power-looms in 1801, was the first person who brought them to profitable use. A great obstacle to their success was presented by the necessity for the frequent stopping of the machine in order to dress the warp. This difficulty was removed in 1804 by the invention of a machine for dressing the whole of the warp before it is placed in the loom, which was made the subject of a patent by Mr. Radcliffe, the inventor. In the use of this machine the warp in its progress to the weaving beam is passed through a dressing of hot starch: it is then compressed between rollers to free it from the superfluous quantity of starch taken up; and afterwards, in order to dry it, the warp is drawn over a succession of cylinders heated by passing steam through them. By this means the weaver is relieved from the necessity of stopping from his weaving to dress the warp.

The machines and apparatus of recent introduction, connected with the cotton manufacture, almost countless as they are in number, are rather extensions and improvements of systems already known, than

inventions partaking of the capital importance of those of Arkwright, Hargreaves, Crompton, Cartwright, Radcliffe, and Roberts. Instead of attempting the hopeless task of describing the various modern inventions, we shall proceed at once to a description of the processes in their ordinary routine. The cotton fibres have to be spun into yarn or thread before they can be woven into calico, fustian, muslin, or other textile material; and this spinning is the most important part of the whole operation. Nevertheless it can be effected, in a slow way, with few and rude implements. Among all the ancient mechanical arts there were few so simple as that of converting the downy filaments of the cotton plant into a continuous thread according to the methods generally used before the time of Hargreaves and Arkwright. The same primitive methods are still employed in eastern countries. There are, on the other hand, few processes for the performance of which the inventive powers of man have since that period been more taxed, in this country and during this age of invention, than for the cheap and perfect production of cotton twist and yarn. The use of the spindle and distaff was superseded in England by the spinning-wheel, in or soon after the reign of Henry VIII. The next improvements in this useful art were those of Hargreaves and Arkwright; which were followed by the whole train of novelties just adverted to.

One of the first processes in a cotton mill is that of mixing the fibres. Owing to the great variety generally found in the quality of different bags of cotton, which would otherwise occasion a corresponding difference in the quality of the yarn produced, the contents of several bags are mixed together in a heap. This is done by spreading out the contents of each bag in a horizontal layer of uniform thickness, the contents of the several bags forming separate layers and resting one upon the other, so that the number of layers corresponds to the number of bags. In making this heap, which is called a *bing* or *bunker*, the several layers are trampled or pressed together somewhat in the manner of building a hay-stack. The cotton of which the bing is composed is then torn down by a rake from top to bottom. It is evident that in its progress a portion of each horizontal layer will be brought away, and that thus, if the work be skilfully done, the contents of the different bags must be collected together in a mass of uniform quality. It is customary to mix in this manner different descriptions of raw cotton for the production of various qualities of yarn; and some skill on the part of the manufacturer is called for in order to produce a mass that will answer the intended purpose at the least possible cost. The practice of different spinners varies much in this respect, but it is considered proper as a general rule to mix together only such qualities as are similar in the length of their staple. The waste cotton produced in the previous operations of the mill is mixed in the bing in certain proportions for making the lower or coarser qualities of yarn. For the higher or finer numbers, and for twist which is used for warp, finer qualities of cotton are required than for low numbers or for weft. It may here be mentioned that in the technical language of the trade, 'high numbers,' meaning fine yarns, denote a great number of hanks to the pound; while 'low numbers,' meaning coarse yarns, denote a smaller number of hanks to the pound.

When the cotton has been mixed, the machine next employed is usually the *Scutching or Willowing Machine.* This is used to open the



[Willowing Machine.]

locks of cotton and separate its fibres, while at the same time it separates from it any sand or seeds which it may contain. This machine

consists of feeding-rollers made of wood and placed at a short distance from each other; the cotton, while passing slowly between the rollers, is struck by a set of beaters made to revolve from 1000 to 2000 times in a minute. The cotton is passed through two such sets of rollers, and subjected to two sets of beaters. It is then taken to the *Spreading Machine*, the use of which is to spread a given weight of cleaned cotton into a given length and breadth, in order to its being presented of uniform thickness to the next process. The spreading machine is, however, not universally used; where the heavier quality of yarn is spun it answers sufficiently well, and effects an adequate saving of labour; but for fine yarns, where the greatest precision is required in order to produce regularity in the size of the yarn, machine-spreading does not answer so well as hand-spreading. The cotton is weighed very accurately before it is put into the spreading-machine, and when perfectly spread is called a *feed*, the thickness of which will of course be regulated by the weight of cotton supplied to the machine. This operation is repeated continuously, so that an unbroken sheet of cotton passes through the machine and is wound on a wooden roller. In this form the cotton is called a *breaker lap*.

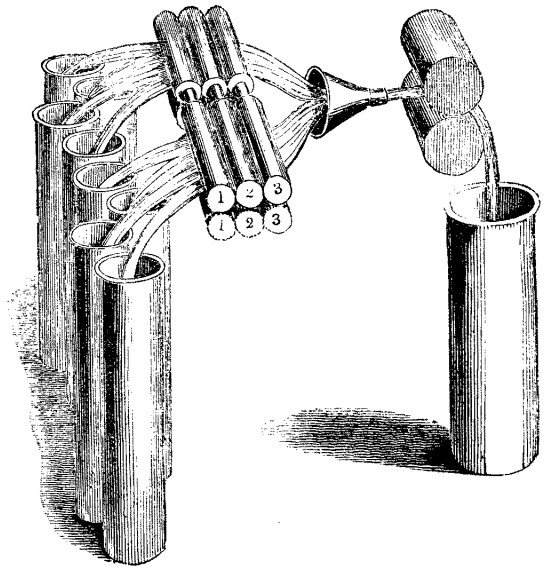
Up to this stage the fibres of the cotton cross each other in every direction. The *Carding Engine* then comes into requisition, to disentangle them, to draw them out, and to lay them parallel to each other. Properly speaking, this is the first operation of spinning—the previous processes being used only to open and clean the cotton. The card is a species of brush made of short wires passed through a sheet of leather and pointing all in one direction. In the early period of cotton-spinning in this country, these cards were nailed on small pieces of board with handles, and two of them were used together, one held in each hand. The first improvement made in this implement was effected about 1760, by James Hargreaves, the same ingenious man who, a few years later, invented the spinning-jenny. This improvement in the cards consisted in having one of them greatly increased in size, and fixed; this was called the stock, and the other was suspended by a cord working in a pulley, fixed to the roof of the work-shop; the effect of this arrangement was that two or more cards could be applied to the same stock. This modification was immediately followed by the greater improvement of *cylinder cards;* the father of the first Sir Robert Peel set up a machine of the kind at Blackburn in 1762, with the assistance of Hargreaves. The inventor of cylinder cards is not known with certainty; but Mr. Baines ascribes the invention to Lewis Paul, who took out a patent in 1748 for improvements in carding. The carding engine, which was the natural result of the invention of cylinder-cards, consists of a horizontal cylinder covered in its entire circumference with narrow fillet cards wound spirally round the cylinder, leaving an intervening space between the several spiral lines thus described. Over the cylinder is a concave frame, the interior surface of which is lined with cards, and the form of which corresponds to that of the cylinder. When the cylinder is made to revolve, the cards on it and on the frame act against each other, by which means the fibres of cotton are disentangled and properly arranged, as already mentioned. The cylinders, which are usually about 3 feet in diameter and 3 feet long, are made to revolve at the rate of 100 to 150 turns in a minute.

The cotton, in the form already described as a breaker lap, is led into the carding machine by a slow motion through feeding-rollers, little more than one inch in diameter, The fibres of the cotton are then immediately engaged by the wires of the main cylinder, and after being by their means properly arranged, are thrown off by its velocity to a second cylinder called a *doffer*.

When cylinder-cards were first used, hand-cards were employed to take off the cotton. Various contrivances were at different times adopted for improving this part of the process; until at length Arkwright contrived for the purpose a plate of metal toothed at the edge like a comb, which, instead of revolving as the former contrivances had done, was, by means of a crank, made to move rapidly in a perpendicular direction, and with slight but reiterated strokes on the teeth of the cards detached the cotton from them in a uniform fleece. This fleece is made to undergo compression on its passage to a roller, from which it is delivered in the form of a thick but soft thread, called a *card-end*, or *sliver*, into a tin can. The duration of the carding process is made to depend upon the quality of the cotton under preparation; if the fibres are short and coarse, the carding should be quickly performed, not indeed by accelerating the speed of the cylinders, but by taking the cotton faster off the cards.

The next operation is called *drawing*, and the machine by means of which it is performed is called the *Drawing-frame*. The object of this drawing is to complete what has been begun by the carding engine, namely, the arranging of the fibres of cotton longitudinally, in a uniform and parallel direction, and to remedy all existing inequalities in the thickness of the sliver. The drawing-frame acts upon the same principle as Arkwright's spinning-frame, two or three sets of rollers being employed moving with unequal velocities. In its passage through the first pair (1, 1) the sliver is simply compressed; but being drawn through the second and third pairs (2, 2 and 3, 3) with gradually increasing velocities, it is necessarily drawn out in the same proportion. In repeating this operation, which is called *doubling*, two, three, or a greater number of the drawings are passed through each set of rollers; in the first they are made to coalesce, and in the second are

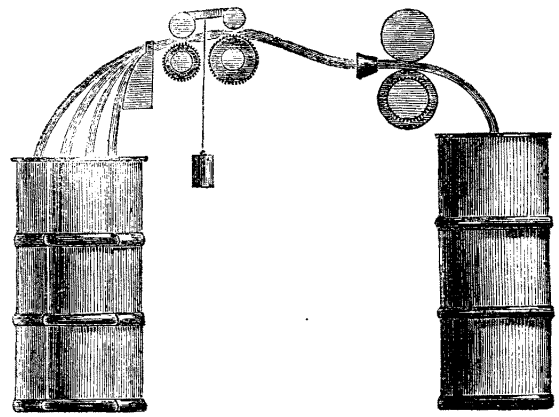
again drawn out. These doubling and drawing processes are repeated very frequently, in order to correct every inequality in the thickness of



[Drawing Rollers and Cans.]

the cord or sliver; they are of the utmost importance, and if ill or insufficiently performed, the yarn cannot prove of good quality.

Roving, the next step in the process, is a continuation of the drawing, with this only difference—that the cord, now called a *rove* or *slub*,

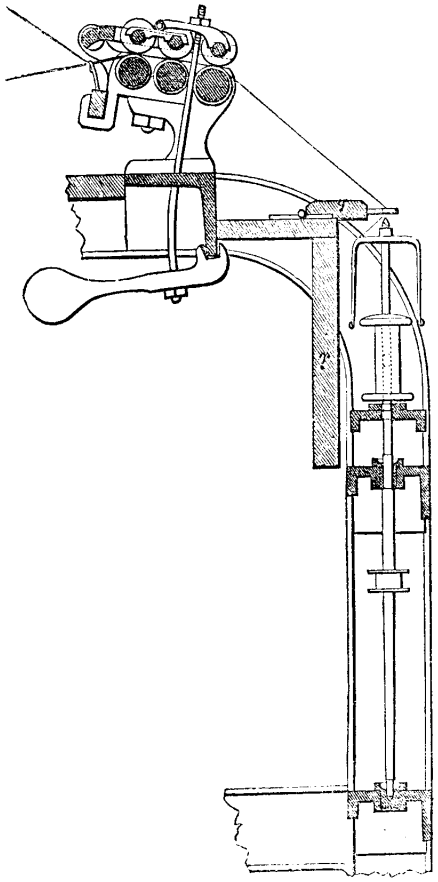


[Roving Cans.]

being so much reduced in thickness that it will not otherwise hold together, a slight twist is given to it by passing it into a metal can, which, while receiving it, is made to revolve with great velocity. The rove thus slightly twisted, is wound upon bobbins, and is then ready for the spinning-frame. About the year 1817, a machine called a *fly frame* was contrived for preparing rovings for inferior numbers of yarn. Instead of revolving cans, this frame is provided with a series of spindles, each of which is furnished with a flyer; the revolutions of this flyer give the requisite twist to the cord, which is delivered at once to the bobbin fitted loosely on the spindle. The *tube frame*, more recently introduced, is used for preparing yarns of all qualities. Instead of cans, this frame is provided with revolving horizontal cylinders: and by its means a much greater quantity of work can be done in a given time than with the fly frame; the rove which it produces has no twist, and is therefore very tender, and the quantity of waste which it occasions is greater than is otherwise experienced.

The important process of *Spinning* then comes for notice. The principle of Arkwright's original *Spinning frame* may be briefly described: There were two pairs of rollers; the first pair slowly revolving in contact; and the second pair, at a little distance, revolving with greater velocity. The lower roller of each pair was fluted longitudinally, and the upper one was covered with leather, by which means the two would have a sufficient hold upon the cotton passed between them. The cotton, when passed between the first pair of rollers, had the form of a thick but very soft cord, and was no further altered in its texture

than by receiving a slight compression; but as the second pair of rollers moved with many times the velocity of the first, the cotton was drawn out many times smaller than when delivered from the first rollers.



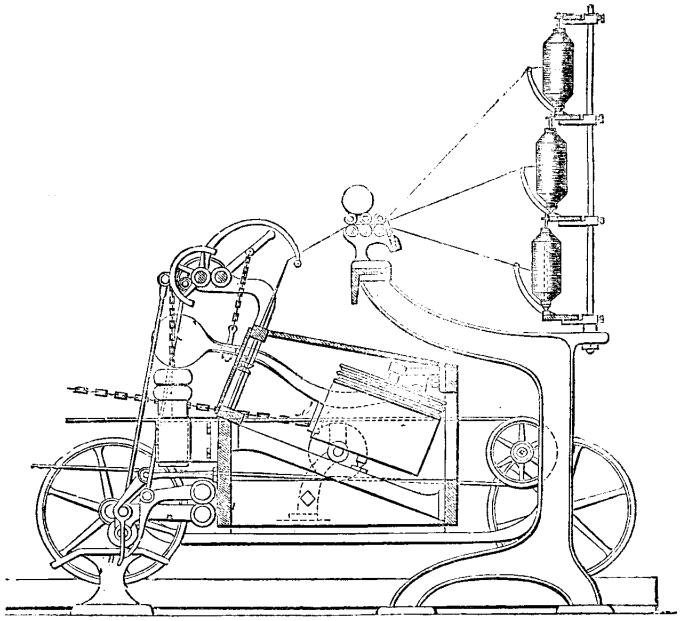
[Throstle spinning.]

The yarn produced by its means received the name of *water-twist*, from the circumstance of the machinery being at first set in motion by water power. The *Throstle frame* is the same in principle as Arkwright's

invention; but the movement of the parts is simplified, so that the speed of the machine is increased, and a greater number of spindles may be driven with an equal amount of power; it was introduced about the year 1810. The *Mule-jenny*, invented by Samuel Crompton, combines the essential principle of Arkwright's frame with the property of stretching possessed by Hargreave's jenny. By means of the mule-jenny, the roving is first drawn and then stretched. The effect of this improvement is to make the yarn finer, and of a more uniform tenuity. When 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; and by this means the twist becomes more equable throughout the yarn. Throstle-spinning is seldom employed for higher numbers than forty to fifty hanks to the pound, because smaller yarn would not have strength to bear the drag of the bobbin; but in mule-spinning no bobbin is used, and the yarn is wound or built upon the spindles without subjecting it to any strain. The spindles in this machine are regularly arranged on a carriage, which when put in motion recedes from the rollers with a velocity somewhat greater than that at which the reduced rovings are delivered from them; during this time the yarn is receiving its twist by the rapid revolving of the spindles; when the rollers are made to cease giving out the rovings, the mule-jenny still continues to recede, but with a slower motion, and its spindles to revolve; and thus the stretching is effected. The distance which the spindles recede from the rollers while both are in action is called a *stretch;* this is usually about fifty-four or fifty-six inches: the space through which the mule moves greater than and during the giving out of the rollers, is called the *gaining* of the carriage; and the further space accomplished by the carriage after the rollers are stopped, is called the *second stretch;* during this latter part of their progress, the spindles are made to revolve much more rapidly than before, to save time. When the drawing, stretching, and twisting of the thread are thus accomplished, the mule disengages itself from the parts of the machine by which it has been driven, and then the attendant spinner returns the carriage to the rollers, again to perform its task. While returning to the roller, the thread which has been spun is wound or built on the spindle in a conical form, and is called a *cop*. The mule-jenny is a complex piece of mechanism, and requires to have all its parts very nicely fitted and adjusted.

The *Self-acting mule* contrived by Mr. Roberts, and improved by later inventors, is a beautiful example of automatic mechanism. The carriage of this mule, after having drawn out and stretched and twisted the thread, is returned again to the rollers by mechanical means without the guidance or intervention of any intelligent agent, the only attendance required being that of children to join such threads as may have been accidentally broken in the stretching. This self-acting mule is even more complex in its arrangements than the original machine, and hence great doubts were entertained as to its successful working; but it has triumphed over all difficulties. Its advantages as regards economy, and rendering the manufacturer independent of a class of workmen who frequently proved refractory, are so great, as to have led to a general adoption of the machine.

If the yarn spun with the mule-jenny be intended for use as weft in



[Carriage of Self-acting Spinning Mule.]

the factory where it is produced, the cops are at once applied to the shuttle; but when intended for warp, and generally when exported, the yarn is reeled into hanks each 840 yards in length, for performing which operation a *Self-acting reel* has been contrived. This process is

attended by young women. The diameter of the reel is 4½ feet; when it has performed 80 revolutions, a *lay* is formed measuring 120 yards, and seven of these lays make up a hank. Each hank is separately tied round with a thread, and weighed to ascertain its fineness; the different sizes are then put by themselves, and separately packed in paper bundles of either five or ten pounds weight.

Fine yarns are usually singed, in order to remove their loose downy fibres and to give them smoothness. This is accomplished by subjecting the thread to the action of a series of coal-gas flames, through or over which it is several times passed with a degree of quickness sufficient to prevent burning.

Cotton *thread*, for sewing, is made by laying together two or more yarns of equal quality, and twisting them; for which purpose distinct machinery is employed. Previous to the doubling and twisting, the yarn is passed through a trough, containing a thin solution of starch; the twist is given in an opposite direction to that applied by the spinning machine, causing the thread to resemble in this respect organzine silk.

Scarcely any operation in a cotton mill, we thus see, is carried forward without the intervention of a machine, by which the work is done with greater precision, and also with greater celerity, and consequently greater economy. The packing of the hanks of yarn into bundles is the work of a *bundle press*, by means of which the hanks are pressed into a small compass, the power of the machine enabling females to exert sufficient strength for the purpose. Even here, however, steam power is sometimes employed.

The degree in which the inventions that have here been noticed have reduced the expenses attending this branch of manufacture is great almost beyond belief. One pound of the yarn known as No. 100 was, in the year 1786, worth 38*s.*; in 1791, it was 29*s.* 9*d.*; in 1795, 19*s.*; in 1799, 10*s.* 9*d.*; in 1807, 6*s.* 9*d*; in 1832, 2*s.* 11*d.*; and in recent years it has been still lower. The average waste in spinning cotton is considered to be about 1½ oz. per pound; it is very much higher in fine yarns than in coarse, and this is one reason for the increased price of the former. Mr. Ainsworth, an eminent Lancashire manufacturer, has recently pointed out the ratio which raw material bears to labour, in four varieties of textile manufacture, thus:—

			For finished Goods.
1 lb. wool for flannel costs	1*s.* 6*d.* + 1*s.* 7*d.*	for wages	= 3*s.* 1*d.*
1 lb. wool, for coarse cloth costs	1*s.* 2*d.* + 4*s.* 0*d.*	,,	= 5*s.* 2*d.*
1 lb. flax for shirting costs	0*s.* 10*d.* + 1*s.* 6*d.*	,,	= 2*s.* 4*d.*
1 lb. cotton for sheeting costs	0*s.* 6*d.* + 0*s.* 6*d.*	,,	= 1*s.* 0*d.*

The mechanical inventions relating to the various processes of cotton manufacture, patented or otherwise, are, as has been already implied, numerous almost beyond belief. The records of the Patent Office, now placed in such admirable order under the superintendence of Mr. Bennett Woodcroft, show this conclusively. It is not possible to give the number of patents with accuracy, because some of them relate to wool and flax as well as to cotton; but it is pretty evident that the last-named fibre occupies the prominent place. Down to the close of the year 1858 there had, since the commencement of the patent system, been 256 patents granted relating more or less to the cleaning, spinning, separating, scutching, and batting of fibrous materials; 82 containing provisions relating to the carding, combing, drawing, doubling, and roving of the materials thus prepared; and the enormous number of 1376 touching in a greater or less degree the processes and apparatus for spinning, twisting, and thread-making. It must not, as just stated, be understood that all these related to cottons; nor that there were 2457 separate patents relating to textile materials, seeing that some of the patents comprise within themselves the characteristics of all three lists, or of two out of the three; but it is quite certain that the patents relating strictly to the cotton manufacture are many hundreds in number. All these are irrespective of weaving processes, which have been made the subjects of a distinct series of patents.

As the weaving of cotton does not differ much in principle from that of linen, woollen, and silk, it will suffice to describe them all in one article. [Weaving.] The statistics connected with the manufactured products of cotton-mills will come most suitably into the subjoined article [Cotton Trade and Consumption], as will likewise a brief notice of the cotton manufacture in foreign countries.

It would not be right to close this article without a few lines descriptive of those important establishments, the cotton-mills of the north—those extraordinary centres of industry, which have stamped a character on the counties containing them. It is computed that, in 1859, if we draw a circle of thirty miles radius around Manchester, that circle will be found to contain more inhabitants than a circle of similar size having London in its centre. Liverpool, the great port for landing raw cotton and for shipping manufactured cotton goods, is just within the circle: Manchester, the cotton metropolis, is by the terms of the argument in the centre of the circle; while other parts of the area include the great towns of Preston, Chorley, Blackburn, Accrington, Clitheroe, Burnley, Haslingden, Bacup, Rawtenstall, Bolton, Bury, Middleton, Oldham, Ashton, Staleybridge, Dukinfield, Hyde, Glossop, Mottram, Stockport, &c.—all of which contain immense establishments for spinning, weaving, bleaching, or printing cotton; and there are so many similar establishments occupying the valleys and roads between those towns, that the whole area may be regarded as one large workshop. The same may be said, in a smaller degree, of the district around Glasgow. Some of the mills spin cotton only, some weave it only, while some spin and weave. Some kinds of cotton goods are more largely made than others in particular towns; fine muslins in one, shirting calicoes in another, fustians in a third, and so on. Most of the spinning and weaving mills are buildings of vast size, speckled over with windows on every side. Some of them have six or seven hundred windows each, which give light to seven or eight stories or ranges of rooms. In those of improved construction, there is apparatus for lifting the workpeople, or some of them, from story to story, thereby lessening the fatigue and the consumption of time involved in ascending staircases. As one part of the perfect system which has gradually become organised in this trade, it is customary to haul up the bales of cotton to the highest story of the building, and then gradually lower the material from story to story until it leaves the bottom range in a finished state; thus the opening, the mixing, the scutching, the carding, the drawing, the roving, and the spinning, follow in their proper order, in rooms occupying different heights in the range of building. If it be a weaving as well as a spinning mill, the weaving machines or power-looms, sometimes fifteen or eighteen hundred in number, are usually placed in a lower and separate building, called the weaving-shed. Nothing is more admirable in the whole arrangement than the manner in which the moving power is conveyed from story to story, from room to room, by means of highly-wrought shafting and wheel-work. The steam-engine may be outside one end of the building, and yet its working efficacy may be felt at the other end, perhaps two or three hundred feet distant. If the mill be in a country district, with a hill close at hand, the architect often plans that the chimney-shaft shall be built on the top of the hill, with a flue leading to it under-ground from the furnaces; this is equivalent to a great increase in the height of the chimney, and in the strength of the draught which passes through the furnace. In the days of Arkwright and the elder Strutt, the mill builders looked out anxiously for a valley, where a stream might afford moving power for a water-wheel; but in the present days of steam-power, the cotton-spinner reckons little on the proximity of a river. In those days, canals were the great channels of communication, along which raw cotton was carried to the mill and manufactured cotton goods conveyed away from it; the transit is now effected almost entirely by railway. There are nearly four hundred miles of railway in Lancashire alone, mostly maintained by the cotton trade; besides those belonging to the cotton districts in the neighbouring counties. These four hundred miles have certainly not cost less than twenty millions sterling; which may, in a certain sense, be regarded as one portion of the fixed capital expended in our gigantic cotton manufacture.

The workers in cotton mills, with the arrangements for their protection, will be noticed in a later article. [Factories.] Some of the numerous processes to which cotton goods are subjected have been described in earlier portions of this work. [Bandana; Bleaching; Calendering; Calico Printing]; and another class of operations will be found noticed under Dyeing.