

C O T T O N.

COTTON, *v. n.* & *n. s.* } Fr. *coton*. Cotton
 Co'TTONY, or } is the down of the
 Co'TTONOUS, *adj.* } cotton tree; the
 cloth made from that down. See the following
 article and GOSSIPIUM. To cotton means to rise
 with a nap; and, in familiar speech, to agree
 well with. Cottonous and cottony are, like cot-
 ton, full of cotton.

The pin ought to be as thick as a rowling-pin, and
 covered with *cotton*, that its hardness may not be of-
 fensive. *Wiseman.*

A quarrel will end in one of you being turned off,
 in which case it will not be easy to *cotton* with another.

Round, and round, and round they go: Mundell-
 sox, that drives his *cotton-mill*, is their exact proto-
 type—without an idea or wish beyond their circle;
 fat, sleek, stupid, patient, quiet, and contented. *Burns.*

So Arkwright taught from *cotton* pods to cull
 And stretch in lines the vegetable wool;
 With teeth of steel its fibre knots unfurled,
 And with its silver tissue clothed the world. *Darwin.*

COTTON. In our examination of this impor-
 tant subject, we shall, in the first instance, briefly
 notice its botanical character, and then proceed
 to a practical examination of its general proper-
 ties and usefulness as an article of commerce.

The plant, or tree, that produces this important
 material, appears to be generally indigenous in
 the tropical regions. In the Linnæan classifica-
 tion of plants it is denominated *gossypium*, a
 genus of the class monadelphia; order polyan-
 dria; CAL. double; and of which there are ten
 species. It seems to have been unknown in Eu-
 rope till a comparatively recent period, none of
 the Latin vocabularies giving any definition of
 its nature or properties. It is adverted to by
 Herodotus, as growing in India. It was found
 in Mexico and in Peru at the time of the Spanish
 invasion, and its manufacture among the Peru-
 vians was carried on to some extent.

The generality of the native West India spe-
 cies of the plant are annuals; whilst those of
 Asia are perennial, both in root and branch,
 rising in a straight line about eight feet high,
 with leaves in five palmate lobes; but the
 plants chiefly propagated are of the herbaceous
 species. The origin and progress of its culture
 in Asia is involved in great obscurity; but it
 was, doubtless, coeval with the origin of those
 ancient dynasties which excited the cupidity of
 Alexander of Macedon, and its manufacture pro-
 gressively extended from the Indus to Cape
 Comorin.

Pliny describes the cotton-shrub as growing
 in the higher parts of Egypt, and 'of which,' he
 says, 'the Egyptian priests were wont to have
 surplices made, in which they took a singular
 delight.' He also tells us, that vestments of
 cotton were worn by the ancient Egyptians, and
 that too, more than a thousand years before the
 commencement of the Christian era. Moses
 speaks of robes of linen, and commands his
 people 'not to wear a garment of divers sorts,

as of woollen and linen together.' The dress of
 the ancient Babylonians consisted of a tunic of
 lawn, which they wore next to their skin. It
 descended, in the eastern mode, to their feet,
 and the Athenians wore long robes of fine
 cotton.

Three species of cotton are cultivated in
 Malta; one natural to the country, another
 from Siam, and the third of a cinnamon color,
 called Antilles cotton. These are all sown in the
 month of April, and the top of the plant is cut
 in the beginning of September, that the fruit
 may increase in size. It is gathered in October,
 when it begins to open, which is a sign that it is
 then sufficiently ripe. It is sown in the follow-
 ing manner: a hole, some inches deep, is made
 in the ground, which is afterwards filled with
 water, and when it is sufficiently soaked, the
 seed is put into it, and covered over, without
 being watered again until it begins to shoot out
 of the ground. The plant, when in perfection,
 grows to the height of from ten to fifteen in-
 ches, and blooms in the month of August.

In the year 1790 the planters, in the southern
 States of America, began to turn their attention
 to the raising of cotton-wool; and, besides car-
 rying the cultivation of the article to a great
 extent, they produced qualities of cotton before
 unknown. In the year 1792 the quantity of
 cotton exported from the United States was only
 138,328 pounds. At present, the annual export
 is supposed to be not less than 60,000,000 of
 pounds, and the amount is yearly increasing.

The American cotton-wool first brought to
 this country was very ill cleaned; and, in con-
 sequence, was for some time indiscriminately
 applied to the manufacture of the coarser spe-
 cies of goods. It was soon, however, perceived,
 that the cotton grown upon the coast, termed
 Sea Island cotton, had a finer and longer staple
 than that grown farther back in the country, and
 known by the name of upland cotton. But it
 was not for several years, and after a succession
 of trials, that this wool was ascertained to be of
 a quality, in every respect, superior to the cotton
 of the Isle of Bourbon. Indeed, it was not be-
 fore the year 1796, that the finest description of
 it was applied to the purposes for which Bourbon
 wool had till then been used, and which it soon
 entirely supplanted; the second quality of it, in
 like manner, supplanting the Brasil wool in
 many kinds of goods for which it had been em-
 ployed.

The upland cotton is a different species from
 the Sea Island, and is separated with such diffi-
 culty from the seed, that the expense of cleaning
 this wool must have put a stop to its farther cul-
 tivation, had not Mr. Whitney, a gentleman of
 the State of Massachusetts, in the year 1795, in-
 vented a machine by which the operation could
 be easily and successfully accomplished. There
 are two qualities of this cotton, the one termed
 upland Georgia, grown in the States of Georgia
 and South Carolina, and the other, a superior

quality, raised upon the banks of the Mississippi, and distinguished in the market by the name of New Orleans cotton. There was at first a strong prejudice against this wool; it was supposed that it was of an inferior quality, and did not receive a good color in dyeing; but being found suitable to different coarse fabrics, its cultivation was so rapidly extended, that, in the year 1807, 55,018,448 lbs. of upland cotton were exported from the United States.

Previous to the extended culture in North America, a very considerable portion of the annual supply was derived from Smyrna—say 6,000,000 to 7,000,000 lbs. The culture in Asia Minor, as well as Macedon and other parts of Turkey in Europe, is still considerable, but consumed chiefly for domestic purposes, and in the eastern parts of Europe; but the little that is now brought to England is used chiefly for candle-wicks. The quality cultivated in Egypt is good, and may be regarded as a new and important feature, should the career of the present enterprising pacha remain uninterrupted for a few years. In addition to the several kinds or growths already enumerated, the Isle of Bourbon, in the Indian Ocean, produces a very superior kind, limited in quantity, but equal in value, though somewhat different, to the American. It is probable also, from the delicacy of some of their fabrics, that a very superior kind is produced in India to any that is imported thence. China also, it is believed, produces a sort peculiar to itself, from which the nankeen cloths are supposed to be made.

But neither the extent of its growth in America, nor of its manufacture in England, is so much an object of surprise, as the very short period in which both have been accomplished. In point of extent, the comparison with the growth and manufacture of India, could it be ascertained, would probably be found trifling; the export of the raw material from Bengal and Bombay, in 1818, exceeded 600,000 bales, chiefly to China, or about 230,000,000 to 240,000,000 of lbs., whilst the internal consumption probably equalled, if not exceeded, that quantity.

It should be noticed, however, that the culture in the West Indies has not decreased in proportion to the apparent decrease of importation. It is true that the culture is very limited there, and the greater portion included under that head is from Demerara; it might also be inferred, from Portugal being included with the Brasils, that some plants are cultivated in Portugal, which is not the case; under the colonial regime the whole of the produce of the Brasils was carried to Portugal, and from thence re-exported: at the present time, however, nearly the whole growth comes direct to England from the Brasils; a comparatively trifling proportion goes direct to France and other parts of Europe. France is, however, the only other part of Europe where the spinning of cotton is carried on to any extent, being in that country about one-third what it is in England, with this difference, however, that whilst England indicates an increase, France indicates a decrease; the number of bags in France, in 1822, having been 190,000,

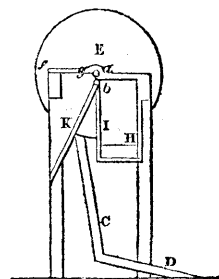
and only 166,000 in 1823; whilst the quantity in England, in 1822, was 541,000 bags, and 576,000 in 1823; the quantity spun in all the rest of Europe, collectively, not amounting to 60,000 bags.

Till within these few years the finest cotton, that was brought from India and the Isle of Bourbon, was comparatively of no use in England. Owing to its extreme delicacy and peculiarity of fibre, the carding engines then in use could not be brought to work it into a state fit for spinning. But the late improvements in that series of machinery which spinners call 'the preparation,' have obviated this difficulty, and, by enabling us to spin that cotton to the degree of fineness of which it is susceptible, have rendered our manufacture the wonder and envy of our rivals.

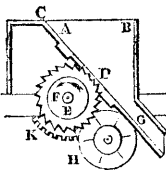
We shall now, however, proceed to our examination of the earliest stages of its manufacture.

The cotton, when collected from the pod, contains the seed, and pieces of the husk by which it was enveloped attached to it; it has, therefore, preparatory to being subjected to the operation of spinning, to undergo a process that will divest it of these superfluous parts. The ancient mode of effecting this was by what is termed bowing it; that is, exposing it to the action of a bow, about four feet long, such as is used at the present day by hatters. The process consisted merely in placing the cotton upon a square table, with horizontal crevices cut through it, and submitting it to the repeated action of the bow, until the dust, seeds, and superfluous parts had separated and fallen through the openings. This inconvenient and desultory mode has in modern times been superseded by a far more effectual and expeditious one, by the application of a machine called a *gin*. Gins are of two kinds, the one called the roller-gin, the other the saw-gin.

The *roller-gin* is represented in the annexed diagram. It consists of two shallow fluted rollers, *a* and *b*, placed so near to each other, that when the cotton is thrust against the line where they enter into contact, they immediately seize hold of it and draw it in between them, while the seeds and other particles, not being able to pass through, fall into the box *K*, and are, by the slanting direction of its bottom, delivered on one side. The motion is communicated by means of the treadle and crank, *C D*, and is equalised by the fly-wheel *E*. The cotton is presented to the rollers over the board *f g*, and is drawn between them, and delivered at *I, H*. In South America this kind of gin is much used, and a negro working with one of them can clean from 30 lbs. to 40 lbs. weight of cotton per day, which, however, is considered heavy work.

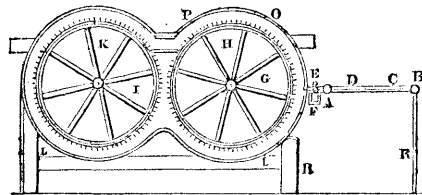


The *saw-gin* is given in section in the annexed figure. The cotton is thrown into the receptacle A B, on that side marked C D, which is formed of strong wires placed parallel to each other, to admit the circular saws E, fixed on the axis F, behind the



grating, about an eighth of an inch apart, to pass between them. By this means, the teeth of the saws seize hold of the cotton, and draw it through the bars; and the seeds and other superfluous parts being too bulky to pass through, remain behind, and eventually fall through the aperture G. The cotton is brushed from the saws by a circular brush H, made to revolve rapidly on its axis. The motion is communicated by manual, or any other power applied to the axis F, upon one end of which is the wheel K, acting in a pinion, fixed to one end of the axis of the brush. When the cotton arrives in this country, it is again submitted to the action of machinery, for the further separation of the extraneous matter, unless it is to be spun into coarse yarn.

The first process the cotton undergoes in this country, is effected by means of an instrument called a *picker*; as represented in the annexed diagram:—



A and B are two rollers, having an endless cloth C D, stretched over them. This cloth is called the feeding-cloth, and its upper surface is, by the revolution of the rollers, always carried towards D. E and F are two fluted rollers, which nearly touch each other, and revolve, so that their touching surfaces pass towards G H. G H I K are cylinders, covered on their outer surfaces with long blunt pins, making about 250 revolutions, in the direction of the letters, per minute. L L is a grating of wires for the seeds to fall through, when the cotton carried by the feeding-cloth is delivered by the small rollers upon the face of G H. By the rapid revolution of G H, the cotton is thrown against the top O P, and is carried forward and delivered upon the cylinder I K, which in like manner carries it rapidly round, draws it over the grating, and delivers it back upon the lower face of G H, which after having drawn it over the remainder of the grating, and divested it of the remainder of the seeds and particles of dust, deposits it in the box R R.

This machine is liable to injure the staple of the cotton, and is therefore superseded by another called a *batter*, represented in fig. 1, plate I, COTTON MANUFACTURE. In this machine, the feeding-cloth upon the rollers A and B carries

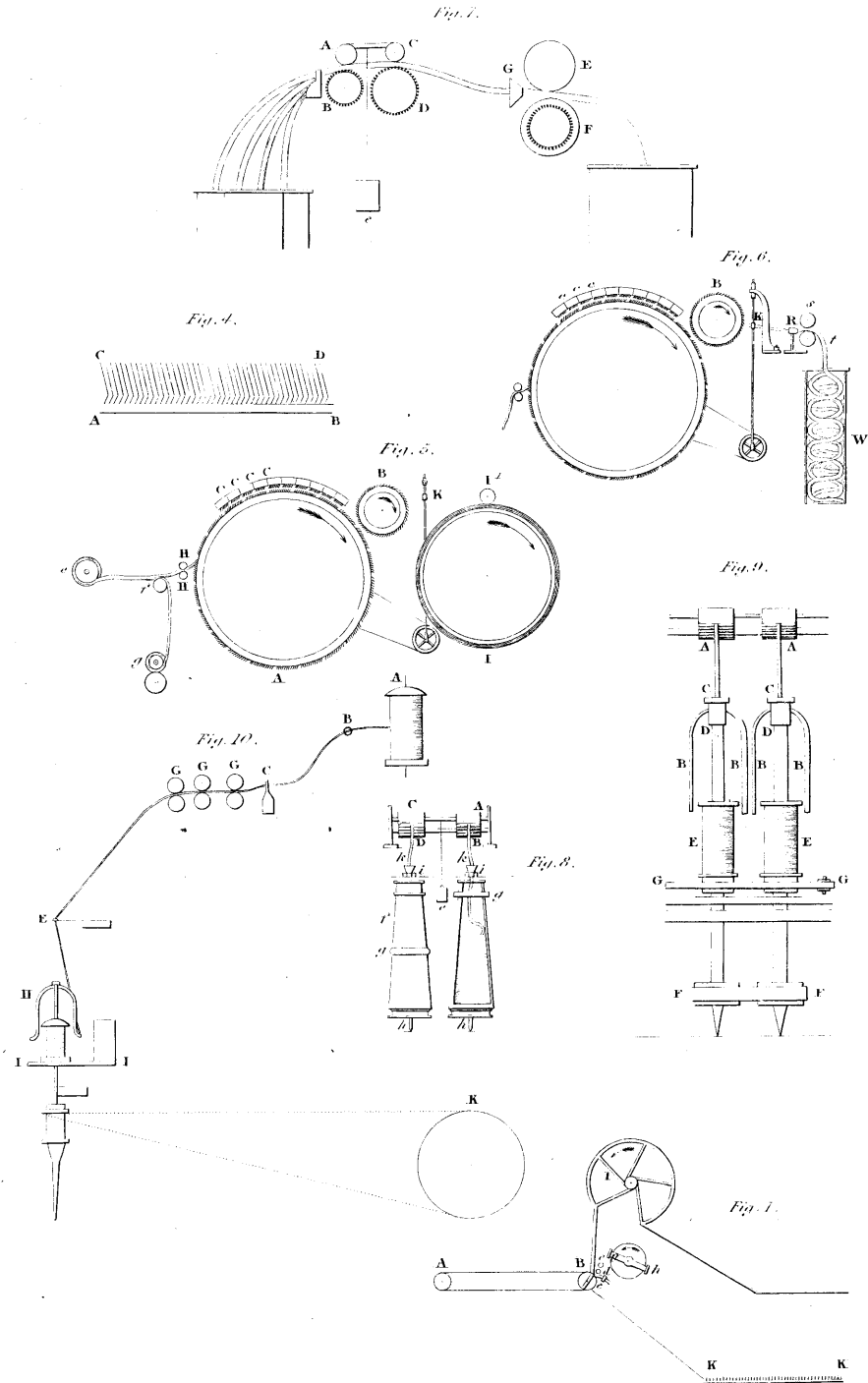
forward the cotton to the rollers c and e, which deliver it upon the curved rack or grating d e, while a scotcher g h, revolving rapidly on its axis, strikes the cotton with its two edges g and h, and divides it; at the same time a draught of air, created by the revolution of the fan I, blows the cotton forward over the grating K K, divests it of the superfluous parts, and ultimately deposits it in a box at the end.

Having thus described the process of *batting*, we may now furnish a brief outline of the manipulations through which the material passes, and then examine the engines in detail.

Carding is that operation in which the first rudiments of the thread are formed. It is performed by cylinders covered with wire cards, revolving with considerable swiftness in opposite directions, nearly in contact with each other, or under a kind of dome or covering, the under surface of which is covered with similar cards, whose teeth are inclined in a direction opposite to those of the cylinders. By this means the separation of almost every individual fibre is effected, every little knotty or entangled part disengaged, and the cotton spread lightly and evenly over the whole surface of the last, or finishing cylinder.

For jenny-spinning, which is still in use for the coarser kinds of thread, the cardings are stripped off in separate lengths. The finishing cylinder is covered with the ordinary cards, nailed on in stripes across, and the cotton contained between the margins or intervals of each stripe, forms one carding, whose length of course depends on the width of the engine, or cylinder. When stripped off by the crank and comb, it forms a loose and shapeless film, which falling on the surface of a plain wooden cylinder, the lower half of which revolves within a hollow shell or casing, the cotton in its passage is rolled up and delivered at the other side in perfect and cylindrical cardings. For mule or water-spinning, the finishing cylinder is covered with spiral, or fillet-cards; and the cotton being taken off in one continued fleece, and contracted by passing through the funnel and rollers, forms one endless and perpetual carding, which is interrupted only, or broken, when the tin can that receives it is completely filled. In the jenny-carding, the fibres of the cotton are disposed across, or at right angles to the axis of the carding; in the perpetual carding they are disposed longitudinally, or in the direction of its length, and it is this circumstance which renders the carding destined for mule or water-spinning, inapplicable to the jenny, and vice versa.

Drawing and doubling is one of the preparatory processes for which we are indebted wholly to Sir Richard Arkwright, and belongs exclusively to the mule, or water-spinning. The doubling, or passing three or four cardings at once through a system of rollers, by which they are made to coalesce, is intended to correct any inequalities in the thickness of the cardings, and also to admit of their being frequently drawn out or extended, by passing through the rollers. The effect of this frequent drawing is to dispose the fibres of the cotton longitudinally, and in the most perfect state of parallelism. The operation of carding effects this in a certain degree; yet the fibres,



J. Slury, sculp.

though parallel, are not straight, but doubled, as may easily be supposed from the teeth of the cards catching the fibres sometimes in the middle, which become hooked or fastened upon them. Their disposition is also farther disturbed by the taker-off, or comb, which strips them from the finishing cylinder; and though the general arrangement of the fibres of a carding is longitudinal, yet they are doubled, bent, and interlaced in such a way, as to render the operation we are now speaking of absolutely necessary. When the cardings have been passed four or five times through the drawing-frame, every fibre is stretched out at full length, and disposed in the most even and regular direction; and though the average length of a fibre of cotton is not two inches, yet the finished drawing, as these prepared cardings are now termed, has all the appearance of a lock of Jersey wool, whose fibres, six or eight times as long as those of cotton, have been carefully and smoothly combed.

Roving is that operation by which the prepared cotton, as it comes from the carding-engine, or drawing-frame, is twisted into a loose and thick thread, and wound upon a spindle or bobbin. In mule, or twist-spinning, the prepared carding or drawing, as it is termed, is again passed through a system of rollers, and is twisted, either by a rapidly revolving can, into which it is delivered from the rollers, or by a fly and spindle similar to those of the flax-wheel; in the latter case it is wound on the bobbin by the machine; in the former it is received in the conical can in which it acquires the twist, and is afterwards wound upon bobbins by children. Sir Richard Arkwright always employed the revolving can, and it is still employed in many of the first mills in the country. The roving-frame, with fly and spindle, which is in fact nothing more than the twist-frame of Sir Richard, is now however very generally in use, especially since later improvements have removed objections to the machine, which rendered its use previously inconvenient. The operations through which the thread passes after it has received the first twist are various, and depend greatly on the use it is intended for. The finer it is required, the oftener it is drawn out and twisted, till by degrees, as in the process of wire-drawing, it is brought down to the fineness required. The rovings are therefore distinguished into first, second, and third, according to the number of operations they have gone through.

Spinning is the last operation which the thread undergoes in the series of processes employed in converting it into thread, and is that in which it receives the final extension and twisting.

Carding, as we have already stated, is performed by two kinds of engines, one of which is called the breaker, and operates upon the cotton preparatory to its being submitted to the operation of the other, called the finisher. A card is a kind of brush, formed by making wires into the form of staples, as represented in fig. 4. The two legs of the staples are placed through holes in a flexible piece of leather, and present, in the side view a form similar to that shown in the figure, where A B is the leather, and C D the wires forced through it. Cards are formed in

two ways; the one called sheet-card is made about four inches wide, and eighteen inches long, or of a length corresponding with the width of the main cylinder, which they have to cover; the other, called fillet-card, is made in one continuous band or fillet, and is used for covering the doffer cylinder. The teeth of the fillet-card are placed pointing in the direction of the length of the fillet, and completely cover the cylinder to which they are applied; whereas in sheet-cards a space is left behind every sheet.

Fig. 5 represents a sectional view of the immediate working parts of a breaker carding-engine. A is the main cylinder, covered with sheet-cards; B the doffer cylinder, covered with fillet-cards; C C C are the tops; *e g* is the feeding cloth supplied with cotton, which has been previously weighed, moving forward over the roller *f*, by means of the roller *g*, and delivering the cotton between the feeding-rollers H H, which carry it to the main cylinder. The main cylinder revolves rapidly in the direction of the dart, and carries the cotton upward between itself and the tops, which are covered with sheet-cards, about one inch and three-quarters to two inches wide, so that they may, as nearly as possible, follow the curve of the main cylinder. I is the lapping-cylinder, having wooden rollers I I, lying upon its upper surface; and K is the doffer, or taker-off, having attached to it the steel comb called the doffing-plate.

The main cylinder, by its revolving motion, is soon covered with cotton, and is divested of it by the doffer-cylinder, which is placed so as nearly to touch it, and which moves at a much slower speed, in the direction of the dart. The effect of this engine would therefore be to distribute the cotton equally over the main cylinder, the top cards, and the doffer cylinder; but the doffing-plate, by the action already described, is continually clearing the doffer cylinder, whose points are consequently left bare to receive a fresh supply from the main cylinder. The doffing-plate continually strips the doffer cylinder of the carded cotton, which it delivers upon the lapping cylinder in one continuous web of about eighteen inches wide, which is the usual width of the engines for fine work. When the top cards are covered with cotton, an attendant is appointed to take them off, and to divest them of the loose cotton by means of a card nailed on a board, which he carries in his hand for that purpose. The quantity of work delivered to the engine is ruled by the speed of the cylinders, and quality of the cotton. When it has passed through the engine, and is wound upon the lapping cylinder (which is so adjusted as to contain about twenty laps), the attendant lifts up the large roller, makes a division in the circular web, and takes it off the roller. In this operation we are presented with the first act of plying or doubling, which is introduced in the process of spinning, in order to obtain equality in the strength and thickness of the yarn.

The cotton is in this state called a lap, and is immediately taken to a finisher-engine, which, in general, is disposed back to front, immediately after the breaker-engine, as may be seen in fig. 6. The construction of the finisher-engine is

exactly similar to that of the breaker-engine, except that instead of having a lapping cylinder, the cotton, when it leaves the doffer, is drawn through a mouth-piece R, formed like the end of a trumpet, by means of the rollers *s* and *t*, and is delivered into the can W. The rollers *s* and *t* are seen in section in this figure. Previously, however, to leaving this process, we shall make a few remarks, as it is, with much propriety, considered the very foundation of all good spinning. The breaker-engine for spinning fine cotton is generally covered with cards of a fineness that will admit 225 teeth, or 450 points in a square inch; and the finisher 275, or 550. But spinners are much divided on this subject, and in some mills the same work is performed with cards one-fifth coarser than it is in others. The top cards are in general one-tenth coarser, and those of the doffer cylinder one-tenth finer than those on the main cylinder: and in some manufactories, at the back part of the engines, where the cotton first arrives, coarser top-cards have been introduced, with a view of divesting the cotton of the largest particles of extraneous matter, and in some instances have been again laid aside as superfluous. Cards must be set easy in the leather, which should be thin and strong. The card-engine is driven by a strap passing from a drum over a fast and loose pulley, fixed on the shaft of the main cylinder.

The cotton having been transferred to the can from the card-engines, in the form of a *sliver*, is next submitted to the process of drawing, represented in fig. 7. In this process three or four card-ends are brought in tin cans, and passed between the rollers A B and C D, which revolve with different velocities; that is, the rollers C and D revolve much quicker than A B, and the top rollers A and C are made to press upon B and D, by means of the weight *e*. Now, supposing four slivers to be placed together, and passed through the rollers A B and C D, and that C D revolve so much quicker than A B, that the sliver will become four times its original length, the cotton will, by such elongation, be reduced in thickness three-fourths, that is, to the same thickness as the single sliver when first brought to the rollers. By this process the fibres of the cotton are laid more parallel to each other, in the direction of the length of the sliver, and the operation is repeated by plying the slivers which have passed the rollers, and passing them through a similar set. The sliver, when thus plied and reduced, is drawn through the mouth-piece G, by the rollers E and F, and delivered into another can. After the cotton has been plied and drawn as many times as the spinner, from the quality of the cotton, and the intended quality of the yarn, considers necessary, it is carried to the roving-frame.

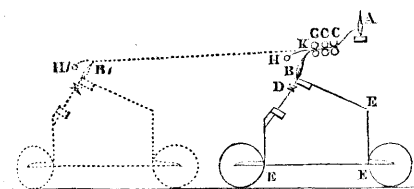
This ingenious piece of apparatus, which is much used in mills where mule-spinning is carried on, is represented in fig. 8, and is termed the *can roving-frame*. A B, are two rollers, moving at a slower speed than C D; A and C, are pressed upon the rollers B and D, by the weight E, as may be seen in the accompanying section.



The cans are represented, the one shut and the other open; the latter opens by means of hinges, after raising the ring *g*. The cans are capable of revolving upon their spindles *h h*, and are supported in an upright position by the collars *i i*, and have at their upper extremities funnel-shaped pieces, *k k*. If two slivers of cotton are brought from the drawing-frame, and passed between the rollers A B, and C D, the processes of plying and drawing will again take place; and the rollers C D, will feed the end thus introduced into the can through the mouth-piece *k*, which, by revolving rapidly upon its axis, will impart to the end, or sliver, a slight degree of twist. When the can is filled, the rollers are thrown out of gear, and the motion ceases; the can is then opened, and the cotton, or as it is now called, the roving, is taken out and wound upon a bobbin, and in that state is carried to a machine called a stretcher. Some objections exist against this species of roving; first, from the necessity of taking the roving out of the can for the purpose of winding it upon a bobbin, during which it is liable to sustain much damage from the fibres being in a very slight state of adhesion; and secondly, from the roving receiving its twist solely from the revolution of the can in which it rests, and by which the twist is not equally diffused over the whole length of the roving. The first objection was attempted to be obviated, by placing the can in a frame, and drawing the roving out through the mouth-piece at which it entered; and a remedy for the second was somewhat unsuccessfully attempted by Mr. Arkwright, who tried to introduce a pair of rollers upon the top of the roving-can, to seize hold of, and feed the roving into the can as fast as it was received from the drawing-rollers. This, undoubtedly, would have perfectly equalised the twist throughout; but the machinery necessary to produce the double rotatory motion was found to be inconvenient, and the plan was in consequence abandoned.

A roving-frame of a different construction, which obviates the preceding objections, and which in consequence, has received more general adoption, is represented at fig. 9. It is called the *bobbin and flier roving-frame*. The rollers for stretching are similar to those before described; and the plied and drawn roving is represented as coming from the rollers at A, whence it passes through an eye at C, over the top of the spindle D, and down one of the legs of the flier B B, which is for that purpose formed tubular. By the revolution of the spindle D, generated by a strap acting upon the pulley F, the fliers are carried swiftly round, and twist and deliver the thread upon the bobbin E, which is moved upwards upon the spindle by raising the board G G, upon which it rests, descending again as the board descends. The roving is, by this means, slightly twisted and wound upon a bobbin, in a fit state to be immediately carried to the stretching-frame, which, being very similar in its construction to the mule, we consider it necessary only to give a side view of one of the spindles of a mule.

It is shown in the annexed figure. A, is the place where the bobbin from the roving-frame



(not shown in this figure), would have been situate; and *ccc*, are three pairs of rollers, revolving at different speeds, for the future drawing of the roving. The roving, when it has been thus drawn, is brought to the spindle *B*, which is formed of polished steel, ground slightly tapering to the end, which is a round blunt point. The spindle receives its motion at the pulley *D*, by means of a band passing round a drum in the box *E E E*; which drum has bands passing in the same manner to several other spindles. When the motion commences, the carriage *E E E*, passes backwards to the position shown by the dotted lines, and carries with it the spindles to the position *B l*, during which the spindle revolves rapidly on its axis, and gives a certain degree of twist to the roving, which already has undergone a reduction in diameter by passing through the rollers *C C C*. The extent to which the frame recedes is about three yards, and when the spindles have given the requisite degree of twist to the yarn, it returns to its former place; while the attendant, by moving the bar *H*, upon its axis, presses the yarn downwards, by means of a piece of wire *K*, which causes it to be wound upon the spindles, so as to form a figure that may be represented by two cones, one having a more acute angle than the other, placed base to base as shown at *A B*, and *B l*. This form is termed a *cop*, and the act of so distributing the yarn, by the movement of *H K*, the *building of the cop*. It may here be observed, that although this is called the stretching-frame, the yarn is not stretched, but merely undergoes a further process of drawing and spinning, and that the stretching is not performed till the next operation, which is performed upon the mule, and termed spinning.

The yarn, delivered from the stretching-frame in the form of a *cop*, is taken to the mule, which is, though much lighter, both in form and action of the parts, very similar to the stretching-frame. The spindles also are of a smaller size, and are situated nearer to each other. The *mule spinning-frame* differs from that of the stretching-frame, inasmuch as the act of stretching is added to the other operations; for when the frame *E E E*, (see diagram) has receded a certain distance, generally about one yard, the rollers *C C C*, cease to move, and the frame still continuing to recede, stretches the yarn. During this process the spindles on the frame *E E E*, move considerably quicker, in order to save time. The stretching is performed with a view to elongate and reduce those places in the yarn which have a greater diameter, and are less twisted than the other parts, so that the size and twist of the yarn may be more uniform throughout. When the *cops* are full, they are taken from the moving

spindles, and placed on stationary parts of other mules, as at *A*, and the yarn is again submitted to the same process until it is reduced and spun to the proper fineness, both as respects the diameter and the twist; during the whole of which process, the yarn can be continually joined, so that the *cops*, which are in separate pieces, can be added to each other in parts, or otherwise, as the continual elongation of the yarn in the course of the different operations of each mule may require. The pieces are joined by children, called *piecers*, who are in attendance on each mule, to join any yarn that may be broken in the act of stretching or twisting. The drums, which drive the spindles in those parts of the mule that recede, receive their motions from bands communicating with the moving power; but the advancement and recession of the carriage, for the purposes of receiving and stretching the yarn, as before described, is performed by means of a wheel moved by hand-labor. A spinner is enabled by experience to judge of and regulate both these operations, as also the building of the *cop*, which is a matter of very great nicety; for if the *cop* is not well built, the yarn will not run off even when it is to be used. The number of spindles on a mule amounts frequently to 300. The yarn produced by mule-spinning, being by far the most perfect, is employed in the fabrication of the finest articles, such as lace and hosiery; and when it is twisted in two, four, or six plies, is used for sewing-thread.

We may now briefly examine the process called *jenny-spinning*. This is of a much earlier date, and is on the whole a less perfect process than mule-spinning; consequently it is but little used, except in the manufacture of yarn for coarse goods. In this spinning, the cotton, after having been cleansed by some of the processes already described, is, preparatory to being exposed to the action of the *jenny*, immersed in a solution of soap and water, to divest it of the glutinous matter generally found on the surface of this and other vegetable fibres; it is then, after the soap and water has been pressed from it, put into a warm stove, and when dry is considered to be in a fit state to be exposed to the operation of the carding-engine. The carding-engine used in *jenny-spinning* is different in its construction to the one before described; for in mule and water spinning there is a breaker and a finisher engine; but the engine used in this process is called the double-engine; the first part, or breaker, is in the same frame with the second part, or finisher, and the doffer from the first part delivers the cotton upon the main cylinder of the second part, which, in like manner, delivers it upon the second doffer. The second doffer, instead of being covered with fillet-cards, as the doffer of the single engines, is covered with sheet-cards, like the main cylinder, but being of smaller dimensions, has generally only twelve cards upon it; therefore the web of cotton combed from such doffer by the doffing-plate is not in one continuous piece, but in several pieces or portions, equal to the quantity attached to each sheet-card upon the doffing cylinder. As the several small portions are delivered by the comb, they fall into the concave part of a smooth

arc that is equal to one-third of a circle. In this arc a cylinder of smooth mahogany slowly revolves in such direction that the lower surface in the arc passes from the engine. This cylinder has small cavities or flutes on its surface, in a parallel direction to its axis; the angles on the projections between the flutes are taken off, so that the several portions of web which fall from the doffer into the arc are seized by the flutes, and carried forward on the concave face of the arc, and formed into a sliver, about half an inch in diameter, and of a length corresponding with the breadth of the carding-engines, which is about from twenty-four to thirty-four inches. The portions thus rolled are called rows, rolls, or rowans.

In this state, the cotton may be considered in the same relative state of progress as a card-end in mule or water spinning; but it is evident that this mode of spinning is very deficient for the purposes of fine yarn, inasmuch as in the rowans the fibres of the cotton are laid across the longitudinal direction in which they are to be spun, so that the advantage derived in the other process of carding, from the fibres being placed in a direction parallel to the intended length of the yarn, is entirely lost. In this process, also, the advantage of plying, which we have noticed as taking place on the lapping cylinder is lost.

When the rowans are perfected by the mahogany cylinder, they are taken up by children, and placed upon the feeding-cloth of a machine called the *billy*, or *roving-billy*, the operation of which is called roving or slubbing; but the latter expression is now but seldom used, except in the manufacture of woollen. This machine is in its construction and action very similar to the mule, as is the feeding-cloth, to that described in the machine called the picker and batter.

The feeding-cloth lies in a slanting position, and the rowans are placed upon it so that they can pass lengthwise in the direction of its action, and be delivered over the upper roller between two pieces of board which possess a capability of claspings and again relieving them. The rowans are then attached to revolving spindles, which have an advancing and receding motion similar to the mule or drawing-frame. By this revolution and recession the spindles perform the operation of spinning and stretching; and at such intervals as the spindles are stretching and twisting, the feeding-cloth stops, and the clasps seize hold of the roving, and detain it till sufficiently spun and twisted, when it is relieved in order to allow a further portion of the rowan to be fed. The roving having by this means received a certain degree of twist, is built on the spindle in the form of a cop, as in mule-spinning, and is then taken to the machine called the *jenny*. The operation of the *jenny* is nearly the same as the *roving-billy*; the only material difference is, that the cops of roving to be spun are fixed upon a moving carriage, which has clasps to hold the roving while in the act of being stretched and spun into yarn.

Water-spinning differs both from the mule and jenny spinning; but the carding and drawing machines are the same as those used in the process of mule spinning. When the cotton has passed

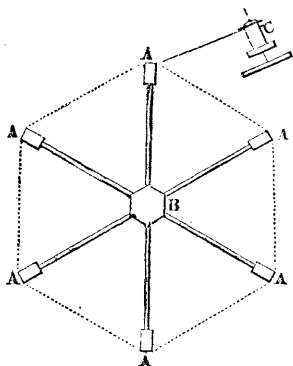
through the carding and drawing machines, it is carried to the spinning-frame, which is upon a different principle to the mule, and, indeed, is more closely allied to the bobbin and flier roving frame. One of the spindles is represented in the engraving, fig. 10. A, the bobbin, brought from the roving-frame; B C, and E, guides for the yarn to pass through; G G G, three pairs of rollers to perform the office of drawing; and H, a flier, formed solid, and having at the end of one arm a small twist like a cork-screw, through which the yarn passes. By the revolution of the flier the yarn receives the requisite degree of twist, and is wound upon the bobbin, which, by the movement of the seat II, on which it rests, has an upward and downward motion, in order that the yarn may be received upon it regularly. The guide D has a slow reciprocating motion in the direction of the axes of the rollers G G G, by which the roving is moved over the surfaces of the rollers, so that the parts wear uniformly.

In water twist-spinning, the operation of stretching is not introduced. The motion is transmitted from the first mover to the drawing and roving frames by means of bevel-wheels, placed on the end of the frame. These wheels communicate motion to the rollers, which have spur-wheels upon their shafts, adapted to give motion to each other by intermediate wheels which give to the lower rollers motion in the proper direction. The spindles receive their motion from bands communicating with the drum K, represented by the dotted lines. This construction of a water spinning-frame is called a *throstle*, and the difference which characterises it from that properly called the water-frame is, that the cylinder K runs through the whole length of the frame, and gives motion to all the spindles at once; whereas in the water-frame the spindles are moved by an upright pulley, communicating motion to only one set of six spindles, which is an advantage, as the motion of one set can be stopped without stopping the motion of the whole. But as the water-frame is far more expensive than the other, it is a matter of doubt which ought to be preferred.

The several sorts of yarn have each their peculiar destination. The yarn from mule and jenny spinning is taken from the frame in the form of a cop; that from water-twist is wound upon a bobbin. The yarn from water-frames possesses much regularity and strength, and is mostly used for the warps of heavy goods, such as fustians and strong calicoes. If the yarn has to be packed for the market, it is reeled upon a frame consisting of six horizontal bars, supported on an axis parallel to each other.

The frame is represented in the accompanying diagram, A A A A A A the horizontal bars, B the axis, and C the bobbin from the water-frame. The dotted lines represent the direction of the twist. These reels are of a sufficient breadth to wind off about fifty cops or bobbins, at the same time.

When the reel has made eighty revolutions, a small bell that is connected with the machinery rings, and warns the attendant to stop the motion of the reel. The portion thus wound is called a lay, and seven of these lays wound



upon the same reel constitute a hank, which is taken from the reel by causing one of the horizontal bars, supplied with a hinge, to fall inwards. The circumference of the reel is a yard and a half, consequently the hank measures 840 yards. The size of the twist is expressed by stating how many hanks go to the pound weight: thus, the yarn called No. 100, is that which takes 100 hanks 840 yards each to weigh an avoirdupois pound. Yarn can be spun upon mules as fine as 200 hanks to the pound; but in water-twist and jenny-spinning it seldom exceeds sixty or seventy.

The last operation that we shall have occasion to describe, is that of warping. The machine on which this is performed is an octagonal prism, five or six feet high, and somewhat less in diameter, revolving vertically, and put in motion by a band and pulley placed under the seat of the warper. The bobbins which furnish the thread are suspended horizontally in a frame on one side. Twenty-eight or thirty threads, forming together a system called a half beer, are wound round the prism in a spiral form from top to bottom. The machine is then turned the contrary way, and the thread wound round the prism upwards from bottom to top, and this is repeated backwards and forwards till a sufficient number of half beers have been wound to form a web of the breadth required. When finished, and the ends properly secured, the web is wound off, and coiled upon the hand into a round ball, called the warp. If the thread has been previously sized in the hank, it is now ready for the loom; but if the warp is made of cop twist, that operation is next performed. The warps are boiled several hours in water till they are thoroughly penetrated and softened; after draining some time they are then uncoiled and worked in the size till fully impregnated, after which the superfluous size is squeezed out, and they are suspended on poles to dry: the warp is then ready for the loom.

Without this operation of sizing, which, as we have before observed, gives strength and tenacity to the thread, it would not support the friction of the loom. Two threads are passed between each dent of the reed, and at each stroke of the treadle one ascends whilst the other descends. There is, therefore, a constant friction of the threads upon each other, as well as against the teeth of the reed. The motion of the reed itself

also backwards and forwards, and of the healds, up and down, is very severe upon the warp, and unless it has been well penetrated by the size, and its fibres well cemented or glued together, this continual rubbing is sufficient to destroy its texture. Good sizing prevents this, but it is still further aided by another operation called dressing, which is performed by the weaver himself after the warp has got into the loom.

This consists first in applying with a brush a kind of paste made of wheat-flour well boiled, to which is often added a small portion of common salt, sometimes of potash, and sometimes even a little tallow. It is in fact a repetition of the operation of sizing, with this difference, that the dressing is applied chiefly to the surface of the thread, which is slightly coated with the paste, and brushed uniformly in one direction from the healds to the beam, by which means the loose fibres are all disposed evenly one way and firmly glued fast to the thread.

In summer the warp is dried simply by fanning it, but in winter, and in damp cold weather, a hot iron is lightly passed over it. It is then dressed again with a brush dipped in tallow or butter, with which it is slightly greased. This gives suppleness and smoothness to the thread, and greatly diminishes the friction of the healds and reed. As such a portion of the warp as is extended between the healds and beam can alone be dressed at one time, this is woven, and the dressing repeated again upon another portion, and so on alternately dressing and weaving, till the whole of the web is finished.

Messrs. Ratcliffe and Ross dress the whole of the warp before it is wound upon the beam; the labor of the weaver is therefore uninterrupted, and his attention directed solely to one object. This alone is a great point gained, but it is attended also by other, not less important, advantages. Great part of the intellectual skill required in weaving, is in the dressing and beaming of the warp; the mere mechanical part of throwing the shuttle, &c. is soon acquired, even by a boy. A more accurate division of labor, by reducing the beaming and dressing to a system by which they are better, more economically, and more expeditiously performed than before, has removed the great difficulty in the art of weaving, and rendered it in a great measure the employment of children. From what we have already said, it will appear that the object in dressing and sizing is nearly the same, and Messrs. Ratcliffe and Ross, by an improved mode of dressing, have succeeded in reducing these operations to one. They have gone still further; they have done away with the necessity of warping, by forming the web at once from the bobbin, and thus reduced the warping, sizing, dressing, and beaming, to one operation. A thousand bobbins and upwards supply the materials for the warp, which in its progress is properly disposed and arranged, sized, dressed, and finally wound upon the beam. See WEAVING.

Messrs. Hall's experiments on the stoving of cotton goods with sulphur, are of a new character, and well worthy of notice. To stove goods in the most advantageous way, they should be

exposed to the vapor of burning sulphur in a moistened state. But they are then rendered less saleable by the appearance of the spots or iron-moulds. The object of the experiments about to be detailed, was at once to combine the good effects, with regard to the appearance and feel of the goods, resulting from stoving, and to obviate the appearance of the spots. The probable conclusion from these experiments is, that small portions of iron are derived from the sulphur, as held in solution in the sulphureous acid gas formed, and are at length deposited in distinct nuclei on the goods exposed to its action, so as to form the spots above mentioned. With the view of preventing this formation of spots, the following experiments were made:—

The clearest and purest sulphur of commerce, called virgin sulphur, &c. was first employed. The spots produced were less numerous than those occasioned by the common kinds of sulphur; but the benefit was partial and inconsiderable only. Flowers of sulphur were then taken and sublimed to the third time; but still the experiment yielded no results of a decisive character. Sulphur precipitated from the alkaline and earthy sulphurets by means of pure acids, still induced the same appearance of spots as before. The same thing may be observed of sulphur purified by means of phosphorus; the phosphorus was first united under water with the sulphur, and then converted into phosphoric acid by continued boiling; much ferruginous matter was separated, and this experiment seemed to promise success; but the result, although the most favorable of all, was far from being perfect. Sulphurous acid gas, produced by the decomposition of sulphuric acid, by means of charcoal and of mercury, still induced the spots, in the same manner as when it resulted from the combustion of sulphur. Sulphurous acid gas expelled from the sulphates of the alkalis or earths, produced the same appearance of spots as before. Sulphurous acid gas passed through acids still retained the same property of spotting.

The usual mode of stoving, consists in burning sulphur in a close chamber, in which the goods to be stoved are hung. Beside this mode of experiments, many trials were made by exposing a little of the material of the goods to the action of the sulphurous acid in a glass jar, containing about six or eight pints of the gas. The cotton, in these experiments, was moistened with a decoction of galls. Rather more than the requisite quantity of sulphur was placed on a bit of tile, brought to a red heat, and placed within the jar. At first the sulphur burnt with its usual blue flame, but at length the flame became extinguished, and the sulphur was seen to sublime, the oxygen of the air being exhausted. After the cotton had remained about an hour exposed to the sulphurous acid gas, it was taken out free from spots; but the spots gradually began to make their appearance during an exposure to the air of about five or ten minutes.

The mode of bleaching cotton in Suabia is worth notice, especially as it is peculiar to that country. This operation is performed in two days, and does not require extensive premises.

An alkaline caustic lee is prepared, by taking two measures of quick-lime, and covering them with ten measures of good ashes; the heap is then to be sprinkled with water, and when the lime is slaked and the mass cooled, it is fit for making the lee, by the addition of cold soft water. The skeins of cotton, being untwisted and tied in parcels, are to be immersed in the lee, in which they are to be left six hours, and to be occasionally turned. They are then to be washed in a river, and afterwards boiled twelve hours in a bath of the same kind of lee, in which, for every sixty-six pounds of cotton thread, six pounds of soap have been dissolved. They are then to be boiled the same length of time in a solution of soap and water only, according to the former proportion; after which, they are to be again washed in the river, and hung up in the air, or laid on the grass to dry as quick as possible. The process for the hosiery is similar. The boiler must be made of copper, and always well cleaned after it has been used.

The manufacture of *Bandanas* has now become a very important branch of our cotton trade; and we cannot do better than furnish our readers with an account of the great *Bandana* gallery of Messrs. Monteith and Co. at Glasgow. This establishment has been long celebrated in the commercial world for the excellence and beauty of its cotton fabrics. Their madder-reds rival in brilliancy and solidity any ever produced at Adrianople; and the white figures distributed over the cloth, surpass, in purity, elegance, and precision of outline, the original *Bandana* designs.

Their new arrangement of hydrostatic presses was completed in 1818, under the direction of Mr. George Ridger, sen., manager of the works. It consists of sixteen of these engines beautifully constructed, placed in one range in subdivisions of four; the spaces between each set serving as passages to admit the workmen readily to the back of the press. Each subdivision occupies twenty-five feet; whence the total length of the apparatus is 100 feet. To each press is attached a pair of patterns in lead (or plates, as they are called,) the manner of forming which will be described in the sequel. One of these plates is fixed to the upper block of the press. This block is so contrived that it turns on a kind of universal joint, which enables this plate to apply more exactly to the under plate. The latter rests on the moveable part of the press, commonly called the sill. When this is forced up, the two patterns close on each other very nicely, by means of guide-pins at the corners, fitted with the utmost care. The power which impels this great hydrostatic range, is placed in a separate apartment, called the machinery-room. This machinery consists of two cylinders of a peculiar construction, having cylindric pistons accurately fitted to them. To each of these cylinders three little force-pumps, worked by a steam engine, are connected. The piston of the larger cylinder is eight inches in diameter, and is loaded with a top-weight of five tons. This piston can be made to rise about two feet through a leather stuffing or collar. The other cylinder has a piston of only one inch in diameter, which

is also loaded with a top-weight of five tons. It is capable, like the other, of being raised two feet through its collar. Supposing the pistons to be at their lowest point, four of the six small force-pumps are put in action by the steam engine, two of them to raise the large piston, and two the little one. In a short time, so much water is injected into the cylinders, that the loaded pistons have arrived at their highest points. They are now ready for working the hydrostatic discharge presses, the water pressure being conveyed from the one apartment to the other under ground, through strong copper tubes of small caliber.

Two valves are attached to each press, one opening a communication between the large prime-cylinder and the cylinder of the press, the other between the small prime-cylinder and the press. The function of the first is simply to lift the under-block of the press into contact with the upper-block; that of the second is to give the requisite compression to the cloth. A third valve is attached to the press, for the purpose of discharging the water from its cylinder, when the press is to be relaxed, in order to remove or draw through the cloth. From twelve to fourteen pieces of cloth, previously dyed Turkey red, are stretched over each other, as parallel as possible, by a particular machine. These parallel layers are then rolled round a wooden cylinder, called by the workmen a drum. This cylinder is now placed in its proper situation at the back of the press. A portion of the fourteen layers of cloth, equal to the area of the plates, is next drawn through between them by hooks attached to the two corners of the webs. On opening the valve connected with the eight-inch prime-cylinder, the water enters the cylinder of the press, and instantly lifts its lower block, so as to apply the under plate with its cloth close to the upper one. This valve is then shut, and the other is opened. The pressure of five tons in the one inch prime-cylinder is now brought to bear on the piston of the press, which is eight inches in diameter. The effective force here, will therefore be 5 tons $\times 8^2 = 320$ tons; the areas of cylinders being to each other, as the squares of their respective diameters. The cloth is, therefore, condensed between the leaden pattern-plates, with a pressure of 320 tons.

The next step, is to admit the blanching or discharging liquor (aqueous chlorine, obtained by adding sulphuric acid to solution of chloride of lime,) to the cloth. This liquor is contained in a large cistern, in an adjoining house, from which it is run at pleasure into small lead cisterns attached to the presses, which cisterns have graduated index tubes, for regulating the quantity of liquor according to the pattern of discharge. The stop-cocks on the pipes and cisterns containing this liquor, are all made of glass. From the measure-cistern, the liquor is allowed to flow into the hollows in the upper lead-plate, whence it descends on the cloth, and percolates through it, extracting in its passage the Turkey red dye. The liquor is finally conveyed into the waste pipe, from a groove in the under block. As soon as the chlorine liquor has passed through, water is admitted in a similar manner, to wash

away the chlorine, otherwise on relaxing the pressure, the outline of the figure discharged would become ragged. The passage of the discharge liquor, as well as of the water through the cloth, is occasionally aided by a pneumatic apparatus or blowing machine; consisting of a large gasometer, from which air, subjected to a moderate pressure, may be allowed to issue, and act in the direction of the liquids, in the folds of the cloth. By an occasional twist of the air stop-cock, the workman also can ensure the equal distribution of the discharging liquor, over the whole excavations in the upper plate. When the demand for goods is pressing, the air apparatus is much employed, as it enables the workman to double his product.

The time requisite for completing the discharging process in the first press, is sufficient to enable the other three workmen to put the remaining fifteen presses in play. The discharger proceeds now from press to press, admits the liquor, the air, and the water; and is followed, at a proper interval, by the assistants, who relax the press, move forwards another square of the cloth, and then restore the pressure. Whenever the sixteenth press has been liquored, &c., it is time to open the first press. In this routine, about ten minutes are employed; that is, 224 handkerchiefs (16×14), are discharged in ten minutes. The whole cloth is drawn successively forward, to be successively treated in the above method. When the cloth escapes from the press, it is passed between two rollers in front, from which it falls into a trough of water placed below. It is finally carried off to the washing and bleaching departments, where the lustre of both the white and the red is considerably brightened. By the above arrangement of presses, 1600 pieces, consisting of 12 yards each $= 19,200$ yards, are converted into Bandanas in the space of ten hours, by the labor of four workmen.

The patterns, or plates, which are put into the presses to determine the white figures on the cloth, are made of lead, in the following way:— a trellis-frame, of cast-iron, one inch thick, with turned-up edges, forming a trough rather larger than the intended lead pattern, is used as the solid ground-work. Into this trough, a lead plate, about half an inch thick, is firmly put by screw-nails passing up from below. To the edges of this lead plate, the borders of the piece of sheet-lead are soldered, which covers the whole outer surface of the iron frame. Thus, a strong trough is formed, one inch deep. The upright border gives at once great strength to the plate, and serves to confine the liquor. A thin sheet of lead is now laid on the thick lead plate, in the manner of a veneer on toilette-tables, and is soldered to it, round the edges. Both sheets must be made very smooth beforehand, by hammering them on a smooth stone table, and then finishing with a plane; the surface of the thin sheet, now attached, is to be covered with drawing-paper pasted on, and upon this the pattern is drawn. It is now ready for the cutter. The first thing which he does, is to fix down, with brass pins, all the parts of the pattern which are to be left solid. He now proceeds with the little tools generally used by block-cutters, which

are fitted to the different curvatures of the pattern, and he cuts perpendicularly quite through the thin sheet. The pieces thus detached are easily lifted out; and, thus the channels are formed, which design the white figures on the red cloth. At the bottom of the channels, a sufficient number of small perforations are made through the thicker sheet of lead, so that the discharging liquor may have free ingress and egress. Thus, one plate is finished, from which an impression is to be taken by means of printer's ink, on the paper pasted on another plate. The impression is taken in the hydrostatic press. Each pair of plates constitutes a set, which may be put into the presses, and removed at pleasure.

Fig. 1, plate II, is an elevation of one press; A, the top, or entablature; BB, cheeks of ditto, or pillars; C, upper block for fastening upper pattern to; D, lower, or movable block; E, the cylinder; F, the sole, or base; G, the water for the discharged cloth to fall into; H, cistern, or liquor-meter; *dd*, glass tubes for indicating the quantity of liquor in the cistern; *ee*, glass stop-cocks for admitting the liquor into the cistern; *ff*, stop-cocks for admitting water; *gg*, the pattern plates; *nn*, screws for setting the patterns parallel to each other; *mm*, stuffs perforated with a half-inch drill. The lower iron frame has corresponding pins, which suit these perforations; so that the patterns are guided into exact correspondence with each other; *hh*, rollers which receive and pull through the discharged cloth, from which it falls into the water-box; *k*, stop-cock for filling the trough with water; *iii*, waste tubes for water and liquor.

The plan of the buildings in which the cotton spinning machinery is placed, is generally in the form of a parallelogram, of a length proportionate to the extent of the manufacture carried on therein, and about thirty feet wide. In the best constructed mills, the carding and other preparatory machines are placed on the lowest floor; the mules and stretching frames on the next; and so on progressively as the machines improve the fineness of the yarn. The mules, jennies, and water-frames are placed with their line of spindles across the building; and the card engines have the axes of their cylinders parallel to the long wall of the building. Four or six rows, breakers, and finishers, are placed alternately.

The steam engine, or first mover, is placed at one end of the building, and the motion is communicated by a horizontal shaft running the whole length of the building, which transmits the motion to vertical shafts with bevel-wheels, which wheels transmit the motion to horizontal shafts in the upper floors. A better idea, however, may be procured of one of these mills by reference to plate II, COTTON MANUFACTURE, in which we furnish a view of the fire-proof premises erected by Messrs. Strutt.

The most important legislative enactment connected with the cotton manufacture, relates to the regulation of the mills, and is especially intended to preserve the health of the persons employed in those extensive works. The act was passed in the month of June, 1825, and

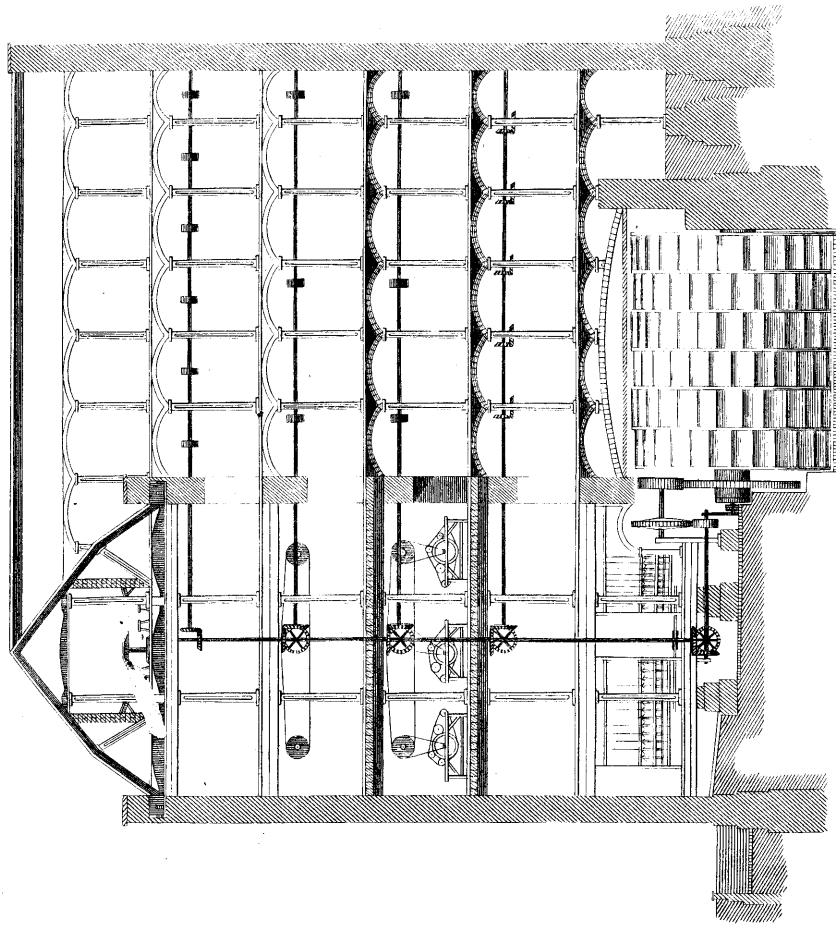
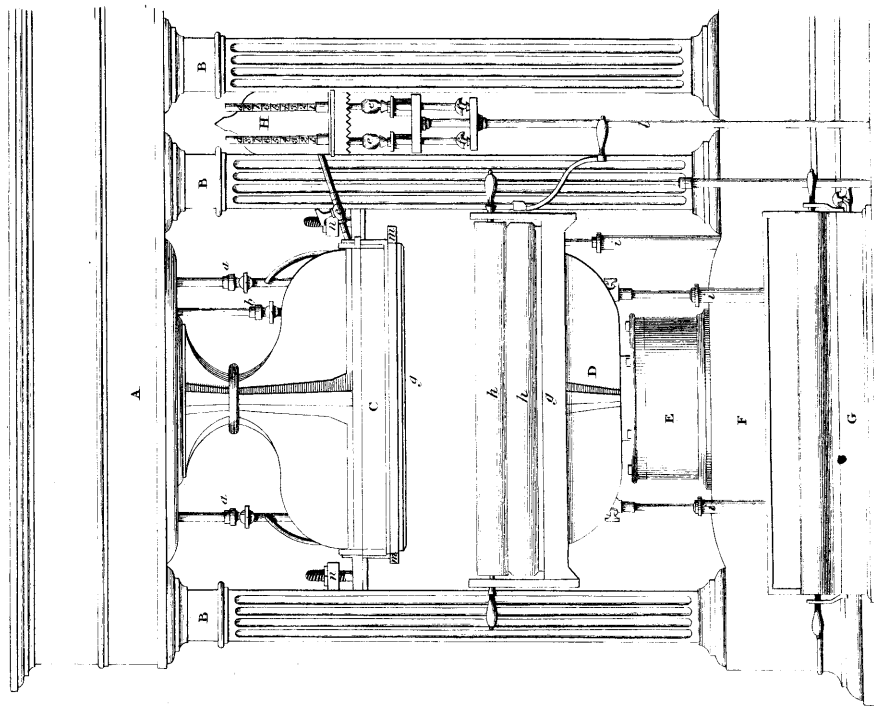
commenced its operation in August, and the result has been most satisfactory. It commences by enacting that no person, being under the age of sixteen years, shall be employed in any description of work whatsoever, in spinning cotton wool into yarn, or in the previous preparation of such wool, or in the cleaning of any mill, manufactory or building, for more than twelve hours in any one day, exclusive of the necessary time for meals, such twelve hours to be between the hours of five of the clock in the morning, and eight of the clock in the evening. And no person under the age above-mentioned shall be worked more than nine hours on a Saturday; such nine hours to be completed between the hours of five of the clock in the morning, and four of the clock in the afternoon.

There shall be allowed to every person, in the course of every day, not less than half an hour to breakfast, and not less than one full hour for dinner; such half hour for breakfast to be between the hours of eight of the clock, and nine of the clock, in the morning; and such hour for dinner to be between the hours of twelve of the clock in the forenoon, and two of the clock in the afternoon. If at any time, in any such mill, manufactory, or buildings, time shall be lost in consequence of the want of a due supply, or of an excess of water, or any accident happening to the steam engine, water-wheels, or mill-gearing, then it shall be lawful for the proprietors of any such mill to extend the before-mentioned time of daily labour, after the rate of one additional hour in any one day during the week (except on Saturdays), in which it is lost, but no longer. The ceilings and interior walls of every such mill, manufactory, or building, shall be washed with quicklime and water, once in every year.

Every person, whether proprietor, occupier, or foreman, of any such cotton mill, who shall offend against any of the provisions of this act, shall for every such offence forfeit and pay any sum not exceeding £20, nor less than £10, at the discretion of the justices before whom such offender shall be convicted.

We may now turn to the *foreign trade* as regards the manufacture of this important article. In the year 1806, 21,734,000 lbs. of cotton were imported into France, and manufactured into the following articles:—About 1,000,000 lbs. into velveteens; about 925,000 lbs. into nankeens, nankinets, crapes, and other small stuffs; about 1,155,000 into dimities; about 14,880,000 into fustians, calicoes, coverlets, simoises, and muslins. In twenty-two of the departments in France, in which this manufacture was carried on, there were, in 1806, 7,450 spinning mules, containing 800,724 spindles, and employing 28,460 persons; and there were in these departments 28,634 looms employed in weaving cotton fabrics, giving occupation to 31,107 persons. The number of machines, and of people engaged in this manufacture in the other parts of the country are not stated.

In the same year France imported (contraband) from England 2,000,000 of pieces of nankeen, 1,000,000 of pieces of cotton cloth for printing, and about 300,000 pieces of other de-



J. B. G. & Co. Eng'rs.

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criptions of cotton goods, such as muslins, cambrics, dimities, &c. valued at £3,000,000 sterling.

The cotton manufacture of Switzerland, whatever may have been the date of its commencement, has not proceeded so rapidly as the French. It was even many years after Sir Richard Arkwright's improvements before it began to make any considerable advance. It was not until the year 1798, that the Swiss had any spinning by machinery, at which time their first mill was erected at St. Gall. Before that period all their yarn was spun upon the one-thread wheel; and even still, about a tenth part of what they produce is spun in this manner. After the introduction of machinery, however, this article of manufacture made rapid advances, and spinning works were erected in all the manufacturing cantons of the republic. In these they now spin water-twist up to No. 40, and mule yarn up to No. 80; but they import from this country all the higher numbers required in their manufacture. A considerable proportion of their machinery is worked in the same manner as a part of the spinning machinery of France; that is, in small systems; and in Switzerland these little establishments are scattered over the country. In the manufacture of the goods, the weaver, in general, provides himself with the yarn, and sells the cloth, when woven, at the nearest weekly market, or exchanges it for a new supply of yarn.

The cotton manufacture is carried on also in Prussia, and there is in the temperament and habits of that people, what leads us to expect that they may become a manufacturing nation. At present, however, like the Austrians, Saxons, and other nations upon the continent who have attempted to carry on this manufacture, they are far behind in the knowledge of the means of economising labor, and in that readiness and precision of execution which the workmen of this country possess. But these they will soon acquire if the business continues to be prosecuted by them. In the mean time they have labor at a cheaper price than that at which we can generally command it; and in manufacturing for markets which lie near to themselves, they can, better than we at a distance, adapt the fashion and fabric of the goods to the changes of taste, and accommodate the supply to the exact measure of the demand. In Russia they have begun to manufacture cotton upon a small scale. At St. Petersburg there is one spinning work, carried on by the emperor, of course at a great expense. They also spin some cotton yarn upon the distaff. In addition to these supplies, they import annually from this country about 3,000,000 lbs. of yarn, of numbers from No. 18 to No. 46. The weaving is carried on in Moscow and its neighbourhood; and, latterly, along that line of country stretching towards the Caspian Sea, particularly about Sarepta, where a colony of Moravians has for some time been established. The goods produced are used chiefly for the garments of the peasantry.

The amazing increase that has taken place in the quantity of cotton goods manufactured in the United States, may be conceived by the follow-

ing facts connected with a district which had not previously a manufacturing character.

In 1810 there existed in New Hampshire, altogether, twelve manufacturing establishments, which produced in a twelve-month, between 4,000,000 and 5,000,000 yards of cotton cloth. Whereas now there are, in the same county, no less than fifty manufactories, making up about 30,000,000 yards! Here there has been a direct increase of more than 500 per cent. It may be added, that the whole surrounding country has now put on a manufacturing aspect; that villages of sixty or seventy habitations have sprung up, where, a short time back, there were but one or two. And that at Lowell a company was incorporated in January 1825, with a capital of 600,000 dollars (£125,000 sterling), for jean, dimity, and twilled goods.

The progress of the Irish in the same line of industry must not be overlooked; and the laudable and spirited exertions of captain Robert Brooke deserve to be particularly noticed. In the year 1780 that gentleman established a cotton manufactory on his lands, situated on the great canal, about eighteen miles west of Dublin. In 1782 the government of Ireland, understanding that some of the manufacturers of Manchester intended to remove to America, and carry their machinery with them, found means to persuade them to go to Ireland, and gave captain Brooke about £3000 for settling them in his houses upon his lands; and they afterwards advanced him £32,000 upon interest and security, that he might give employment to a great number of weavers, who were then starving and riotous for want of employment in Dublin. By means of these, and other acquisitions of inhabitants, the manufacturing village, which was called 'Prosperous,' consisted afterwards of several hundred houses, erected on a spot where, in the year 1780, there stood one single hut; and the manufacture gave employment to about 3000 men, women, and children. Besides captain Brooke's, which was the principal one, there were at this time several other manufactures of cotton established in various parts of Ireland by the spirited exertions of individuals, and the liberal encouragement of parliament.

The quantity of cotton wool exported from Great Britain to Ireland, is very considerably increased during the past five years, as appears from the following parliamentary statement, printed in 1826.

	lbs.
1821 . . .	1,386,564
1822 . . .	1,716,395
1823 . . .	1,950,283
1824 . . .	2,177,703
1825 . . .	2,598,893.

The lightness, as well as cheapness, of the calico, has rendered it a chief article of dress amongst all classes of people, and annihilated the manufacture of many of the lighter kinds of woollen and worsted stuffs, formerly so much in demand. The trade of Halifax, and the surrounding country, which consisted almost wholly in such stuffs, has gone entirely to decay, and been replaced by the manufacture of calicoes and other

cotton goods: and such are the quantities now manufactured, more especially in the country round Colne, and thence to Bradford, that from 16,000 to 20,000 pieces are brought weekly to the Manchester market; the produce of those districts which adjoin or are included between these towns.

To the same improvements in spinning which gave birth to the manufacture of calicoes, we are indebted for that of muslin, a branch not less important to the country than honorable to our pride and industry as manufacturers. For this elegant article of dress all Europe had long been tributary to India, where the manufacture has, through the long lapse of ages, arrived at the greatest perfection. Muslins were first introduced into this country by the East India Company, about the year 1670, before which time cambrics and Silesia lawns were worn, and such fine linens from Flanders and Germany, as were brought back in exchange for our woollen manufactures of various kinds exported thither in considerable quantities. The manufacture was attempted at Paisley as early as the year 1700. A few looms were employed, but this trade was soon annihilated by the introduction of the goods of India. Eighty years afterwards a more successful rivalry commenced. British muslins were first successfully introduced in the year 1781, but were carried to no great extent till 1785, since which period their progress has been rapid beyond all example. In the year 1787 it was computed, that not less than 500,000 pieces of muslin, including shawls and handkerchiefs, were annually made in Great Britain. The manufacture has, from that time to the present, continued progressively to increase and improve, and bids fair to become the most lucrative and extensive of any in this country. The rapidity with which it approaches to perfection, and its surprising extent in the short space of twenty years, are amongst the many important consequences that have resulted from the improvements in the art of spinning. By the cheapness and superior quality of our yarn, we are enabled to employ thousands of looms in the production of this elegant and useful article of dress, to keep in this country millions of specie which was heretofore sent to the east to purchase this commodity, and to clothe ourselves with this fabric at one-third of the expense formerly required.

Some curious data connected with the state of the cotton trade in Manchester are furnished in the MS. notes of a tour made by their imperial highnesses the archdukes John and Lewis of Austria. They say, 'It is calculated, that 1,500,000 lbs. of raw cotton are worked up every week in the manufactories of Manchester; and in the same space of six days, a single house

pays £10,000 for the purchase of raw cotton. One single manufactory pays £1500 a week for wages. From these facts an idea may be formed of the active industry of this place, and of the riches which commerce must bring into it. The manufactories use so great a number of thermometers, that an Italian whom we know, (a Mr. Zanetti), who is settled in Manchester, sells ten or twelve dozen every week. Three hundred steam engines in constant motion produce all these wonders.'

The rapid increase of the cotton trade appears to have been owing, in a great measure, to the more liberal introduction of machinery into every branch of it, than into any other of our staple manufactures. The utility and policy of employing machines to shorten labor, has been a subject which has exercised the pens of several ingenious writers; while their introduction into almost every branch of manufacture has been attended, in the outset, with much riot and disorder. They are, undoubtedly, most wonderful productions of human genius, the progressive exertions of which neither can nor ought to be stopped: they enable the manufacturer to produce a better article than can be made by the hand, in consequence of the uniformity and certainty of their operations; and at a much lower price, in consequence of the vast quantities of goods they are capable of performing. They thus support the credit of our manufactures abroad; and enable us, under the vast load of taxes, and consequent increase in the price of every necessary of life, to meet our foreign competitors with advantage at market. They can even allow the goods to furnish, in their passage, a considerable revenue to the government. And although they do, undoubtedly, on their first introduction, throw some persons out of employ, by changing the nature and course of business, they almost immediately make up for the inconvenience by astonishingly multiplying the absolute quantity of employment. If they take away their work from carders and spinners, they return it them back ten-fold as winders, warpers, weavers, dressers, dye, bleachers, printers, &c. &c.

We shall conclude our present article by subjoining a summary of the rise and progress of this important branch of British manufacture.

From 1770 to 1780 the importation of cotton wool averaged 5,735,575 lbs. per annum. From 1781 to 1790 about 13,000,000 lbs. weight, and from 1791 to 1801 about 32,000,000 lbs. weight; and the following is a statement of the quantity imported in each of the twenty-two years 1802—1823, distinguishing the several countries from whence imported, and the number of bags and bales from each respective country

COTTON WOOL, IMPORTED FROM

Years.	United States of America.	Brasils and Portugal.	East Indies.	West Indies, &c.	Total No. of Bags and Bales.	Total in lbs. weight.	Quantity in lbs. weight taken for spinning in each of the nine years 1815—1823.	
1802	107,494	74,720	8,535	90,634	281,383	77,393,600		
1803	106,831	76,297	10,296	45,474	238,898	59,921,990		
1804	104,103	48,588	2,661	86,385	241,637	70,506,355		
1805	124,279	51,242	1,983	75,116	252,620	72,229,537		
1806	124,939	51,034	7,737	77,678	261,738	75,157,530		
1807	171,267	18,981	11,409	81,010	282,667	86,206,870		
1808	37,672	50,442	12,512	67,512	168,138	22,676,740		
1809	135,000	166,107	35,764	103,511	442,382	117,775,530		
1810	240,516	149,535	79,382	92,186	561,173	136,570,735		
1811	128,192	118,514	14,646	64,789	326,141	91,662,535		
1812	95,331	98,714	2,617	64,563	261,215	63,027,570		
1813	37,721	137,168	1,421	73,218	249,503	49,820,530		
1814	48,000	151,500	13,500	74,500	287,500	59,745,373		
1815	201,000	91,200	24,300	54,900	371,400	96,720,370		90,537,350
1816	166,000	124,000	31,000	49,000	370,000	94,140,330		90,350,230
1817	195,560	114,490	117,955	49,155	477,160	125,132,230		110,532,210
1818	219,950	160,200	247,300	57,850	660,300	177,257,375		112,235,750
1819	212,250	125,450	178,300	31,070	545,070	150,735,728		110,235,570
1820	301,200	179,700	57,300	31,950	577,150	143,637,325	128,735,235	
1821	300,100	121,050	29,700	37,250	488,100	128,573,275	128,527,725	
1822	330,000	143,200	19,300	40,650	533,150	139,797,735	140,795,375	
1823	448,070	148,070	38,650	33,610	668,400	180,233,795	150,325,795	

The following is an account of the official value of the cotton wool imported; the number of bags and bales, and the official value thereof re-exported; and the official and declared real value of the quantity of cotton yarn and of cotton manufactures exported to all parts of the world (except Ireland), in each of the ten years 1814—1823.

The official values imply a fixed value assigned by the government, in 1694; and may or may not have a relation to the real value of the present time; but they are important and interesting as denoting an increase or decrease of quantity.

Years.	Official Value of Raw Imported.	EXPORTED.					
		Raw.		Value of Yarn.		Value of Manufactures.	
		Bags.	Value.	Official.	Real.	Official.	Real.
1814	2,030,862	. . .	366,270	1,119,850	2,791,248	16,690,366	17,393,796
1815	3,335,564	. . .	397,664	808,853	1,674,021	21,699,505	19,124,061
1816	3,160,075	30,000	343,768	1,380,486	2,628,448	16,335,124	13,072,758
1817	4,161,824	22,700	721,430	1,125,257	2,014,181	20,357,147	14,178,021
1818	5,767,547	60,000	1,245,781	1,296,776	2,385,305	21,627,936	16,643,579
1819	4,871,513	65,800	1,085,536	1,585,753	2,516,783	16,876,206	12,363,333
1820	4,957,057	27,500	370,610	2,022,153	2,826,643	20,704,600	13,843,569
1821	4,347,258	51,000	1,062,302	1,898,695	2,307,830	21,639,493	13,786,958
1822	4,731,252	58,700	1,273,263	2,353,217	2,700,437	24,566,920	14,534,253
1823	6,241,561	39,700	707,312	2,425,419	2,625,947	24,117,549	13,751,415

By the first of the above statements it appears that the total quantity of cotton wool imported, in the nine years 1814—1823, has amounted to about 1,235,000,000 of lbs. weight, and the stock on hand at the close of the year 1814, having been about 24,000,000 of lbs. it makes a total quantity of 1,260,000,000 lbs. weight in

the nine years to be accounted for: which has been disposed of in the following manner, viz. 1,062,000,000 of lbs. weight taken for spinning; 105,000,000 lbs. re-exported in a raw state; and 92,000,000 of lbs. remaining on hand at the close of the year 1823.