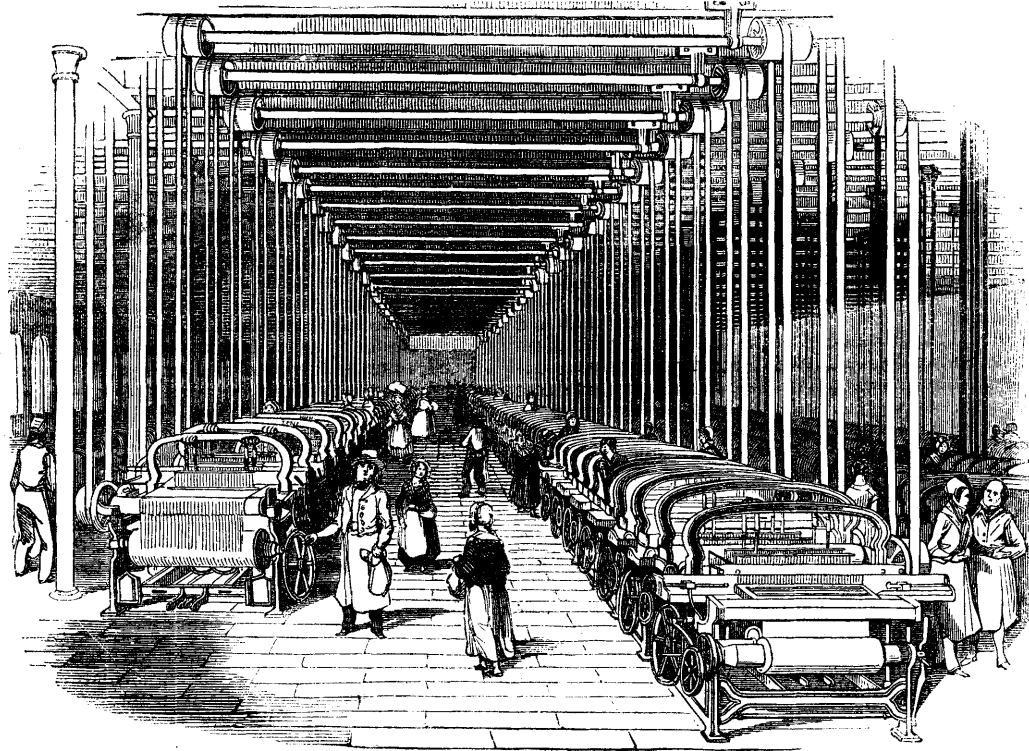


A DAY AT A COTTON-FACTORY.



[Power-looms.—Cotton Manufacture.]

If we take the town of Manchester as a centre, and draw around it a circle of ten miles radius, we shall find within that circle the seat of the most extraordinary manufacture which the world has yet witnessed: extraordinary in relation to the annual amount of property produced, to the effects which that property has wrought on the social features of the district, and to the mechanical inventions whereby the manufacture has been founded. We allude, of course, to the Cotton manufacture. At a period which may be remembered by persons yet living, the quantity of raw cotton worked up in Britain was about three millions of pounds annually: it is now three hundred millions. At a period not very much earlier, it employed a spinner one year to produce as much yarn as he can now produce in about a day. In 1760 not more than forty thousand persons are supposed to have been employed in this manufacture: there are now, in all its various branches, considerably above a million. In 1760 there was, perhaps, not a single yard of cotton goods exported; whereas in recent years the exports of cotton have nearly equalled all our other exports put together. And, lastly, at the present day the population of the manufacturing district is four times as great as it was at the former period.

Should it be asked why this district is so distinguished as the seat of the cotton manufacture, we may perhaps be correct in saying that the circumstance is due to a number of different causes. For instance: five centuries ago, when Edward III. married the daughter of the Earl of Hainault, he invited a number of Flemish clothiers to come to England; and they,

settling at Bolton, within the district which we have marked out, established the processes of spinning and weaving there. Again, when the revocation of the Edict of Nantes drove many weavers from France, in 1685, many of these settled at and near Bolton; and although both of these immigrations relate more to the history of the *woollen* than to the *cotton* manufacture, yet they laid a foundation for the modern improvements in both. Then, again, the physical character of the district presents marked facilities for such a manufacture: the hilly range which separates Lancashire from Yorkshire gives rise to numerous streams, which, before they reach the estuary of the river Mersey, give motive power to water-wheels, and a supply of water to bleach-works and dye-works, such as has no parallel for extent in any other country. It has been said that the Mersey and the Irwell are the two "hardest-worked rivers in the world." We may also adduce the existence of coal in abundance in the county, and iron in adjacent counties with which there is easy communication, as causes for the settlement of the cotton manufacture here. We must not forget, too, that Liverpool, one of the most admirably situated ports in the kingdom, is in the immediate vicinity of the cotton districts; serving at once as a *dépôt* for the imported raw material and for the exported finished goods. Lastly, we might be expected to mention the canals and railways which intersect this district in unparalleled abundance; but these are rather *consequences* than *causes* of the location of the manufacture.

We may regard this district as one huge town, almost as one huge factory; for there is such a con-

necting link between Manchester as a centre, and Bolton, Bury, Rochdale, Oldham, Ashton, Stayley Bridge, Hyde, Stockport, &c. as branches, that we cannot properly appreciate the one without noticing the others. Let us, then, beginning at the centre, take a rapid glance at this wonderful scene of industry.

If we take our station in Market Street, Manchester, at the west end of which is the Exchange, we are immersed in the very heart of the whole system. We have around us the wholesale 'warehouses' and offices wherein is transacted all the business between the dealers, the manufacturers, the spinners, the bleachers, the calico-printers, &c., whether of Manchester or of any of the surrounding towns. One street especially, viz. Mosley Street, presents a curious index to the whole arrangement. Here almost every house is occupied in the way stated: no manufactures are carried on; no retail shops exhibit the manufactured goods; but every house, and almost every floor of every house, constitutes the business-establishment for some large manufacturing firm. The houses were once small and humble; but the value of room in Manchester has increased so rapidly, that it has been a profitable speculation to rebuild nearly the whole of them in this street on a large and elegant scale. So thoroughly developed has the system become, that it is not found necessary to keep a large stock of manufactured goods at these places. A bargain is struck, say for ten thousand pieces of calico, as per sample; and this may be done in a small room, between the manufacturer and the dealer, while the goods are perhaps at that moment being manufactured at Bolton, or Ashton, or Stockport. Even the kitchens or cellars, as they would be termed in other places, are warehouses or counting-houses, and may be rented by a calico-printer, while the ground-floor constitutes the place of business for a fustian manufacturer, the first floor for a spinner, the second for a muslin manufacturer, and so on.

The admirable manner in which the wholesale Manchester business is now conducted, has been the growth of experience. Dr. Aikin, fifty years ago, separated the history of Manchester, as regards the position of its manufacturers, into four epochs, and these will give us some insight into the gradual changes in the agency of a mercantile system. The first epoch he places anterior to about the year 1690, when the manufacturers worked hard merely for a livelihood, without having accumulated any capital; and Aikin supposes that there were few or no manufacturers who had accumulated so much as 3000*l.* or 4000*l.* The second epoch began about the year just named, and lasted, say till 1730. The manufacturers during this epoch began to acquire little fortunes, but worked as hard and lived in as plain a manner as before, increasing their fortunes as well by economy as by moderate gains. They began to build modern brick houses, in place of those of wood and plaster. They confined their trade to the wholesale dealers of London, Bristol, Norwich, Newcastle, and Chester. Aikin says:—"An eminent manufacturer of that age used to be in his warehouse before six in the morning, accompanied by his children and apprentices. At seven they all came in to breakfast, which consisted of one large dish of water-pottage, made of oatmeal, water, and a little salt, boiled thick, and poured into a dish: at the side was a pan or basin of milk, and the master and apprentices, each with a wooden spoon in his hand, without loss of time, dipped into the same dish, and thence into the milk-pan; and as soon as it was finished they all returned to their work. In George I.'s reign, many country gentlemen began to send their sons apprentices to the Manchester manufacturers."

Dr. Aikin's third epoch is from about 1730 to the era of Arkwright's inventions. The marked feature

of this epoch was the manner in which the manufacturers 'pushed' for orders. At first the chapmen or dealers used to keep gangs of pack-horses, and to drive them to the principal towns with goods in packs, which they opened and sold to shopkeepers; lodging what was unsold in small stores at the inns, and taking back sheep's wool to the manufacturing district. By degrees, however, turnpike-roads were improved, waggons were laden, instead of pack-horses; and the chapmen only rode out for orders, carrying with them patterns in their bags. In the former epoch, country districts were supplied from the five or six large towns which received goods direct from Manchester, each acting as a centre to the surrounding counties; but now the manufacturers began to send their riders to every part of the kingdom soliciting orders.

The fourth epoch was consequent on the introduction of machinery into the manufacture. The trade became so large, that partners in commercial firms went to reside in London or on the Continent: foreigners and London merchants sent agents to reside permanently at Manchester; agents, factors, and brokers were established, some at Liverpool and some at Manchester, to manage the transactions between the Liverpool merchant and the Manchester manufacturer, both in respect to the raw cotton and to the manufactured goods; all the manufacturers around Manchester agreed to make that town their mart, and to appoint certain days of the week as 'market-days' with each other; and Manchester became, what it has ever since continued, one of the wealthiest towns in the empire.

When we depart from the mercantile focus of Manchester, and walk in any direction towards the suburbs we come in sight of the cotton-factories, those enormous brick structures which excite such astonishment in the mind of a stranger. There are nearly two hundred of these vast piles in the immediate vicinity of the town. One or two canals pass through Manchester, and the factories are generally situated in convenient proximity to these canals. A first-rate cotton-factory, with its machinery, costs very little short of a hundred thousand pounds; and a slight guess may hence be made at the value of the whole. The division of the town near the Oldham Road is especially full of these large factories; and the scene which is presented when the operatives leave these factories to go to their meals is one of the most striking that can be conceived; the busy hive pours forth in a stream from each building, some of which employ more than a thousand hands; and in a few minutes all have reached their homes, in small streets near the factories.

Departing still farther from the centre, we see ample evidence of the commercial character of the district, in the numerous railway-stations which the outskirts of the town exhibit, each leading to some busy tributary to the giant depôt of manufactures. On the west, we have the station of the railway to Liverpool and Warrington; on the north-west, that of the railway to Bolton and Bury; on the north-east, that to Oldham, Rochdale, and Leeds; on the south-east, that to Ashton, Staley Bridge, and Sheffield and finally, that to Stockport and London. A vast traffic is carried on by means of these lines of railway, especially from Manchester to the towns in its vicinity, both as respects passengers and goods.

If we next enlarge the radius of our visit, and pass from town to town of the 'cotton district,' we shall have the means more and more of appreciating the extent to which the system is carried. Say that we proceed north-westward, to Bolton, a distance of about ten miles. Here we come to a town which, in connection with the history of the cotton manufacture, is second to Manchester, and in some respects even takes precedence of it. Bolton was once the centre of the

district, as Manchester now is, and was noted for its textile fabrics many centuries ago. Leland, writing in 1552, says:—"Bolton upon Moore Market stonidith most by cottons, and course yarne. Divers villages in the Moors about Bolton doe make cottons." It is now known, however, that the goods which obtained the name of 'cottons' in those times, were really a kind of woollen; and that the first undoubted evidence we have of the real cotton manufacture in England dates back to the year 1641 only, just above two centuries ago. Bolton, in bygone times, had its warehouses, where dealers were wont to come from all the surrounding towns: a system which has been superseded by the concentration of the wholesale dealings at Manchester; but Bolton still holds its rank as one of the most important towns of the series. There were, in 1838, more than seventy cotton-factories in Bolton parish, and there are more than twenty large bleach-grounds within five miles of Bolton.

There is a pleasant walk of three or four miles northward from Bolton, which we will notice because it enables us to show that some of the factories, situated out of the dense mass at Manchester, are more favourably circumstanced than many readers are apt to suppose. In walking along the road from Bolton to Turton, which is a thoroughly open and country district, we arrive at a spot where a gentle range of hills separates the road from a valley through which a small river flows. On one of these eminences is a pretty church, recently built; and just beyond it is a small village of cottages, mostly new, almost wholly occupied by persons employed in a neighbouring cotton-factory. The factory is in the valley just spoken of, and the house of one of the proprietors is on a gentle eminence between it and the village. There is a school-house or room, supported partly by the proprietors of the factory, and there are chapels in the village for the principal denominations of Christian sects. The factory is bounded on every side by green fields; and being situated on the banks of the little stream, receives its motive-power from thence by means of a magnificent water-wheel sixty feet in diameter, the largest or nearly the largest in the kingdom. The employers and the employed live near each other, and all are located in a spot where there are as many green fields and as much blue sky, as pure rivulets and as pure air, as if no such place as a factory were near. In Manchester itself the factories are certainly and necessarily surrounded by smoke and bustle; but there are four times as many factories beyond the limits of Manchester as there are within those limits; and many of this larger number are analogous in their position to the one above described.

If, leaving Bolton, we direct our attention eastward, a distance of four or five miles brings us to Bury, another of the busy manufacturing towns. Nearly a hundred and twenty cotton-factories were, in 1838, enumerated in the parish of Bury, comprising the town and its environs. But Bury is perhaps still more celebrated for its print and bleach works than for its spinning and weaving factories. It was here that the first Sir Robert Peel, father of the present premier, established several print-works (*i. e.* 'calico-printing' establishments), and laid the foundation for the fortune of his children; there are members of the Peel family yet residing there, although some of the works have passed into other hands.

Bolton and Bury, besides their present rank as manufacturing towns, have contributed their full share, and more than their share, to the inventions by which the manufacture has been enabled to attain its present vast extent. It was to John Kay, of Bury, that the weavers are indebted for the 'fly-shuttle,' by which the weft-thread is thrown across the warp with

so much more facility than by the old method. It was to his son, Robert Kay, also of Bury, that we owe an ingenious contrivance by which three or four different coloured threads can be used in weaving with great facility. It was Whitehead, of Bury, who introduced the plan of 'piecening,' by which much time is saved in spinning cotton. It was a Bolton barber, Richard Arkwright, who was mainly instrumental in placing the manufacture in its present position, and the wealth of whose son has recently so astonished the world. It was Crompton, of Bolton, who invented the 'spinning-mule,' and whose house is still shown near that town, in which he used to work secretly in his garret, until inquisitive persons, by mounting ladders to look in at his window, discovered the secret of his machine, and robbed him of the fruit. It was also in this immediate neighbourhood that Hargreaves, the inventor of the 'spinning-jenny,' endeavoured to introduce his machine, and experienced the fate which so often attends inventors, *viz.* persecution.

A little north-east of Bury lies Rochdale, another important member of the series. In the parish, including the town and environs, there are about a hundred factories, as well as extensive bleach and print works. Rochdale has, however, been remarkable rather for its woollens than its cottons.

From Rochdale we may turn southward, and we shall there find an immense amount of factory operations going on. Rochdale and Oldham are both approached from Manchester by way of the Manchester and Leeds Railway, and an easy and constant communication is thus kept up. Oldham parish, which is a large one, contains no fewer than two hundred cotton-factories, and carries on a large manufacture, not only in cottons, but also in woollens and in hats. Oldham is a place which retains many characteristics, such as in other places have been rubbed off by the friction of intercourse with larger towns. Among these the dress of the operatives is observable. The writer happened to be opposite to one of the factories of Oldham on a May evening, when the people were leaving work, and was struck with the universal use of *handkerchiefs*, instead of *bonnets*, as a head-covering for the women and girls; while both sexes, almost without exception among several hundreds, wore wooden clogs with brass buckles or clasps. Wooden clogs have been much worn in Lancashire ever since the Flemish clothiers located there, and appear to have become smarter than they were originally; but in most of the towns they are gradually giving way to the use of leather.

Proceeding a little farther southward, we come to that extraordinary knot of manufacturing towns, Ashton, Stayley Bridge, Duckinfield, and Hyde; a group which displays perhaps more remarkably than any others the effects of the progress of the cotton manufacture. We here come to the banks of the Mersey, that small but mighty river, which, separating Lancashire from Cheshire throughout its whole extent from hence to the sea, feeds more factories, perhaps, than any other river in any other country. At the extreme south-east corner of Lancashire, where it joins Cheshire and Yorkshire, lie these four towns, two on the Lancashire side, and two on the Cheshire side of the Mersey. Ashton in 1775 contained five thousand inhabitants; in 1831 it contained more than thirty thousand. Stayley Bridge in 1748 contained forty-eight houses and one hundred and forty people; it has now twenty thousand inhabitants. Hyde in 1770 contained one dwelling-house and one chapel, while Duckinfield was at the same time designated as a "pleasant country spot;" now they contain some of the largest factories in the whole district, and an extensive population. These towns being, as has been

said, on the banks of the Mersey (or rather the Tame, for although the same river, it is not called the Mersey till it reaches Stockport), have water communication with Liverpool; while three canals in the neighbourhood connect them with Manchester, Huddersfield, and Derbyshire. At one of these towns, or rather manufacturing villages, viz. Hyde, there is a group of factories which were thus spoken of by Dr. J. P. Kay, in a work on the 'Moral and Physical Condition of the Working Classes employed in the Cotton Manufacture in Manchester,' published a few years ago:—"Twelve hundred persons are employed in the cotton factories of Mr. Thomas Ashton of Hyde. This gentleman has erected commodious dwellings for his work-people, with each of which he has connected every convenience that can minister to comfort. He resides in the immediate vicinity, and has frequent opportunities of maintaining a cordial association with his operatives. Their houses are well furnished, clean, and their tenants exhibit every indication of health and happiness. Mr. Ashton has also built a school, where 640 children, chiefly belonging to his establishment, are instructed on Tuesday in reading, writing, arithmetic, &c. A library, connected with this school, is eagerly resorted to, and the people frequently read after the hours of labour have expired. An infant school is, during the week, attended by 280 children, and in the evenings others are instructed by masters selected for the purpose. The factories themselves are certainly excellent examples of the cleanliness and order which may be obtained by a systematic and persevering attention to the habits of the artizans."

The population of the township of Hyde increased *ninefold* between 1801 and 1831!

We have not yet completed the circuit of this remarkable district. Following the course of the Mersey from Stayley Bridge and its neighbourhood, we soon arrive at Stockport, a town which at the present day ranks, after Manchester, as high perhaps as any other in the district in the extent of its factory arrangements. Being situated on the southern bank of the Mersey, the town itself is in Cheshire; but its factories have gradually extended to the Lancashire side. Like all the other towns, it has intimate communication with Manchester by railway, the Manchester and Birmingham Railway passing through the town; while the Sheffield line places Ashton, Duckinfield, Stayley Bridge, and Hyde, within reach of the great cotton metropolis. An incident came under our own notice at Stockport, which, as it illustrates one of the features in the factory system, we will mention. A factory, built many years ago, on the plan then in vogue, was enlarged at a later period to meet the extended business of the proprietor; but the new portion was built on the fire-proof plan of modern factories, that is, having very little wood in its construction. The old portion of the building caught fire, on the occasion alluded to, and was utterly destroyed; while the new portion, contiguous to it, and filled with machinery moved by the same steam-engine, escaped almost entirely unhurt. The poor workpeople, standing on the opposite bank of the river, were witnessing the wreck which would infallibly throw half of them out of work for a time; and they had the best of all possible grounds for appreciating the new mode in which these large buildings are now constructed.

South-west of Stockport there are some large factories here and there, and also northward of the Mersey through Eccles towards Bolton; but we need not stop to mention these more particularly, after the details already given. Suffice it to say that all the towns which we have mentioned lie within about ten miles of Manchester, on every side, and form, with it, one great workshop for cotton goods. We also find the

whole of this district chequered over with the lowly dwellings of the hand-loom weavers, those hard-working men who are competing with the steam-engine in the business of working up the spun-yarn into woven fabrics. The clack of the hand-loom is to be heard on many a road-side in the district. We do not, when speaking of cotton factories and weavers within a certain distance of Manchester, mean to imply that they are limited to this district: far from it; the remaining parts of Lancashire and of Cheshire, together with Yorkshire and Derbyshire, and especially the Glasgow district of Scotland, present a very considerable extent of cotton manufacture; but it is within the limits which we have chosen that the wonderful effects of the manufacture are most observable.

When we speak of a 'cotton-factory,' it means in most cases a factory for *spinning cotton-yarn*, afterwards to be used by the weaver, the stocking-maker, or the bobbin-net maker; but sometimes, and especially in the modern factories, *power-loom weaving* is combined with spinning, that is, the same steam-engines which work the spinning-machinery also work the looms which weave the yarn into cotton cloth. Hence the factories are distinguished as 'spinning,' or 'weaving,' or 'spinning and weaving' factories. But it does not follow that *all* kinds of cotton-cloth are either spun or woven in the same factory. In fact it is very far otherwise; each manufacturer confining his operations, generally to a small number of different kinds. The varieties of woven cottons are very large; but so far as regards a slight glance at the principles of the manufacture, all these varieties may be put out of view, and we may consider *spinning* and *weaving* as the two staple objects of the ten or twelve hundred cotton-factories which engirdle Manchester. If, then, we can glance at the interior arrangement of any one large factory wherein spinning and weaving are both carried on, we shall be able to form something like a judgment of them all. Many such are to be found, both in Manchester and in the towns by which it is surrounded; and it matters little where we make our choice, for the manufacturers of the district generally are liberally disposed to permit strangers to view the operations. We will give our description with reference to Mr. Orrell's factory in the neighbourhood of Stockport, as being one of those which exhibit all the most important improvements in the engineering and mechanical arrangements of factories.

Stockport is itself in Cheshire, but the factory under notice, being on the north side of the river Mersey, is in Lancashire, and we must therefore rank it among the Lancashire factories. The intercourse now between Manchester and Stockport is mainly carried on per railway, and is very extensive; Manchester being as much the mart for Stockport cottons, as for those of Ashton, Oldham, or Bolton. The railway conveys us to the immediate vicinity of the factory, which we approach under one of the arches of the lofty viaduct over the Mersey. When we came within sight of the factory, its arrangement cannot appear otherwise than striking to a stranger; for the lofty chimney is separated from the factory itself by a public road, and stands isolated on a kind of rocky mount. Being a well-formed structure, this chimney (which, but for the smoke, looks more like an honorary column than anything else) presents a fine appearance. The furnaces, which supply heat to the boilers for four large steam-engines, are situated in a building at one end of the factory; and the smoke from these furnaces passes through a flue under the public road, into the chimney, which thus conveys it up into the atmosphere at a distance from the factory.

When we come in front of the factory itself, we find it speckled over with windows to an enormous amount.

The building extends, from end to end, nearly three hundred feet, having a centre and two projecting wings. There are six ranges of windows in height, each range giving light to one floor or story of workshops. There are nearly a hundred windows in each of these ranges, on the four sides of the building, so that the whole amount to not much fewer than six hundred. The perfect regularity with which the windows of modern factories are arranged, constitutes one of their most conspicuous features. The ground-floor is two hundred feet in depth from front to back, but the upper floors are much less than this.

Withinside the building, the extraordinary scene and deafening noise presented by the operations conducted on the ground-floor are well calculated to bewilder a stranger: but of these more anon; we will at present confine our attention to the upper floors. There are staircases conveniently situated for gaining access to the various floors; but besides this there is a very ingenious arrangement for mounting to any floor without the least exertion on the part of the person ascending. There is a kind of square well, open from top to bottom of the factory, and measuring a few feet square. We place ourselves on a platform within this space, and by pulling a rope, place the platform in connection with certain moving machinery, by which it is carried up, supporting its load—animate or inanimate—safely. When we desire it to stop, on the level of any one of the floors, we have only to let go the rope, and the platform will stop. When we wish to descend, we pull another rope, which enables the machinery to give a reverse movement to the platform.

When, having ascended either by this piece of mechanism or by the staircase, we reach any of the upper floors, we find them to consist of very long rooms, lighted on all sides by windows, and filled with machinery so complicated and extensive that we may well wonder how all can receive their movement from steam-engines in a remote part of the building. Yet such is the case. There are two engines for the spinning-machinery, of eighty horse-power each; and two for the weaving-machinery, of forty horse-power each. These splendid engines are supplied from six boilers, the fires for which consume more than twenty tons of coal per day; and the main shaft from each engine is so connected with other shafts, both vertical and horizontal, as to convey motive-power to every floor, and to every machine in every floor.

Let us next see what are the most distinctive features in these processes of manufacture, and how each one is dependent on the others. The unprecedented train of inventions by which the present state of the manufacture was brought about, and the beauty and intricacy of the machinery by which it is effected, are subjects for a volume, rather than for half a dozen pages, and have indeed formed the subjects of volumes by Dr. Ure, Mr. Baines, Mr. Guest, and other writers. But the broad principles of the operations by which the contents of a cotton-pod are converted into woven calico or muslin, may perhaps be made clear.

In the first place, then, we have to ask what this remarkable substance is. It is a downy substance contained in the pod of the cotton-tree, a plant cultivated extensively in India, America, and other countries. When the pods begin to open, women and children go through the plantations, and pluck the cotton and seeds, leaving the husks behind. The cotton and seeds thus gathered, are exposed to the action of the sun till quite dry, and are then passed through a machine called a 'gin,' by which the seeds are separated from the fibres of cotton. The cotton is not further prepared in the land of its growth, but is packed very tightly in bags, and in that state imported into England, the bags

containing somewhere about three hundred pounds each on an average.

When these bags of cotton arrive at Liverpool, they are placed in warehouses; and cotton-brokers then negotiate dealings between the merchants of Liverpool and the manufacturers of Manchester and its vicinity; consequent on which the cotton is forwarded by railway or canal to the towns where it is to be manufactured.

We will suppose bags of cotton, such as those above alluded to, to have arrived at the factory which is the object of our notice. They are classified according to their qualities, to suit the different kinds of yarn spun from them; and after being opened, the cotton is removed, preparatory to the manufacture. Although the fibres of cotton form very light locks or tufts when they have been cleaned from the seeds abroad, yet they are so powerfully pressed when being made up into packages, that the tufts get matted and entangled, and require opening before anything else can be done; because, in all the subsequent operations, each fibre must be combined, unbroken, with others, to form the collected group or thread. This opening of the matted cotton is effected by a large and powerful machine called a *willow*. This machine consists of an inner framework, capable of revolving with very great rapidity, and enclosed in an outer case. Upon the four edges of the inner frame are fixed a series of iron pins or pegs, which in their rotation pass between other similar pins fixed to the inner surface of the outer case. Now if a quantity of cotton be put in the receptacle between the inner and outer frames, and the inner one be made to rotate, it is not difficult to conceive what will follow. The clotted locks of cotton, tossed about within the machine, are caught by the various iron pins, and torn open fibre by fibre. All the dirt and other impurities which may have been mixed with the cotton are at the same time separated from it, and made to fall through a kind of grating into another receptacle. Various forms of the willow, or 'devil,' as it is sometimes called, are used; but all act on the principle of separating the fibres by revolving spikes, the revolutions amounting to five or six hundred in a minute.

The fibres are thus nearly separated one from another, and nearly cleansed from dust, but not quite; and therefore the next process is to complete the opening and cleansing thus begun. This process is called 'scutching,' or 'batting,' or 'blowing' (for all three terms seem to be in use), and is effected in various ways, but generally by some such arrangement as the following:—The cotton is laid upon a kind of endless apron, which by its movement conveys its burden to a fitting spot, where flat bars, carried rapidly round, strike the cotton violently as it exudes from between two rollers, and thus separates the fibres most thoroughly. There is also a particular kind of fan or vane, so arranged as to produce a most powerful draught, by which all the dirt and dust are carried up and conveyed away—not only out of the machine, but out of the room, and out of the factory itself; for so admirable are the arrangements of a modern factory, that the room in which a very dusty process is carried on is as free from floating dust as any part of the building.

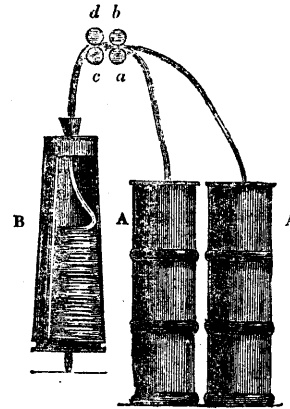
The cotton is now in the form of a very clean, light, downy substance, consisting of short fibres thoroughly disentangled. But these fibres are not *parallel*; they lie across each other at every imaginable angle, and any attempt to combine them together in this state would be fruitless: they must be rendered parallel, and to effect this is the object of the beautiful operation of *carding*, one of those which have exercised such a large amount of inventive ingenuity. If we were to take two combs, and pass the teeth of one between

those of the other, we should have a rude idea of the process of carding, especially if we had a few fibres of cotton entangled among the teeth; for the movement of the two combs would tend to arrange the fibres in some degree parallel. A number of pieces of wire are inserted in a piece of wood or leather, so that all shall project to an equal distance and at an equal angle; and if two such pieces of apparatus were placed with their wires in contact, and moved in contrary directions, a few fibres of cotton placed on the lower one would be *combed out* by the upper one, and arranged parallel. In various stages of the history of the manufacture, the two cards have been arranged in different ways. Sometimes one was on a convex surface, and the other on a concave surface fitted to it: sometimes one was on a cylinder, and the other on a flat surface: sometimes both were on the surfaces of cylinders. But the principle of action is the same in all, and is nothing more nor less than a process of combing. In some arrangements the cotton is brought into the form of a 'lap,' or flat layer, by the scutching-machine, and in that state transferred to the carding-engine; while in other cases the latter is fed by hand with cotton.

The cotton leaves the carding-engine in the state of a delicate, flat, narrow strip or riband, called a *sliver*; and these slivers have now to be converted into *drawings* by being elongated, narrowed, and thinned to a still more delicate condition. This process is one to which Arkwright paid particular attention, as having an important influence on the quality of the spun cotton. In the first place the slivers are collected in tall cans, generally either four or six in number, on one side of the 'drawing-frame,' and are from thence carried upwards to two pair of rollers, the two rollers of each pair revolving in contact. Here all the slivers or cardings are collected into one group, and are drawn between the rollers by the rotation of the latter. Now if these rollers all revolved equally fast, the cotton would leave them with the same united thickness as when it entered; but the last pair revolve quicker than the first, so as to draw out the cotton into a more attenuated riband; because the more slowly-revolving rollers do not supply the material fast enough for the maintenance of the original thickness. This is perhaps the most important principle in the whole range of the cotton manufacture; for it is exhibited alike in the present process and in the next two which follow. All the four or six slivers are connected into one before being caught between the rollers; and after leaving the rollers, the united 'drawing' passes through a kind of trumpet-shaped funnel, and thence conducted into a tall can, round the interior of which it coils itself. One consequence of the drawing-process, if properly conducted, is that the drawing is perfectly equal in thickness in every part, and formed of parallel fibres; and in order to ensure this, the drawing is repeated more than once, each narrow riband being 'doubled' with others before each successive drawing.

The slender ribands thus produced next pass through the 'roving-machine,' where they are brought to the state of *rovings*. In many respects the process of roving is similar to that of drawing, inasmuch as it draws out the cotton to a state of still greater attenuation; but as the cotton, in its now reduced thickness, has scarcely cohesive strength enough to make the fibres hold together, the roving has a slight twist given to it, by which it is converted into a loose kind of thread or spongy cord. A remarkable degree of ingenuity has been shown in the invention of machines to effect this double operation. In the 'can-roving frame,' contrived by Arkwright, here sketched, the cardings, coming from two cans, A A, and passing be-

tween the pairs of rollers, *a b* and *c d*, become elongated, and fall into the can B, which by its rotation lays the



roving in a coil, and at the same time twists it slightly. This was followed by the 'Jack-roving frame,' in which the revolving can contained a bobbin whereon the roving was wound as fast as made. Next succeeded the 'bobbin-and-fly frame,' which, from the time of Arkwright to the present day, has undergone a greater number of improvements than most other machines in the cotton manufacture. This consists of a system of vertical spindles, on each of which is placed a reel or bobbin, and also a kind of fork called a 'fly,' still farther removed than the bobbin from the axis of the spindle. The drawing or delicate sliver of cotton is first drawn through or between rollers, and elongated to the state of a roving; then this roving passes down a tube in one prong of the fork or fly, and becomes twisted by the revolution of the fly round the bobbin, while at the same time the twisted roving becomes wound with great regularity upon the bobbin. The machine in fact performs three different and distinct operations: it first attenuates the 'drawing' to a state of still greater thinness and delicacy than it had before; it then gives to the 'roving' thus produced a slight twist, sufficient to enable the fibres to cohere; and lastly, it winds this twisted roving upon a bobbin, on which it is conveniently transferred to the spinning-machine. There is a variety of the apparatus employed in this process called the 'tube-roving frame,' which produces a much larger quantity of roving in a given time than the 'bobbin-and-fly frame;' but the roving produced is inferior, and only fitted for certain purposes.

We then come to the *spinning* process, that which has given a name to the whole series, and to the factories in which the whole are conducted. Indeed when we consider that this is the process which finally presents the cotton in a state fit for the weaver, and that all the others are preparatory to it, we may reasonably deem it the most important in the manufacture. Hargreaves' spinning-jenny, Arkwright's spinning-frame, and Crompton's mule-machine were all constructed expressly for the process of spinning. If we bear in mind the true nature of the process of spinning, we shall see that all the beautiful machines which have been invented within the last hundred years for the spinning of cotton are merely different contrivances for effecting these two objects, viz., the elongating of the roving till it contain in thickness exactly as many fibres as are necessary to produce the required size of yarns, and the twisting of these fibres into a compact thread.

James Hargreaves, in 1764, made such a notable improvement in the spinning-wheel, that he could spin

many threads at once, instead of a single thread upon the old plan. It is said that on one occasion a spinning-wheel happening to be overturned, Hargreaves observed that both the wheel and the spindle continued to revolve for a considerable period; and he conceived the idea of moving several spindles at once with one wheel. He contrived a frame, in one part of which he placed eight rovings in a row, and in another part a row of eight spindles. The rovings, when extended to the spindles, passed between a clasp which opened and shut, and thus loosened or held them. A certain length of roving being extended from the spindles to the clasp, the clasp was closed, and was then drawn along to a considerable distance from the spindles, by which the threads were lengthened and attenuated. This was done with the spinner's left hand, while the right hand turned a wheel which caused the spindles to revolve rapidly, and thus the roving was spun into yarn. By a further adjustment the yarn was wound on the spindle.

This was one of the great and notable applications of mechanism to spinning, and Arkwright's spinning or 'water-twist' frame was another. The name 'water-twist' arose from the circumstance that, whereas Hargreaves' machine was worked by hand, Arkwright's was worked by a water-wheel; and hence the yarn or twist which he produced was called 'water-twist.' The principle of this machine bears much more resemblance to the 'bobbin-and-fly' frame than to the 'spinning-jenny.' The roving or loose cord, after it leaves the bobbin on which it is wound, passes between rollers whose velocity of rotation is regulated so as to elongate the roving; and the thinner roving thus produced is then twisted into yarn or thread by the revolution of a fork or fly round the spindle on to which the thread is wound. The horizontal rotation of the bobbins, combined with the vertical rotation of the fly, gives the twist.

At a later period Crompton made a peculiar modification of the 'spinning-jenny' and the 'water-twist frame,' so as to produce a kind of a combination of both, which he called a 'mule-jenny'—one among the many odd appellations which have been given to the machines in the cotton manufacture. It was found that though Arkwright's machine could produce strong yarn for the warp or long threads of cloth, it could not produce fine and delicate yarns; and Crompton sought to contrive a machine which should obviate this defect. Like the 'water-frame,' the 'mule-jenny' has a system of rollers to reduce the roving; and like the 'spinning-jenny,' it has spindles without bobbins to give the twist, and the thread is stretched and spun at the same time by the spindles after the rollers have ceased to give out the roving. The spindles in the mule travel to and fro in a carriage, whereas in both the former machines the spindles were fixed in position. The elongation was performed first partially by rollers, on Arkwright's principle, and then finished by the stretching action of a moveable carriage on Hargreaves' principle, and it was found that a finer and more delicate yarn could thus be produced.

The details above given will render us better understood when we say that in modern cotton-factories the spinning-machines partake generally of the character either of Arkwright's or of Crompton's machines. The roller principle, modified in a manner which is represented by the *throstle*-machine, is that by which the strong and hard yarns are produced; while the moveable carriage of Hargreaves and Crompton, made automatic in the *self-acting mule* of Mr. Roberts, is the arrangement adopted for spinning the finer yarns. Some factories are fitted up only for throstle-spinning; others for mule-spinning; and these two terms have now got into such general use, as to imply at once what kind of

machines are used—whether those for the stronger or those for the finer work; whether those which work by rollers and the bobbin-and-fly, or those which work by the travelling carriage; whether those for which Arkwright is to have the greater honour, or those for which honour is due to Crompton. Some factories, again, have both throstles and mules; and such is the case in the establishment whose interior arrangement we have described. Two or three of the ranges are entirely fitted up with mule-frames, whose appearance is very remarkable. There is a carriage which draws out five or six feet, bringing with it a large number of threads or yarns, which are stretched by this action, and at the same time are twisted by the revolution of the spindles to which they are attached. In the common mules this carriage is moved by the left hand of the spinner, but in the self-acting mule it is moved by machinery.

The yarn, produced by these two classes of machines, is appropriated to various purposes according to its fineness, strength, hardness, smoothness, and other qualities. Some is employed as *warp* or long threads for coarse goods; some for *west* or cross-threads; some for printing-calicoes; some for fine muslins; some for cotton hosiery; some for bobbin-net; some for sewing-cotton. The owner of the spinning-factory either works up the yarn into woven goods or sells it to others, according to the nature of the business which he carries on; or he may perhaps combine both methods, by spinning all the yarn for one particular kind of goods which he weaves in the same building, and also spinning other kinds of yarn which he sells to other persons.

At the factory under our notice there are the enormous number of *thirteen hundred* power-looms, all employed in making one kind of cotton goods, of which there is an astonishing quantity produced every week. Wherever the weaving process is carried on, there are always many intermediate steps to be pursued after the spinning is completed; such as 'dressing,' 'beaming,' 'winding,' 'warping,' &c. At this factory these processes are conducted in the upper floors of the building. The dressing is a process by which either melted size or flour-paste is applied to the yarn, as a means of rendering it smooth and stiff. We had occasion to speak of the action of the admirable modern 'dressing-machines,' while describing the operations of a Sail-Cloth Factory, some months back, and may here therefore merely remark that the threads of yarn, spread out in a parallel layer, after dipping into a trough of paste, are brushed by two reciprocating brushes, by which the paste is laid smoothly over the surface, and are then dried by passing over steam-heated cylinders or boxes. It was estimated ten years ago that there were 80,000 power-looms in Great Britain; that each power-loom required three pounds of flour weekly for the dressing of the yarn which it wove; and hence that there were 44,562 loads of flour consumed annually for this purpose only, valued at nearly 100,000*l.* This is one of those minor circumstances which tend quite as much as those of more obvious importance to show the gigantic extent of this manufacture.

Besides the dressing, there are several curious machines employed to prepare the yarn for the loom; by arranging the threads in a parallel layer, winding them on the warp-beam or roller of the loom, passing them through the 'harness' or loops and strings of the loom, and so on. Many of these operations are nearly alike in all the textile manufactures, whether of cotton, wool, linen, or silk.

When we descend from the upper rooms of the factory to the ground-floor, where the weaving takes place, the appearance is certainly more astonishing than anything else presented in the factory. Thirteen hundred looms, each one a distinct and complete piece of

mechanism, are here arranged in parallel rows, over a space of ground measuring probably two hundred and fifty feet by one hundred and fifty; having passages between the rows. Each loom is between three and four feet high, and perhaps five or six wide; and they are all so placed that one female can attend to two looms. Every loom receives its moving-power from mechanism near the ceiling, where shafts and wheels present almost as complex an assemblage as the looms beneath them. These shafts are connected with the main-shafts of the two smaller steam-engines, so as to receive their moving-power from thence.

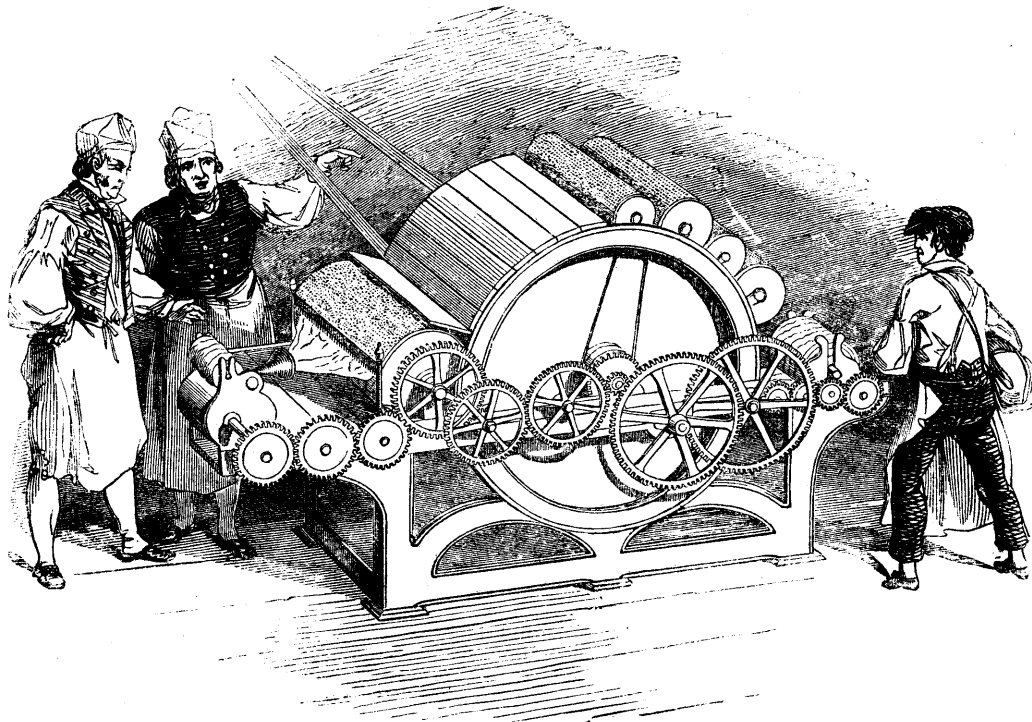
In order to understand how this immense room is lighted, we must state that only half of it is under or in the main building itself: the other half extends to a great distance in the rear, having no other rooms over. A series of arches, in the wall of the main building, open a communication between the two halves of the weaving-room, so that numerous passages lead from one to the other. In the hinder half the roof is intersected at regular distances with skylights, running from end to end, and placed at such an angle as will throw down the light conveniently upon the looms below. At regular intervals openings can be made in the roof, as a means of ventilation, according to the temperature below.

Six hundred and fifty females are here engaged in attending the looms, two to each, and these comprise almost the only occupants of the weaving-room. The noise created by thirteen hundred machines, each consisting of a great number of distinct moving parts, and each producing what would in an ordinary-sized shop be considered a pretty vigorous din, is so stunning and confounding, that a stranger finds it almost utterly impossible to hear a person speak to him, even close at

his elbow, or even to hear himself speak: he walks along the avenues which separate the rows of looms, and arrives one after another at looms all exactly alike; he sees these clattering, hard-working machines on all sides of him, with the heads of the six hundred and fifty females just visible above them; and he may not unreasonably marvel that the persons, exposed to this incessant uproar for ten or twelve hours a day, can appear indifferent to it. Yet such is the case; habit smooths away the inconvenience, and the workpeople seem to think light of it.

In these power-looms steam-power may be said to do everything. It unwinds the warp from the warp-beam; it lifts and depresses the treddles, by which the warp-threads are placed in the proper positions for receiving the weft-threads; it throws the shuttle from side to side, carrying the weft-thread with it; it moves the batten or lay by which the weft-thread is driven up close; and finally, it winds the woven cotton on the cloth-beam which is to receive it. The female who has to manage a pair of looms has merely to attend to a few minor adjustments, which altogether about occupy her time; such as mending one of the threads which may have been broken, removing an empty shuttle and replacing it with a full one, removing an empty warp-beam, or a filled cloth-beam, and replacing them with others fitted for continuing the process.

When the cloth has left the loom, whatever be its quality, it has to undergo certain finishing processes. In some cases it is drawn-between heated rollers, which impart to it a smoothness and gloss; in other cases, such as are instanced by velvets and fustians, a nap or pile is raised by a very remarkable series of operations; while other varieties require a yet different mode of procedure.



Carding-Engine and Factory Operatives.]