THE MODERN COTTON SPINNING FACTORY

By W. H. Booth

II. THE OPERATIONS OF CARDING, COMBING, DRAWING, SLUBBING AND ROVING

In the January issue the study of the work of the modern cotton-spinning factory was begun, that instalment of Mr. Booth's paper dealing with the general subject, including the raw material, and the preliminary operations of its preparation. The present portion of the article discusses the further treatment of the material and the machinery required, to be followed by a concluding article upon the final processes.—THE EDITOR.

CARDING.

The laps from the scutching room should possess three special qualifications, namely, correct weight per unit of length, even thickness over their whole surface, and even, smooth edges. The first is attained by adjusting the weights fed to the first scutcher, or by varying the lattice speed of the second scutcher. Even thickness is a product of correct working of the scutchers, and even edges result from the same cause and from care in transporting laps to the carding engines. It is therefore desirable that the output of the cleaning department shall be such as to give proper time for adjustment and repairs in order that the cards may not go short of laps.

Cotton is carded to remove short and imperfect fibres and any remaining bits of husk, leaf, or even sand. Carding opens up and separates each individual fibre and, to some extent, begins the process of laying the fibres parallel.

There are two main varieties of carding engines, roller and flat, Fig. 1.

In the roller card, only employed for coarser counts and for waste carding, a large cylinder *A* with a surface speed of 1,600 feet per minute and covered with wired cloth as in Fig. 1, the wires being bent forward in the direction of rotation, picks up fibre from a smaller roller *K*, known as a licker-in. This roller has clothing of heavier wire and has a surface speed of half that of the main cylinder. This roller combs down the fibre entering from the small fluted feed roller *Q*, which draws in the lap *O*, and from this licker-in the fibre is combed off by the upward quicker running cylinder. Round the cylinder several pairs of rollers are set in place of the flats shown in Fig. 1; one of these, with its teeth set the reverse way from the teeth of the cylinder, practically touches the cylinder and revolves, so that the surface moves in the same direction as the cylinder surface, but only at some 20 feet velocity per minute.

The fibre is caught up by this roller and is well combed in the process of transfer. The other roller, which runs twenty times as fast and in the same direction, has its teeth inclined forward in the direction of motion and strips off the fibre from its slowly-moving companion, and is in turn itself stripped by the cylinder which carries the fibre again to the roller, the clearer being so placed as to cause the fibre to pass as many times as it can succeed in doing from cylinder to roller, clearer, cylinder, and roller again. The action appears fortuitous, but an inspection of a running engine shows that each succeeding pair of rollers and clearers presents a more even appearance, less dotted with partly carded fibre.

Apparently the well-carded stuff does not get taken up by the slow roller and is carried on to the doffer *R*, a slow-moving large cylinder on which the teeth are set opposite from the main cylinder teeth and its surface moves with the cylinder surface, but at a speed of only sixty to seventy feet per minute. The cylinder parts with its load of carded fibre to the finer wires of the doffer, and a rapidly-reciprocating short-toothed steel comb *S* combs the fibre off this doffer cylinder upon a smooth plate. The vibration is 600 to 1,000 per minute. The smooth plate on which the stripped fibre falls has tapering vertical walls which close in the filmy web of fibre, and this now enters a trumpet cone and passes between rollers which condense it. It travels thence as a band between other rollers, which pass the sliver through another trumpet on a revolving plate *V*, which delivers the sliver into a tall tin cylinder *W*. The discharge orifice of the horizontally-revolving plate describes a circle of one-half the diameter of the tin, and as the tin cylinder rotates slowly on its axis the sliver is coiled neatly all round the tin.

The lap of cotton, which is fed in at about 9 inches per minute, is spread over a length of perhaps 18,000 inches of cylinder. This thinly-spread fibre is crowded upon a less length of roller surface and again expanded upon the greater length of cylinder surface and so on as it travels from roller to cylinder again and again. Then on the doffer the 9 inches is gathered into a surface length of eighty to one hundred times as much and the lap has received its first draw-out. The carding is an operation of great agitation and bits of husk and leaf are loosened out. The film produced should appear regular, clear and free from cloud when held to the light. The rollers above the can-coiler slightly draw out the sliver as it is delivered from the first condensing rollers on the doffer plate. This is only a slight draught, but it keeps the sliver taut and helps to parallel the fibres. But there is still very little parallelism of the fibres, and such yarn as could be spun from such curled fibres would be thick, rough and fuzzy. Truly parallel fibres are secured by the operation of drawing in the case of coarse yarns, while, in the spinning of finer yarns, there is an intermediate additional combing process which again rejects some material as waste. The carding engine also rejects fibres to waste. This waste consists of the shorter fibres flung off from the rapidly-rotating cylinder by centrifugal action and deposited below the cylinder in the base of the casing. This waste is known as fly, and it is sold to spinners of coarser counts, the fly from good Egyptian cotton being superior to the cotton bought in the raw state for coarse counts. But the roller car is almost obsolete—entirely so for fine counts—having been displaced by the revolving flat card, as illustrated in Fig. 1. In this machine there is the same large cylinder, doffer and licker-in, but in place of the rollers and clearers there is a traveling band of closely-linked flat bars *B B*, covered with card cloth and traveling very slowly round the upper part of the cylinder on the side frames of the machine, which are carefully turned concentric with the cylinder. The chain of flats in an endless band turns away from the cylinder at *M* as they approach the doffer cylinder and pass back, a few inches above the working flats, to the cylinder near the licker-in at *N*. As the flats, which are only 1⅜ inches to 1⅝ inches in width, turn up round the carrier roller, they are stripped by a reciprocating comb *F* and cleaned of the fibre that sticks to them by means of a slowly-rotating helically bristled circular roller brush *G*. This stripped fibre is waste, and the cleared flat starts again at the cylinder as it reaches the carrying roller at that point of its cycle.

The rate at which cotton passes through the carding process is slow, an engine 45 inches wide on the wire face only turning out from 5 to 7 pounds of Egyptian cotton per hour for counts of 60's, while for low counts of 10's to 20's, 15 to 18

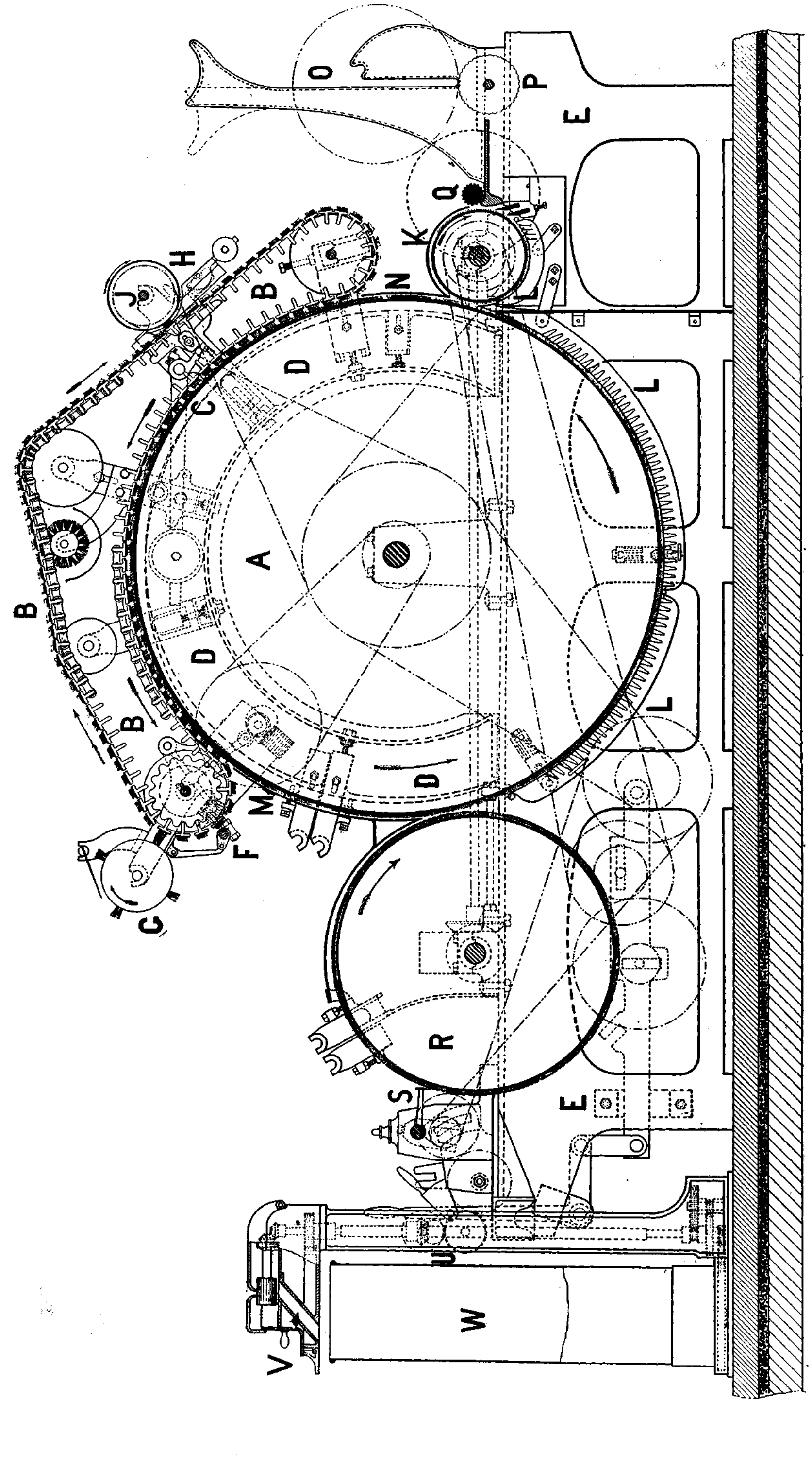

FIG. 1.—PATENT IRON REVOLVING FLAT CARDING ENGINE. PLATT BROTHERS & CO., LTD., HARTFORD WORKS, OLDHAM

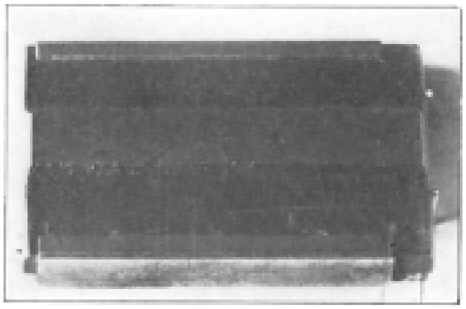

FIG. 2.—BACK OF CARDING ENGINE FLAT

pounds may be carded per hour. The number of cards is therefore large, especially in a coarse-counts mill.

As an instance of one of the many improved details of cotton machinery generally, there may here be cited the slow-motion driving of the doffer cylinder, whereby, if the web or sliver has broken down, the doffer and the feed rollers are both thrown into slow gear while the attendant pieces up the sliver. The slow motion is given instantaneously by releasing a lever, and it automatically discontinues itself after sufficient time has elapsed to effect piecing up. This prevents the big delivery of fleece during piecing up, which results in considerable waste. The wired cloth with which carding cylinders and flats are covered is made of varying fineness and length of wires.

Wires are fixed into the cloth in the form of two pronged staples, and each prong is bent at an angle at about a fourth of its projection from the cloth, this causing the wire to point forward and not to stand out radially from a clothed cylinder or vertically from a flat. There may be 250 staples in a square inch of cloth or 500 points of wire. The back of the cloth is thus nearly covered by horizontal lengths of wire forming the bases of the staples, and the wire projects about 3/8 inch from the face of the cloth when new. As many as 108 or 112 flats go to each engine. The points of the wires on the flats, as well as on all other clothed surfaces, are ground from time to time by means of long emery rollers, which rotate rapidly with a quick to and fro end movement also. It is essential to grind all cylinders truly cylindrical, and to grind the flats from the working face which slides upon the concentric frame. The roller *J* is this emery roller. The flats are so set that their wires just fail to touch the wires on the cylinder. This can be ascertained by means of a thin "feeler" gauge of flat steel. Speaking generally, the best class of cotton will require 50 per cent. more wires per square inch than will the lowest classes.

The clothing of carding-engine

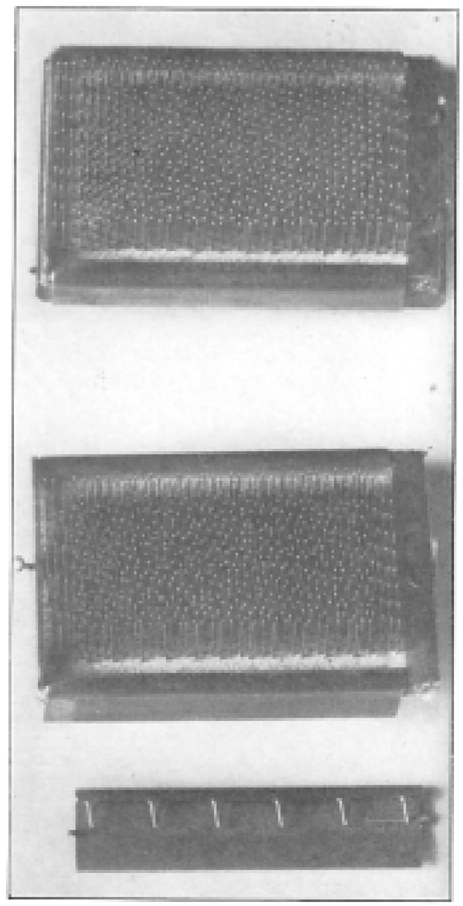

FIG. 3.—SHORT SECTION OF CARDING ENGINE FLATS, SHOWING CLOTHING AND HOLDING CLIP

cylinders and flats is done with a sort of rubber canvas, in which are set immense quantities of wire points. This wire is of hardened and tempered steel. In order to keep the wire perfectly bright, the processes of hardening and tempering are performed in a vacuum, thus keeping the wire away from oxygen. Messrs. Sykes Bros., of Lindley, Huddersfield, whose production is illustrated in this article, employ an electrical process of heating and are able to produce a perfectly smooth, bright wire. Card clothing is made on long bands 1½ inches wide for doffers, and 2 inches wide for the main cylinders, and it is wound tightly in

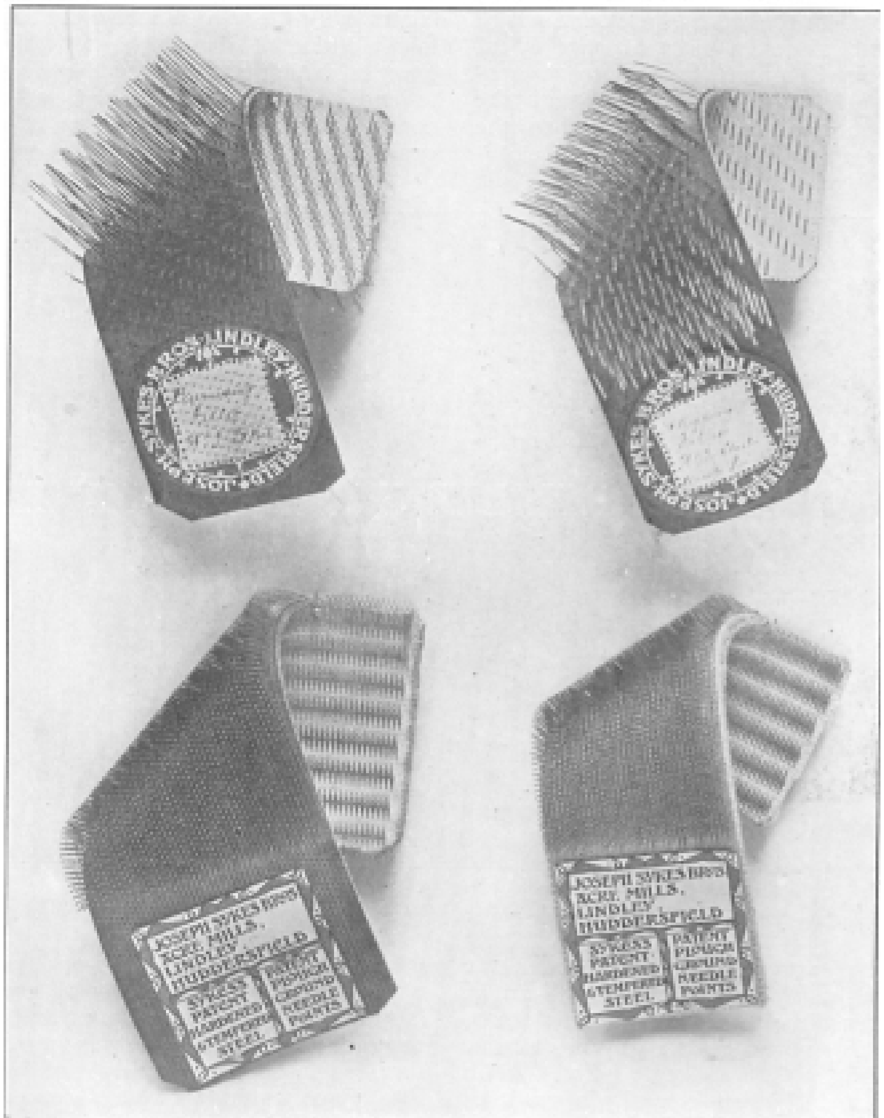

FIG. 4.—SAMPLES OF CARD WIRE CLOTH FOR STRIPPING AND BURNISHING

spiral form and nailed into wooden plugs let into the face of the cylinders. The machinery by which card clothing is made is very ingenious. Many of these machines run at 400 revolutions per minute, and at each revolution the cloth is pricked through in two places, a piece of wire is cut off from a reel, bent into a two-pronged staple, inserted through the two pricked holes and bent to the correct angle, so that when the clothing is attached to the cylinder the wires point forward at a small angle. After the cloth is in place, the points of the wire are all ground to one height and to a needle point. A bit of card clothing is really a work of art, and a beautiful piece of repetition work. The production of a carding engine per hour is only a few pounds of carded cotton, so that many millions of points of wire come into action in the process of carding each pound of fibre, the essence of good carding being the absolute separation of every fibre, and the removal of all curls or matted fibres. A rough parallelism is given to the fibres, and dust and short fibres are thrown off.

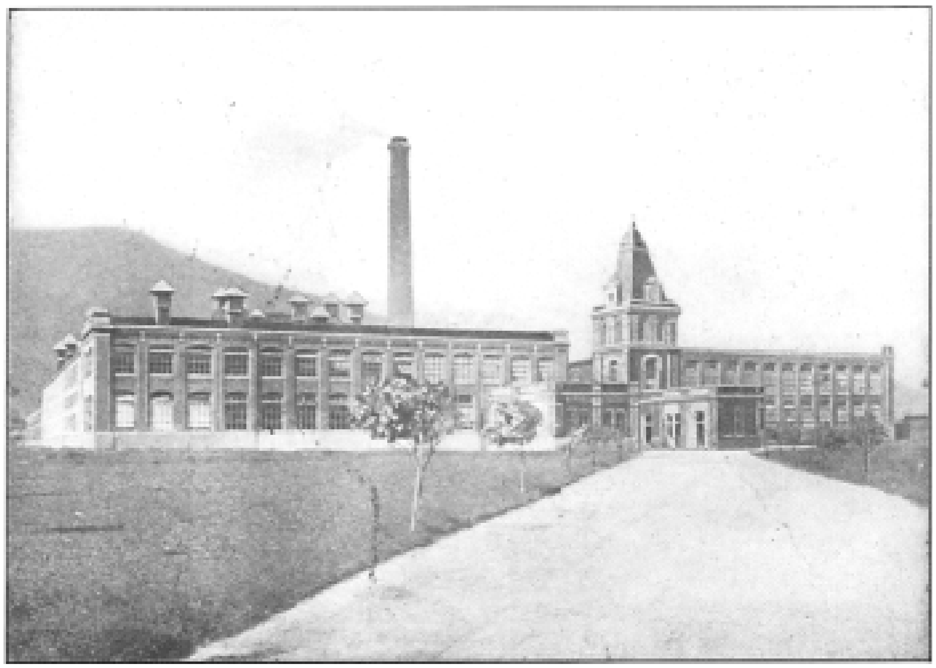

FIG. 5.—BANGU MILL, RIO DE JANEIRO, BRAZIL. PLATT BROS. CO., LTD., OLDHAM

Among the many modern improvements in cotton machinery are the stop-motions at many points, which cause a machine to stop if the sliver or end breaks, and the many safety checks which prevent the door of a gearing-box from being opened when a machine is at work, and when the box is open or some cover is open or removed, also prevent a machine from being set in motion until such cover is safely put back into place again. These safety devices obtain the approval of H. M. Inspectors of Factories.

Since the radius of the cylinder must vary, as the wires are ground shorter, it is necessary that the bends, or part on which the flats slide as they travel round the cylinder, should be flexible, so that by suitable setting screws they may be sprung into the smaller radius. Other methods are employed for producing the necessary concentricity: that of Messrs Platt Bros. consists of a narrow crescent bend *C* held at five points, at which are setting screws for constraining the flexible bend to the desired radius, the screws being held in a stiff arch bar as seen.

When the carded fibre leaves the engine, the thin, fleecy web, when held up to light, should show an even distribution of fibres over its area, an entire openness of fibres, a freedom from curls, webs or neps, and an absence of broken bits of leaf or husk. These latter are very persistent and can rarely be absolutely eliminated. Some remain to be dragged loose in the drawing frames, and some even appear in the final yarn, only to be removed when the yarn is passed through a narrow slot in a steel plate in the subsequent operation of winding upon other bobbins. In fine spinning the additional process of combing clears the cotton of almost the last trace of specks.

COMBING.

This latest addition to processes is only common in fine spinning mills, though there is an increasing tendency to apply the process to coarser yarns. As the cotton comes from the cards its fibres are not parallel. They can be made parallel by sufficient drawing, but by means of the comb they can be at once laid parallel. Combing serves also to remove all fibres that are less than the desired length. If a bundle of loosened fibre, such as a long curl of hair, be held near to one end and a comb be pushed down upon the hair and drawn away from the part held, all the fibres which do not extend so far as the point held will be pushed in front of the comb and separated from the remaining longer fibres, which will be stretched out straight and parallel by the passage of the comb teeth. If now the hair be held near to the other end—now combed out straight—and the comb again inserted and drawn towards the previously held extremity, it will comb out all the hairs whose ends are not

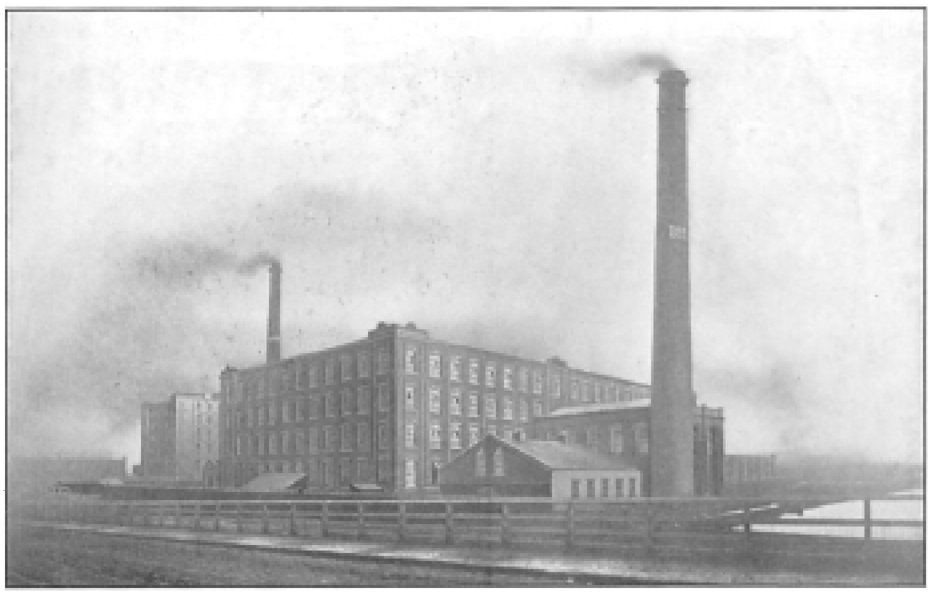

FIG. 6.—A MODERN PAIR OF COTTON MILLS. MACHINERY BY PLATT BROS. & CO., LTD., OLDHAM

held in this second hold. Obviously, all the hair now left will be longer than the distance between the two held points. This is the operation which is carried out by the combing machine. It is, of necessity, a discontinuous process, for the sliver to be combed must be projected in short lengths of an inch or more, according to quality; these ends must be combed out by one comb while held by a nipper further back; another comb must descend on the sliver at the combed side of the nip; the already combed end of fibre must be seized by a fresh nipper, and, the back nip or hold being released, the fibres must now be drawn away from the comb, and the short combed-out fibres will now remain behind this second comb. This comb is now released, the sliver shot forward another length, carrying the crumpled short fibres upon it as left by the second comb, and the back nip being again established upon the fibre, the first comb sets to work and removes this short fibre as well as combing straight the fresh projected ends. As each short length of sliver is combed out, it is laid overlapping the previously combed length and leaves this part of the machine as a continuous band again, and since each machine combs six slivers, there are six combed slivers finally laid together and combined into one sliver for the drawing operation which follows. To prepare the carded sliver for combing, some fourteen to twenty-four cans of card sliver are wound to form a cylinder from 7 to 12 inches in length. The united slivers are drawn out somewhat in passing through the three pairs of drawing rollers. The lap formed by this sliver-lap machine, Fig 7, is not quite even in thickness throughout its breadth, because the card slivers are not flat, but rather rounded in shape, and a sliver lap is a trifle corrugated if seen in cross-section.

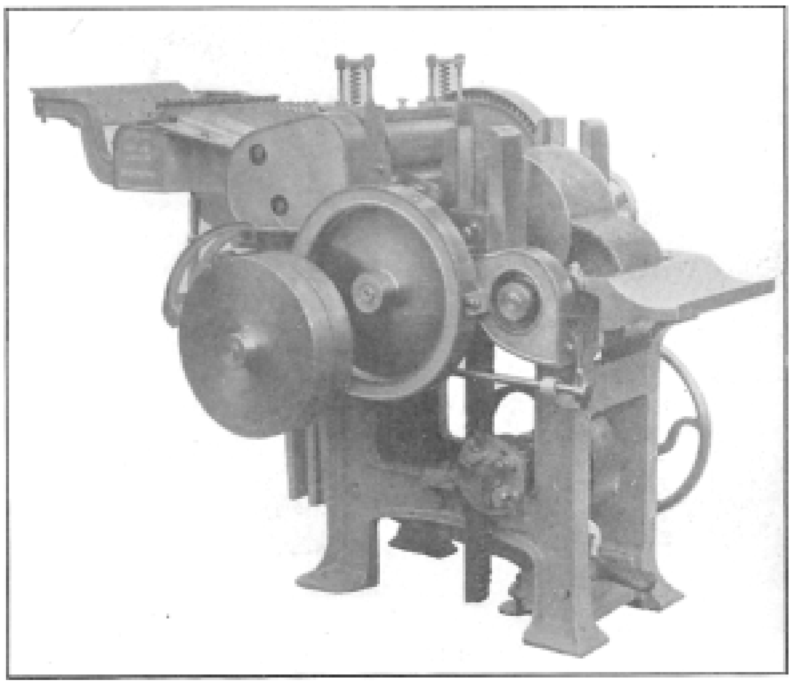

FIG. 7.—SLIVER LAP MACHINE. DOBSON & BARLOW, LTD.

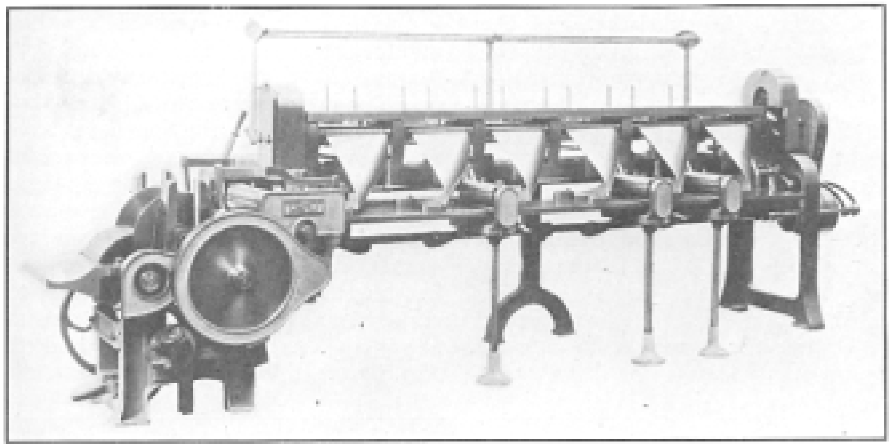

FIG. 8.—RIBBON LAP MACHINE. DOBSON & BARLOW, LTD.

Six of these sliver laps are now laid upon each other in a ribbon-lap machine, Fig. 8, each being drawn down between rollers, turned at right angles to the rollers and superposed, as shown, by peculiar turning plates, the whole being further drawn at the end of the machine and formed into a lap fit for the combs. All this drawing and duplication adds to the evenness of the flat sliver ribbon and enables the nips of the comb to hold all the fibres which come under the nip, this preventing excessive waste from slip, as well as helping to a preliminary straightening of the fibres, and so again saving long fibres which may be so much curled round as to be acted on as if short.

For this reason, some mills pass the card sliver through one head of drawing before preparing the lap for the combs, the sliver lap being made from slivers already passed through one drawhead and drawn six times in length.

To return to the combing machine, Fig. 9, this is usually made with six combs to comb six ribbon laps and deliver one combed sliver into one

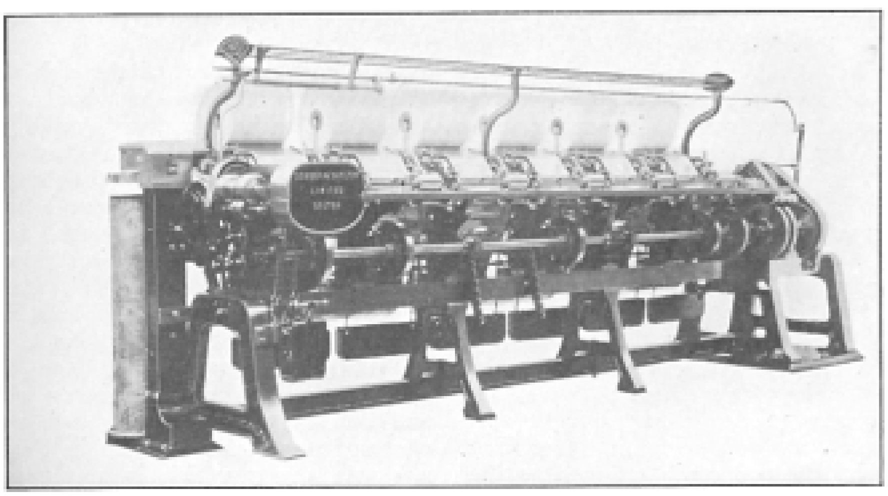

FIG. 9.—HEILMANN COMBING MACHINE. DOBSON & BARLOW, LTD., BOLTON

can. The ribbon lap is placed on rollers behind the machine, and the ribbon sliver is turned slowly off the rotating lap by the slow movement of these supporting rollers. It descends over a smooth plate and passes between two small feed rollers, which turn outwards intermittently to throw forward the length of fibre to be combed. Upon this fibre descends a nipper plate, which has a peculiarly curved edge, which nips the fibre upon the edge of a leather-covered plate below; the fibres to be combed hanging freely from the held point or nip below, while close up to the lower nip plate, in the combing roller covered with rows of comb teeth over part of its circumference. When the nip is made, the first row of teeth is ready to act. There will be as many as seventeen lines of short-comb teeth or needles, the first being coarser than the next, and so on, to the last finest set. These graduated teeth segments are all separately fixed. As the teeth pass through the out-hanging fibres these may be seen gradually to draw out straight and parallel, the noil or loose, short fibre left by the top comb, as well as the loose fibres in the projecting sliver, pass forward on the teeth of the cylindrical comb. A pair of small diameter rollers, which still hold the length of fibre previously combed, now commence to turn backwards and throw back the combed sliver ends over the ends of the freshly combed sliver, thus piecing up again the discontinuous web. These small detaching rollers now again turn forwards, drawing the new sliver ends between them, and the single top comb having descended upon the sliver in front of the nip, and the nip being released, the rollers now draw the sliver forward through the top comb, which pushes back the loose fibre, to be afterwards removed by the lower sets of combs as described. The waste on the lower comb is removed by a circular brush, picked off this by a wire-covered doffing roller, which, in turn, is stripped by a reciprocating comb. This waste is sold for the spinning of less fine counts.

FIG. 10.—DELTA MILL, ROYTON. MACHINERY BY PLATT BROS. & CO., LTD., OLDHAM

From the detaching rollers the combed sliver issues as a fleecy web, and the six webs made in each machine of six combs are combined into a single sliver, which is now ready for drawing. The Heilmann comb is made by all makers, but Messrs. John Hetherington & Sons make a form with a double nip, two sets of combs on the under cylinder and two blank segments instead of one of each as in the single-nip machine. The detaching roller, which swings to and fro, as well as turning backwards, for piecing up the combined sliver, is worked at double speed by means of two cams and more output is obtained. The nipper plate, as well as the detaching roller, has a swinging movement to and from the detaching roller, and by this movement it throws the combed sliver upon the ends which project from the detaching rollers and form the piecing. The ends are taken hold of by the rollers, and the top roller swings back from the advancing nipper and the top comb descends through the sliver, and both it and the nipper now retreat and comb back the sliver now held in the nip of the rollers. It must also be observed that in the cylinder comb there is a recess between the last row of teeth and the plain portion, into which, when the detaching rollers turn backwards, the thrown back ends of sliver enter and are stroked down under the lower detaching roller by the advancing radial face of the plain portion. It is on this stroked-down fibre that the piecing up is made, and the pieced sliver is then drawn forward as the rollers again turn forward. The forward turning of the rollers is, of course, greater than the backward turning. In the Nasmith combing machine made by John Hetherington & Sons certain improvements are made upon the original Heilmann machine, such as a greater overlap of the piecing, a slower advance of the nipper towards the rollers, and an easier and more gentle closing of the nipper, and a better output is obtained from this machine.

Following upon the carding engine for coarse counts, or after the combs for fine counts, comes the operation of drawing. As stated previously, a drawing operation may also take

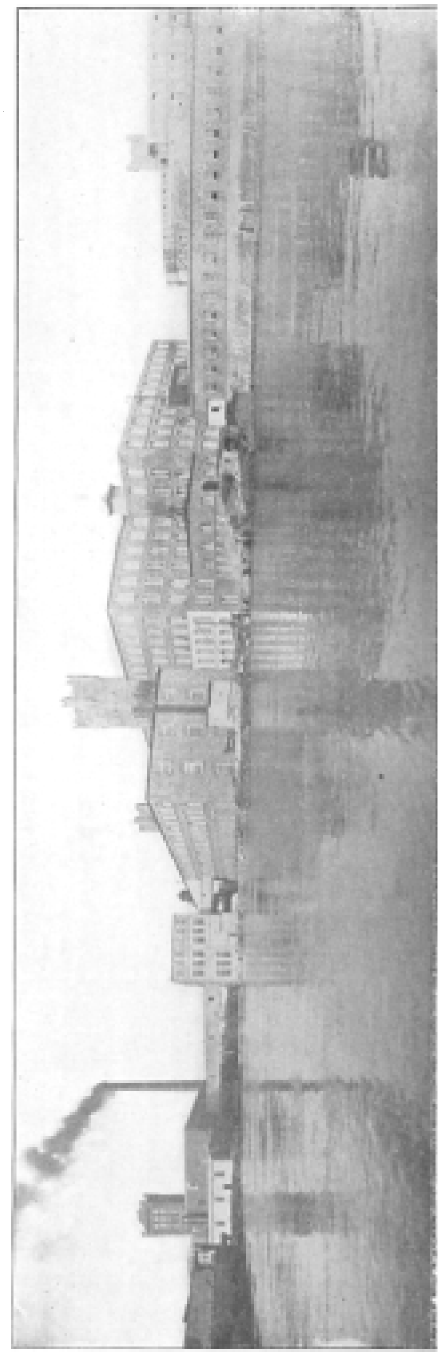

FIG. 11.—VALLEYFIELD MILLS, CANADA. MONTREAL COTTON CO., VALLEYFIELD

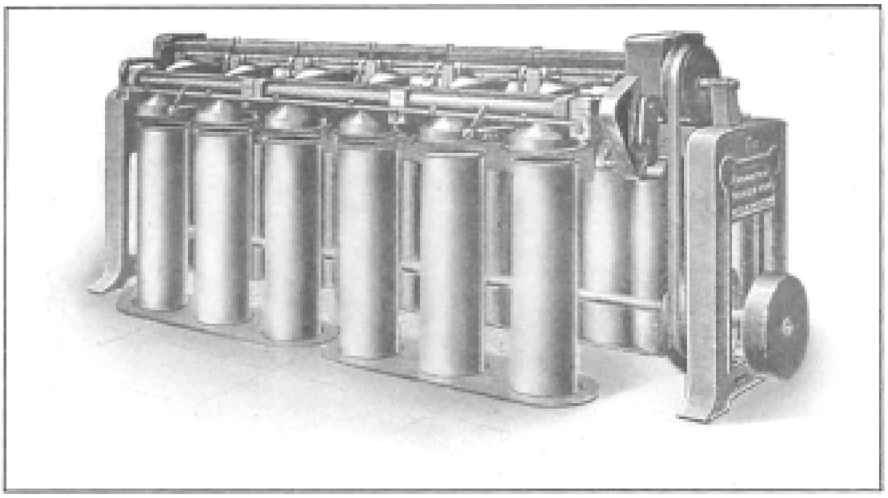

FIG. 12.—DRAWING FRAME. HOWARD & BULLOUGH, LTD., ACCRINGTON

place between the carding and the combing operations, in order somewhat to ease the duty of the combs and to prevent a little of the waste of long fibres, for the operation of combing will remove practically every fibre which is not held at one end, and even the longest fibres may be laid so transversely as not to be held by the nip. The draught in the sliver lap machine and in the ribbon-lap machine does much, however, towards laying fibres sufficiently parallel to be combed without undue waste.

DRAWING.

Drawing is one of the most important processes in the preparation of cotton for spinning. If a tuft of raw cotton from the bale or from one of the earlier opening or scutching processes be held between the thumb and fore finger of each hand and pulled slowly apart, preferably under a magnifying glass, it will be observed that many of the fibres are hooked or looped into others. Under the stress of the pull, the loosest end of a looped fibre is pulled from its hold on the other fibres and drawn out straight, and when the tuft has been pulled in two, the parted ends are seen to consist of approximately parallel projecting fibres. By laying the two tufts upon each other, with these fibres parallel and again pulling apart, and repeating this process several times, all the fibres will be found to have come unwound and to be lying straight and in one direction. The operation of drawing is a mechanical reproduction of this process. A drawing frame, Figs. 12 and 13, consists essentially of a frame carrying four rows of finely-fluted rollers with top rollers leather covered and weighted. About six or eight sliver cans to each section of roller are brought together and put through the rear of the four pairs of rollers. This roller rotates at a moderate speed; the second row of rollers runs 50 per cent. faster; the third row nearly 600 per cent., and the fourth 600 per cent. as fast as No. 1. The six or eight slivers are thus drawn down to one of about the same weight as each of the six or eight, and in this long draw, the curled and looped fibres have become much straightened out. The drawn sliver goes into a can just as it does when it leaves the carding engine, and six or eight of these cans are in turn passed through a second drawhead of four rollers, and usually a third, especially for finer counts. Thus, there may be two draws of 8 × 8, or three of 8 × 6 × 6, or three of 8 × 8 × 8, representing 64, 288 or 512 reduplications of the card sliver.

In this way any fault in any one lap has been reduced to one of no importance, impossible to be measured. The averaging capacity of the drawing frames is at the root of the evenness of the yarn. Each sliver as it enters the frame passes over a short channel end lever, so that if any sliver breaks, the lever drops back and by a simple gear stops the frame, which also stops if the delivery sliver should break or possibly catch up and wind on the fourth roller or other roller.

Thus the carded cotton, which arrives coiled in cans at the first draw head, leaves the last draw head in similar cans for the next two or three processes, known as first slubbing, intermediate and roving. The operation of drawing serves two purposes. First it produces parallelism of the fibres, and secondly it eliminates irregularities in the sliver by the averaging effect produced by the hundreds of duplications whereby any thick or thin sliver is nullified in its effect. Obviously, therefore, where the reduplication of the combing process and sliver lap machines is omitted, as with coarse counts, the drawing process will be of even greater importance, and for fine counts the fibres cannot well be made straighter than they are left by the combs, so that so extensive a system of drawing after combing is not so necessary. Still it is necessary to draw after combing, since the sliver from the combs is built up as described by laying each short combed length of fibre upon ends of adjoining lengths; and the sliver cannot, therefore, be quite even along its length, and must be made so by the reduplication effect of drawing.

The important matter to watch in the drawing frame is that the dis-

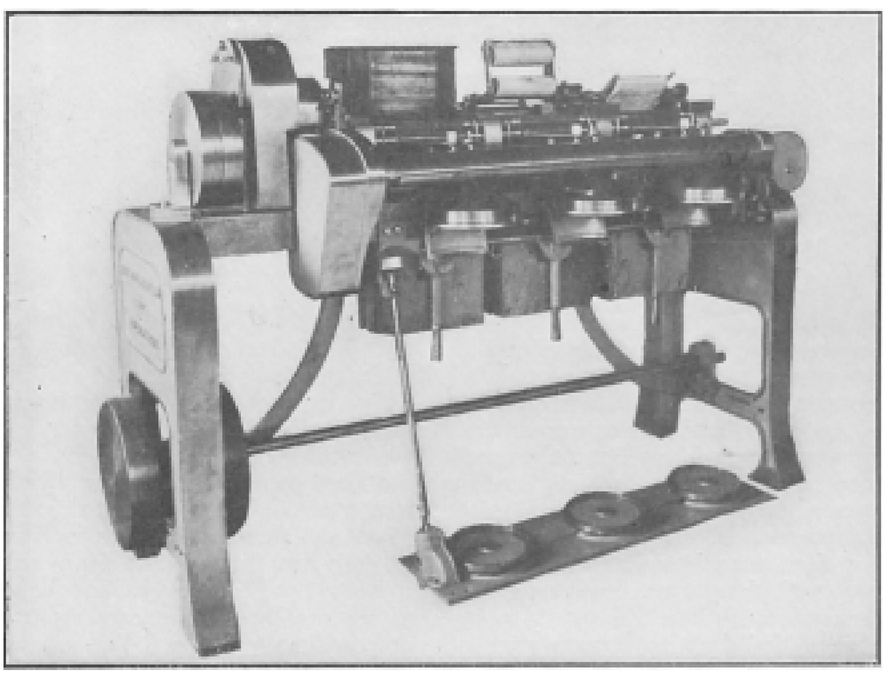

FIG. 13.—DRAWING FRAMES (THREE DELIVERIES), SHOWING ROLLER WEIGHTING, TOP CLEARERS RAISED AND DELIVERY CANS REMOVED. DOBSON & BARLOW, LTD.

tance apart of any pair of the four drawing rollers shall be greater than the longest fibres of the material. If this be not arranged there would be fibres held by two pairs of rollers at one time, and since any pair always rotates faster than the next behind it, the fibres would be broken in the draught, the leather covers of the top rollers would be destroyed by friction, and there would be an enormous addition to the power necessary to drive the mill. It would require several thousand pounds' pull to break the 70,000 threads that are at one time being spun in an ordinary mill. Each of these simple threads is represented by two places of pull in the spinning frames, by six equivalents in the intermediate machinery and by nine in the drawing, so that the actual pull is equal to the combined tension of a million and a quarter simple threads, or a possible 200,000 pounds. In brief, a mill with short-fibre machinery could not work long stuff, though the converse would be possible.

Since the drawing frame runs at a high speed, it is necessary promptly to stop it if a sliver breaks, and for this purpose the slivers run over a spoon lever at the entry side, and the breakage of a single sliver will stop the frame; for the lever, when released from the pull of the sliver, falls back slightly, and its lower hooked end is caught by an oscillating bar, and this causes movement to be communicated to the belt fork. Howard & Bullough apply electric stop motions at all points of the machine. Thus, if a sliver breaks the top roller naturally comes into contact with the lower roller, and this completes an electrical circuit and causes the machine to stop very promptly. Thus the electric stop will act if any sliver can runs empty or a sliver breaks; if the sliver laps round either the top or bottom front roller; if the sliver breaks at the delivery or front side of the machine, or when the delivery sliver can is full under the coiler. The electric stop motion depends on the fact that cotton fibre is a good insulator. The sliver delivered by a drawing frame is delivered into a can by a coiling plate above, exactly as in the can-filling motion of the carding engine or combing machine. The can has a slow rotation about its vertical axis, and the circle of the coiler is half that of the can, so that the sliver is coiled in a series of circles, each re-

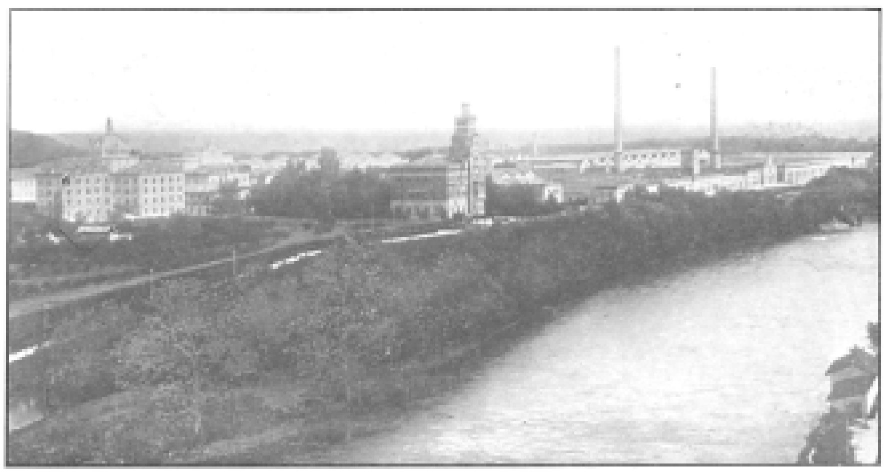

FIG. 14.—MILL OF MR. BONIGNO CRESPI AT CRESPI SULL 'ADDA, MILAN. MACHINERY BY PLATT BROS. CO., LTD., OLDHAM

moved slightly from the adjoining coil. In order to relieve the pull on the sliver as a can becomes empty, it is now quite usual to fit a loose bottom to the cans with a very light spiral spring below it. This raises the bottom and the coiled sliver upon it when the can becomes partially empty, and thus reduces the long hanging weight of sliver. This serves to prevent sliver from pulling apart or even slightly drawing out. This is especially desirable with combed sliver, for there is very little grip of the untwisted fibres upon each other, such as is given being only that of the compressing rollers through which the sliver passes on its way to a can. Up to this point, unless it be the very slight twist that is put in by the slow revolution of the cans, there is no twist in the sliver. No spinning has yet been done, but this commences at the next operation of slubbing, for a slubbing frame is a spinning frame pure and simple.

FIG. 15.—THE ORB MILL, WATERHEAD, OLDHAM

SLUBBING AND ROVING

Between the last head of drawing and the actual spinning there are two, three or even four reductions of the sliver carried out on the slubbing frame, the intermediate frame, the roving frame, and, in fine spinning mills, in the jack frame. These frames are all practically identical except as regards size. All of the same length, the first will contain usually 90 to 100 spindles with bobbins of 10 to 12 inches in length, the second 136 to 140 spindles with 9 to 11-inch bobbins, and the third will contain 176 to 180 spindles with 5 to 8-inch bobbins, while the fine roving frame will have 208 to 220 spindles. The spindles are set in two rows, alternating, and carry a flyer or fork, which is fixed upon the point of the spindle and extends downward the length of the bobbin. The flyer ends in a tubular top, and into this the sliver enters from the rollers, passes down one of the hollow legs of the flyer and emerges at the lower end, whence it is passed through the eye of a presser finger, which lays the reduced sliver evenly on the bobbin and presses it down firmly by virtue of pressure generated by the centrifugal force of a back vertical bar forming a part of the finger attachment. Since the rollers rotate at a uniform speed, the surface velocity of the bobbin must differ from that of the flyer by just this front roller speed. This is easily obtained by simple gearing, the spindle being driven by one shaft and the bobbin by another one. These shafts pass in front of one row of spindles and behind the other row and drive the spindles by skew bevel gears. The bobbins are carried by collars, which slide on the spindles and are similarly driven. But the bobbin-driving shaft is carried on the copping rail, which rises and falls through the height of the bobbin and the spindles pass through bearings carried by this rail. The rail rises or falls by the thickness of the roving (or slubbing) each rotation, and thus lays the roving closely on the bobbin. A full layer being laid on from end to end of the bobbin, the next layer finds the bobbin thicker by two diameters of the roving, and this renders it necessary that when the bobbin follows the flyer its speed shall be increased with each layer, and the reverse if the flyer follows the bobbin. A differential speed must, therefore, be placed in the course of the bobbin-driving gear, which becomes far from simple, after all. This differential gear consists of a pair of conoidal bell drums some 3 feet in length. One cone is driven at a fixed rate by the spindle train. The bobbin train is driven through a jack-in-the-box motion from this same cone shaft, but the frame of the jack in the box motion is driven by the second cone, which, in turn, is driven by a belt from the first cone. This belt has a shifting fork moved by a rack, and the rack is driven by a link train so as to move the cone belt at each reversal of the bobbin rail and to vary the bobbin speed for each layer of roving. The mechanism is so contrived that it also reverses the bobbin rail with a shorter traverse

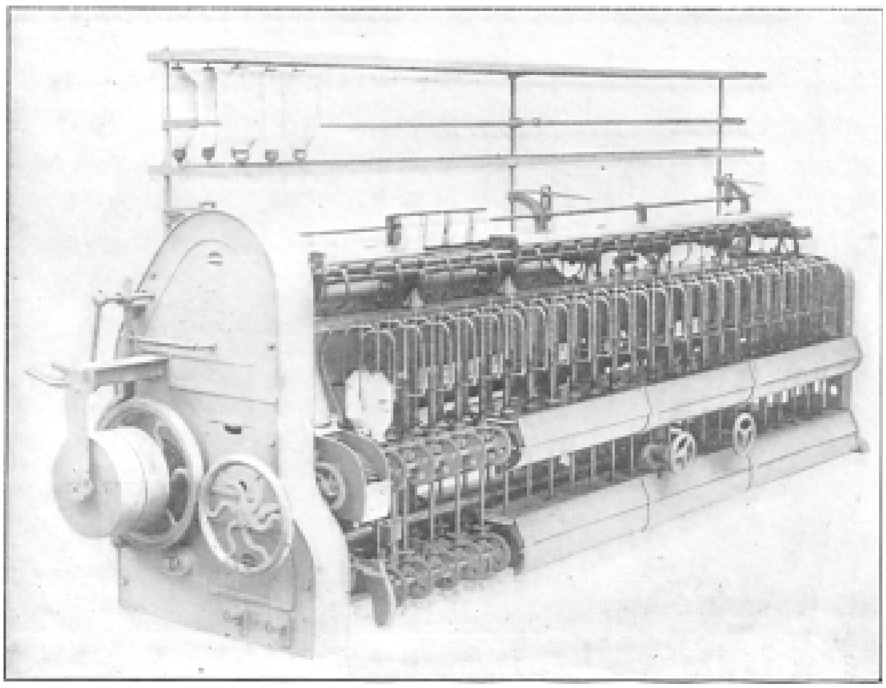

FIG. 16.—INTERMEDIATE SLUBBING FRAME. PLATT BROS. & CO., LTD., OLDHAM

every layer, the result being that a fitted bobbin consists of a parallel barrel of material coned down at each end to the bobbin, the angle per cone being about 45 degrees. Thus no ends are required on the bobbins, and the tubes are much less expensive than headed bobbins. The old-fashioned headed bobbins would chip round the edges of the heads and cause a lot of waste. In all these primary spinning frames the mechanism is identical, except in its size, and the object of these frames is gradually to reduce the material until it is about eight times the weight per hank of the final yarn. The spindles run at a speed of 440 to 600 for the largest size, 650 to 750 intermediate, 1,100 for roving, and 1,200 per minute for fine roving or jack frames; and the counts of the softly twisted yarn or roving vary from 0.5 to 1.3, 1.2 to 3.5, 3.0 to 7.0 and 7.0 to 16.0 or higher in the four frames, respectively, the number of turns or spinning thrown in per inch length being about 0.8, 1.4, 2 to 3 and 2½ to 4. There is, therefore, some slight cohesion of the fibres and some compression of the thread, but no very serious strength as yet, and there is a good deal of drawing yet to be done. In the first slubbing frame one can of sliver makes one thread of slubbing; but in the subsequent frames, Figs. 16-17, it is usual to effect a doubling of the thread from the previous frames.

The essentials of these machines are the usual three rows of rollers to deliver a fixed quantity of sliver; a spindle with a bobbin upon it, so driven by differential gear that the surface speed of the bobbin shall differ from that of the presser finger attached to the spindle by the amount of the front roller delivery; a variable-speed cone to effect this in conjunction with the differential gear, and a rising and falling rail to carry bobbins up and down their spindles at a decreasing traverse, so as to wind the yarn on the bobbin into cone shape. Before the invention of the differential motion the bobbins were

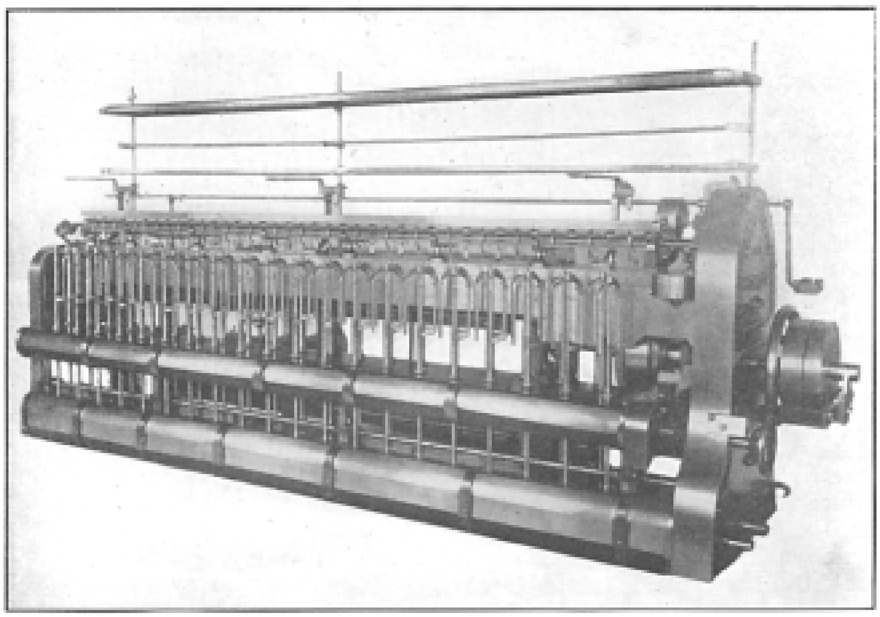

FIG. 17.—INTERMEDIATE SLUBBING FRAME (SHORT), BY DOBSON & BARLOW, LTD., BOLTON

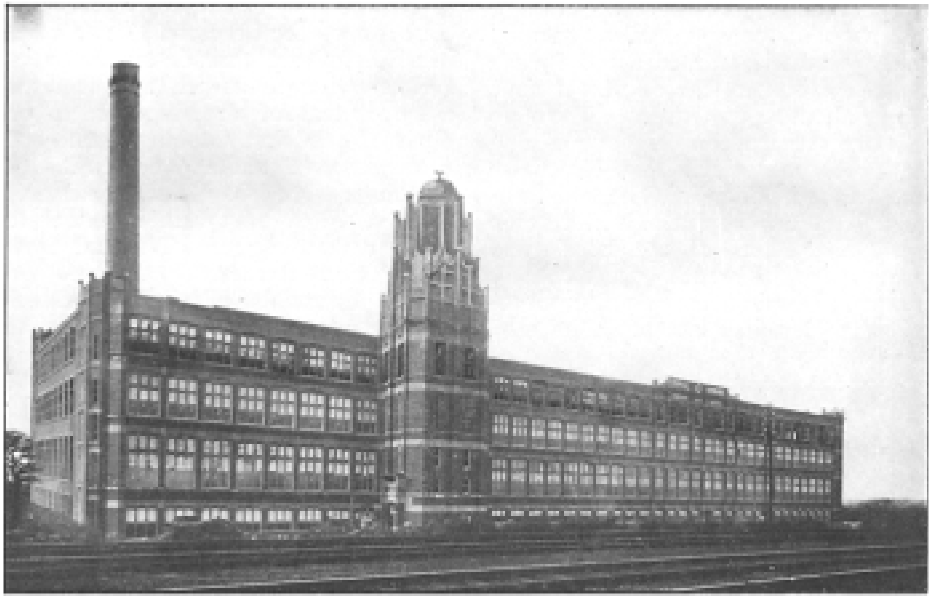

FIG. 18.—COPULL RING MILL, CHORLEY. MACHINERY BY PLATT BROS. & CO., LTD., OLDHAM

filled very loosely and held but little material; but the differential movement enabled bobbins to be hard wound and also allowed the roving to be made with a minimnm of twist, and thus the more easy of draught in the rollers.

Since the bobbin rail rises and falls, the bobbin driving shaft has to be driven through a radial swing frame from the fixed gearing; and, taken as a whole, these speed frames, as they have come to be called generically, are exceedingly ingenious adaptations of mechanism.

In coarse spinning these speed frames are the slubbing, the intermediate and the roving frame. In fine spinning a fine roving frame or jack frame is added to make a fourth in series of these preliminary reducing machines, Figs. 16-17.

They are practically identical in everything but size.

(To be Continued.)