COTTON-SPINNING MACHINERY. Under this heading are grouped the machines which convert raw cotton into yarn ready for weaving, namely: I. Openers; II. Eveners and lappers; III. Carding-machines; IV. Drawing-frames; V. Mules and other spinning machines; VI. Spoolers; VII. Warping apparatus; VIII. Dressing apparatus. These will be successively considered.

Of late years the processes of cotton manufacture have been materially changed in some respects, and especially in the means used for opening the cotton from the bale and preparing it for the card. The old "willow" is now entirely superseded in the best mills by the improved "opener," which delivers the cotton taken from the bale in a tightly-wound "lap," instead of in loose light masses, which were liable to take fire if there was any gritty or gravelly matter among the cotton, as is often the case. Such fires are very troublesome to extinguish if once ignited.

I. The Opener confines the cotton in an iron casing until it emerges in the sheet to be wound up

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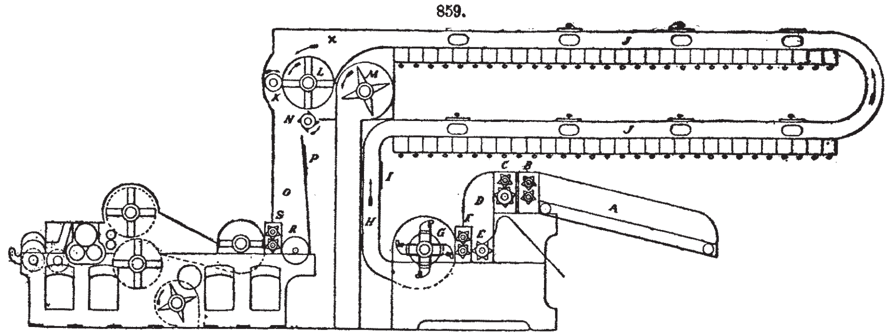
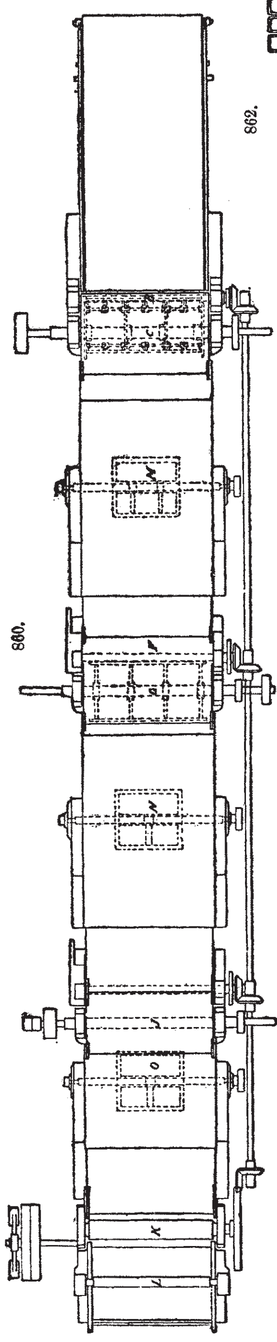


into a lap, ready to be transferred to the second machine, or lapper, where three of the opener laps are usually drawn down in thickness, and united in one, which in its turn is taken to the card. Two things are required to be accomplished by these machines: first, the thorough opening and loosening of the matted cotton as taken from the bales; and second, the removal of sand, stones, and seed, left by the gin, which are always found to a greater or less extent in the cotton as put up for market.

Fig. 859 represents an improved opener, built by the Kitson Machine Company of Lowell, Mass.,



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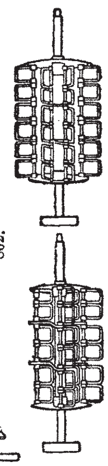

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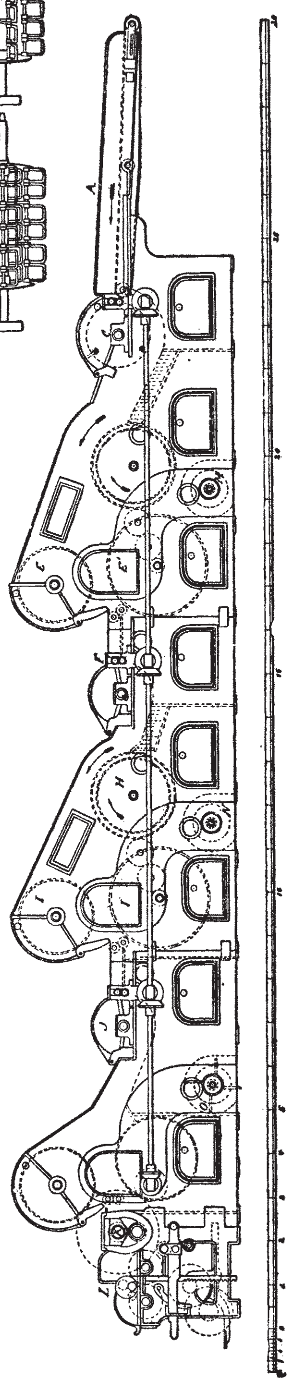


861.

and used in some of the principal cotton mills of this country. The feed-table or endless apron *A* receives the cotton and carries it to the feed-rolls *B*. The rolls *C* are the pulling or preparing rolls, and run twenty times faster than the rolls *B*; they consequently pull the matted bunches of cotton apart, and drop them in a softened condition into the gauge-box *D*. The rolls *F* and *E* receive this cotton from the gauge-box *D* in a sheet of uniform thickness, and carry it to the beater *G* in the opener. By the force of this beater it is blown through the circles *H* and trunks *J* to the condenser *X*, connected with which is the exhaust-fan *M*, which carries off the dust, and aids in pulling the cotton through the trunk. The entire bottom of the trunk *J* is made of hoop-iron slats standing edgewise a short distance apart, and the cotton, after being well opened by the preparing-rolls *C* and beater *G*, and blown over this sieve-like arrangement, is thoroughly cleaned. The roll *K* and the screen *L* in the condenser *X* slightly compress the cotton as it passes between them and drops into the gauge-box *O*. The ratchet-roll *N* acts as a clearer for the screen *L*, and at the same time throws out the surplus cotton if the gauge-box becomes too full. *P* is a glass door by which the operator can see the height of cotton in the gauge-box. The construction of this gauge-box and its connection with the rolls *S* and screen *R* are such that the cotton is measured in one uniform sheet to the lapper or scutcher, through which it passes and comes out in the form of an even lap, ready for the finisher-lapper or card. It is claimed for this trunk arrangement of machines that the cotton is cleaned in a more thorough manner than by the old process; that it will not clog in passing through, neither is there danger from fire; that the cotton is measured off by the gauge-box evener than it can be spread by hand, thus insuring an evener lap; and that the trunk, taking out the greater bulk of sand and grit before it reaches the lapper, saves the wear and tear of the same. This machine will open and clean 4,000 lbs. of cotton per day, with an expenditure of about 8 horse-power.

Another form of cotton-opener and picker, as built by Messrs. Whitehead & Atherton of Lowell, Mass., is represented in Figs. 860, 861, and 862. The cotton as taken from the bale is spread loosely on the feed-apron *A*, which delivers it to the feed-rolls *B*, from which it is taken by the hinged beater or whipper *C*, the details of which are shown in the smaller drawings on the right, Fig. 862, in which are exhibited the beaters which strike the cotton, and which are rectangular loops of best Norway iron hanging on rods, which are supported by the arms. The whole is driven by a belt-pulley, and the rapid motion causes the whippers to assume a radial position, as represented in Fig. 862, and strike the cotton from the feed-rolls, with a blow which is sufficient to remove the seeds and dirt, which fall through the gratings shown in the elevation, while the cotton is carried on to the wire-gauze cylinders *E E′*, from which the air is exhausted by the fan *M*. Passing through between these gauze cylinders, the cotton goes to another pair of feed-rollers *F*, from which it is again taken by the beater *G*, and carried on as before to the gauze cylinders *I* and *I′*, the air from which is exhausted by the fan *N*. The beater *J* again throws the cotton forward to a third pair of gauze cylinders, exhausted by the fan *O*, and from these it passes through the condensing-rollers *K*, and is wound up in a lap or sheet at *L*. The leaf-extractors *D* and *H* are large cylinders fitted with buckets like those of an overshot wheel on their periphery, and revolving slowly in a reverse direction to that of the cotton, as shown by the arrow. The cotton is thrown by the beater against the edges of these buckets, and much light material which has not fallen through the "grids" or gratings is caught in them, and dropped in their revolution into the dust-box under the machine.

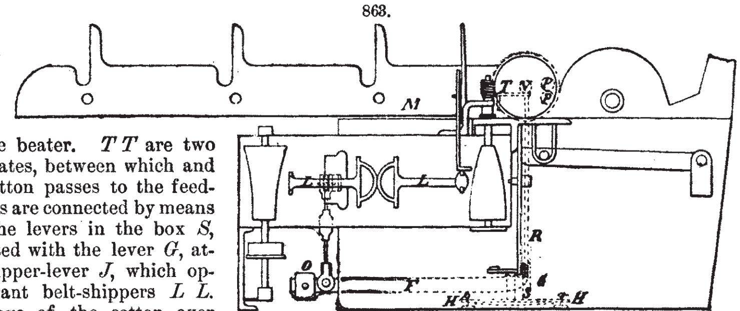
The peculiar merit and novelty of this machine, which is now very extensively used, lies in the hinged or flexible beater, which, while delivering an effectual blow on all the cotton which is fairly loose, will yield to a hard mat or cake, such as is often found in heavily-pressed cotton, until the successive rapid blows have so loosened it as to permit its easy separation, thus avoiding much of the jar and wear to the machine incident in the use of the rigid beater, and also saving power. These machines, as represented in the cuts, have been found by actual test to open and clean 4,000 to 5,000 lbs. of cotton per day, with an expenditure of less than 2 horse-power per 1,000 lbs.

The lap which is taken from these machines now passes to the second picker or lapper, when three laps are united and drawn down into one, which is taken to the card. This operation is intended to secure evenness in the thickness of the sheet delivered to the card, and this object is also aided by the improved "evener," as illustrated and described below.

II. Eveners and Lappers.—The object of an evener, applied to a finisher-lapper, is to regulate the supply of cotton which passes through the machine so that laps of any required weight can be obtained, without being compelled to weigh the cotton on to the feed-apron of the breaker-lapper. To accomplish this result, a number of different kinds of eveners have been invented, many of which have been open to the serious and fatal objection of not being sensitive enough to produce an even weight of laps, in consequence of the construction of the evener being such that the feed-rolls were obliged to serve the double purpose of holding the cotton while being operated upon by the beater (necessitating a great weight upon the feed-rolls to hold the cotton) and to even the supply of the same passing through the machine.

The construction of the Whitehead & Atherton evener, represented in Figs. 863 to 865, is such that its only office is to regulate the supply of cotton, while the feed-rolls have no direct connection with the evener to interfere with its sensitiveness. In Figs. 863, 864, *PP* are two feed-rolls for holding the cotton while being acted upon by the beater. *T T* are two of eight evener-plates, between which and the roll *V* the cotton passes to the feed-rolls. These plates are connected by means of rods *R R* to the levers in the box *S*, which are connected with the lever *G*, attached to the shipper-lever *J*, which operates the quadrant belt-shippers *L L*. During the passage of the cotton over the evener-plates, should an uneven surface present itself, the plates immediately under the part that is uneven operate, and either increase or reduce the supply of the cotton to the beater, as is required to produce a given weight of lap. The cotton, being delivered as evenly as possible in this manner to the lapper, passes through two more beaters, which complete the cleaning and prepare it for the next operation.

863.



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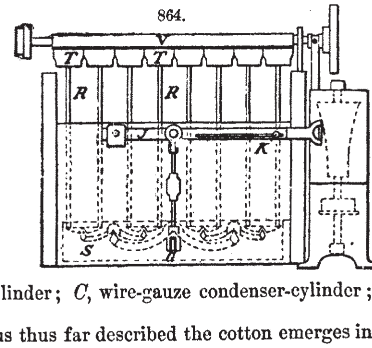
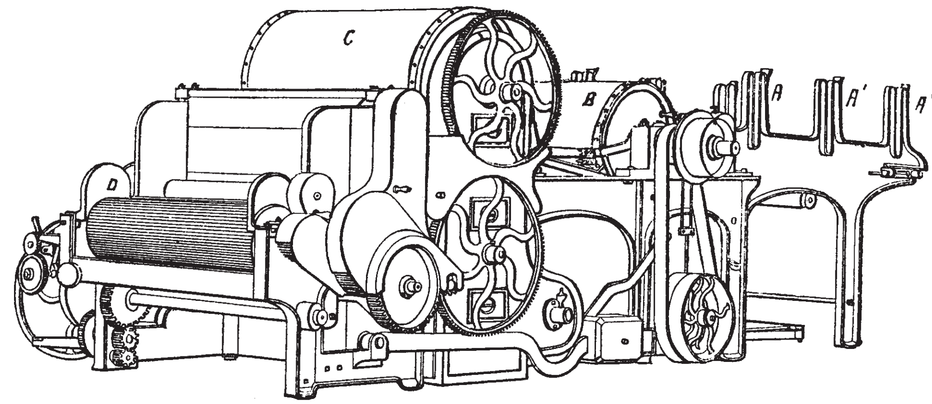


Fig. 865 is a perspective view of the finisher-lapper. At *A*, A^1, A^2 are the rests for laps from the opener. *B* is the beater-cylinder; *C*, wire-gauze condenser-cylinder; and *D*, the fluted roll for joining the laps.

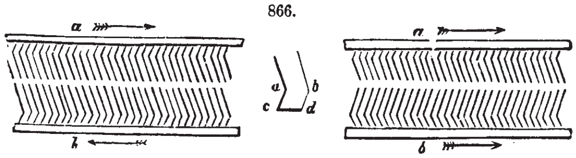
III. Carding Machines.—From the apparatus thus far described the cotton emerges in the form of a very clean, light, downy fleece called a lap, consisting of short fibres thoroughly disentangled. But these fibres are not *parallel;* they lie across each other at every imaginable angle, and any attempt to combine them together in this state would be fruitless; they must be rendered parallel,

865.



and to effect this is the object of *carding.* This is an important process, as regularity and perfection in carding are essential to the fineness and beauty of the cloth. Cards are formed of strips of leather, in which are inserted small staples of wire called teeth, having the projecting ends slightly bent in one direction. The strips of leather are fastened to flat surfaces or cylinders of wood or metal, and the cotton is passed between two or more of these surfaces. The teeth of cards are of various sizes, being thicker or slenderer to adapt them to coarse or fine materials. It is essential that the teeth should be all alike, equally distributed, and equally inclined over the surface of the leather. The teeth are implanted by pairs, and retained in it by the cross part *c d*, Fig. 866, at right angles with the teeth. The leather must therefore be pierced with twin holes at the distance *c d*, and in such a manner that the slope of the holes in reference to the plane of the leather be invariably the same; for otherwise, the teeth would vary with the angle of inclination, and the card would be irregular. The leather should be of the same thickness throughout, so that all the teeth may project an equal distance. Card-making requires a degree of precision which is hardly possible with hand work, and cards are now manufactured exclusively by machinery.

866.



Strict uniformity is necessary as to the size, shape, obliquity, and length of the teeth, and also in the angle which they bear to the cylindrical surface around which they are placed. The action of the cards will be understood from Fig. 866. If the two cards *a* and *b* on the left be moved in opposite directions, as indicated by the arrows, with a tangled tuft of cotton-wool between them, the fibres will be seized by all the teeth, one card pulling them one way and the other pulling them in the opposite direction. The fibres are thus disentangled and laid in parallel lines, each card taking up and retaining a portion of the cotton. All the cotton may be gathered on one card by reversing the position of the two, and placing them as shown on the right of Fig. 866. Then, by drawing the upper card *a* over the lower one *b*, the teeth of the latter offer no resistance, but give up their cotton to the upper card.

The following is a description of the card-making machine invented by Mr. Whittemore. Long sheets or fillets of leather, of suitable length, breadth, and thickness for making cards, are stretched by winding the fillets upon a roller or drum, from which it is conducted upward between guide-rollers to a receiving-roller at the top of the machine, where it is held by a cramp, by which means the leather is kept stretched.

The holes are pierced in the leather to receive the wire staples or teeth of the card by means of a sliding fork, the points of which are presented to the face of the leather, while the fork is made to advance and recede continually by the agency of levers, operated by rotatory cams upon a revolving main shaft. The leather fillet is shifted so as to bring different parts of its surface opposite to the points of the sliding fork, so that the holes shall be pierced at regular distances. This is done by cams, which shift the guide-rollers and confining-drums laterally as they revolve, and consequently move the fillet of leather at intervals to the distance required between the holes.

The wire of which the teeth of the card are made is fed from a coil on one side of the machine, and brought forward at intervals by a pair of sliding pincers, moving to and fro through the agency of levers, operated by rotatory cams upon the main shaft. The pincers having advanced a distance equal to the length of wire intended to form one staple or two points, this length of wire is pressed upon exactly in the middle by a square piece of steel, and being there confined, a cutter is brought forward which cuts it off from that part of the wire held in the pincers. The length of wire thus separated and confined is now, by a movement of the machine, bent up along the sides of the square steel holder, and shaped to three edges of the square, that is, formed into a staple; and in the same way the wire is cut and bent into staples as long as the machine is in operation.

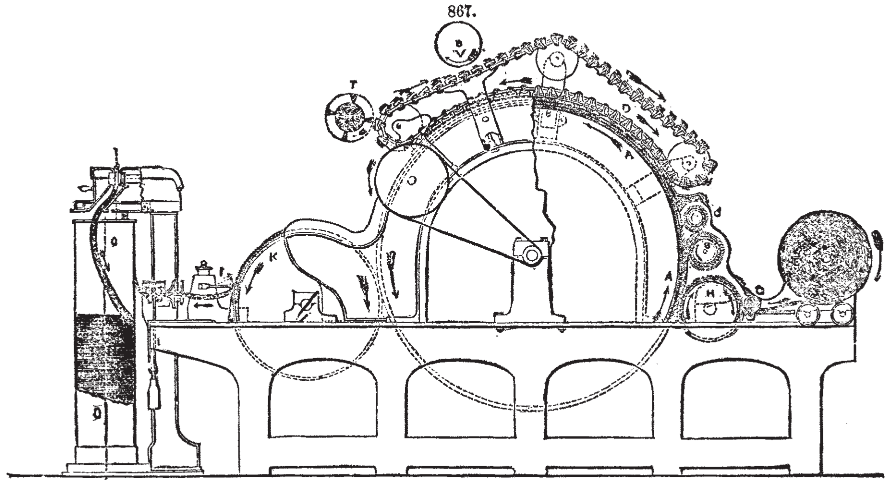
The wire staple is held with its points or ends outward in close proximity to the forked piercer before described, and by another movement the staple is moved forward, its points entering the two holes previously made in the leather by the sliding fork.

While the wire staple is being thus introduced into the leather, its legs or points are to be bent, that is, formed with a knee or angle. This is done by a bar or bed, which bears up against the under side of the wire staple when it has been passed half way into the holes in the leather, and another bar above it, being brought down behind the staple, bends it over the resisting bar to the angle required, forming the knee in each leg. A pusher now acts behind the staple, and drives it home into the leather, which completes the operation.

In this manner a sheet of card, sometimes called card-clothing, is made, of the kind usually employed for carding wool, cotton, or other fibrous materials. The wire staples are set in the leather, sometimes in lines crossing the sheets, which is called ribbed, or in oblique lines, called twilled, which variations are produced by the positions of the notches or steps on the periphery of the cam or indented wheel, which shifts the guide-rollers that hold the leather fillet as described.

The carding engine consists of one or more cylinders, covered with card leather or clothing, and a set of plane surfaces similarly covered, made to work against each other, but so that their points do not come into absolute contact. The action of the machine is substantially similar to that of the old hand-cards, which were simply wire brushes drawn past each other by hand in the manner already described. For making coarse yarns one carding process only is employed; but for finer yarns the cotton is first passed through a breaker carding engine, which performs the first rough carding; and the slivers delivered by this are then doubled by laying together a large number of them side by side and overlapping one another, so as to obtain sufficient thickness and breadth of material to allow of

867.



a further carding. The lap thus formed is fed into a second or finisher carding engine. As many as 96 slivers from a breaker card, each drawn out of a separate can, are laid together by a doubling machine into a single thickness for the supply of the finisher, in order that the mixing of the cotton may be more thoroughly effected, and more perfect uniformity insured in the sliver delivered by the finisher. For the finest qualities of yarn the finisher card is itself used as a breaker, and the sliver delivered by it is afterward combed by a combing machine. Fig. 867 shows the general arrangement of the mechanism of a carding engine such as is used as a finisher. The lap *E*, formed of a number of slivers, in this case from the breaker card, laid together into a fleece by the doubling machine, is carried by the feed-roller *G* to the *licker-in H*. The latter draws the cotton into the machine, so that its filaments are immediately seized by the large cylinder *A*, which generally rotates at a much higher speed than the drum *H*. The cotton is then teased out by the teeth of a "fancy roller," *B*, which runs in the same direction as the main cylinder. Its teeth, however, are bent forward in the direction of motion, and it therefore requires to be driven at a higher velocity than the carding cylinder, and has accordingly a surface speed of 2,000 feet per minute, that of the main cylinder being about 1,600 feet. The cotton is thus taken from the teeth of the main cylinder and thrown against those of the stripper *C*. The fibres, having thus been subjected to a preliminary carding, are again swept off the teeth of the stripper, moving at only 400 feet per minute, by the higher speed of the main carding cylinder. In some machines more rollers and strippers are added, so that knots taken out by the first drums and returned to the cylinder are again caught by others. Passing the combination of rollers, the fibres are next brought into contact with the cards of the top flats *D*, which arrest knots and hold them until the entanglement is removed, or until the flat is taken out and cleaned, which is occasionally done. The teeth of these flats are set to face those of the carding cylinder *A*, and travel forward in the same direction as the surface of the cylinder, but at a very slow rate. The flats are arranged to work at a slight inclination to the surface of the carding cylinder, so that the delivering side of each flat is closer to the cylinder, and a wider space is left at the entering side between the flat and the cylinder for the cotton to enter. The angle thus formed is called the bevel of the flat. On quitting the carding cylinder each flat in turn is stripped of any impurities by a vibrating comb. The flats are further cleaned by the brush *I*, and their surface is kept true by an emery-wheel, *V*.

The fleece of straightened fibres, which now lie in parallel rows among the teeth of the cylinder card, is removed by the doffer *K*, which is covered by a spiral fillet of cards revolving at a much slower rate than the cylinder, and in a different direction. From the doffer the fleece is removed by a vertically reciprocating comb *I*, called the *doffer-knife*, which has a rapid motion tangential to the surface of the teeth. The material is then contracted into a sliver by condensing rollers, which, revolving at a relatively greater velocity as the sliver proceeds, slightly draw it, and tend to make the fibres parallel. Thence the sliver is coiled down in the can *O*. The coiler consists of a revolving plate having an eccentric aperture, through which the sliver is passed from a pair of rollers above the plate. The can is also made to revolve with a slow motion in the opposite direction to the coiler, and the centre line of the latter is eccentric to the axis of the can, whereby the sliver delivered from the coiler describes a succession of curves in the can, which form coils continually crossing each other, so that when the sliver is removed its parts do not adhere together.

The breaker carding machine differs from that above described in having a series of pairs of carding rollers or workers and clearing rollers or strippers, arranged around the entire upper surface of the main cylinder. In each pair of rollers the fibre undergoes combing out and straightening. The means for taking the cotton upon the main cylinder and delivering it in coils are similar to those already detailed. Carding machines are sometimes made which are a combination of the breaker and finisher card, having rollers and clearers on the side of the cylinder next the feeder, and flats on the side next the doffer. The finisher carding machine was formerly constructed without the licker-in, the main cylinder taking the fleece directly from the feeding roller. This caused the fibres to clog the cards.

For the purpose of *sharpening the teeth*, when a carding engine is first filled with new sheets, fillets, etc., the cylinders are put in motion the right way, and a light emery-board, about 4 inches broad, is traversed over the top of the cylinders with a very delicate hand; this is called facing up the teeth, because the points of the wires are running against the board, and is intended to cut down any single wires that may be too long. After running the cylinders in this way about 15 minutes, their motions are reversed, and they are mounted on the main and doffing cylinders; these are denominated the fast-grinders, and, after being properly set, are caused to revolve in an opposite direction to the card-cylinders. This operation is continued until the whole of the teeth on both cylinders are ground down to one uniform length; but, during the process of grinding, the emery cylinders are made to traverse a little each way, so as to grind the wires to a round point, and prevent them from being hooked. The cards are then dressed up—first with a brush dusted with chalk, and then with emery-boards, called strickles; this latter process is called sharpening, and is continued daily to the breakers, and every second day to the finishers. The fast-grinders are not applied above once a year, or only when the cylinders on some part of the surface have become higher than on the other parts, or, technically, "off the truth." By this method of grinding the cards when necessary, and sharpening them every working day, they are always in good order, and consequently

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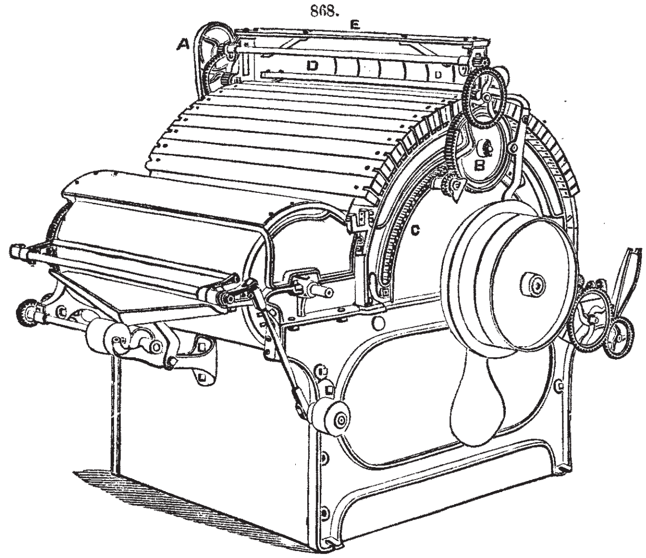
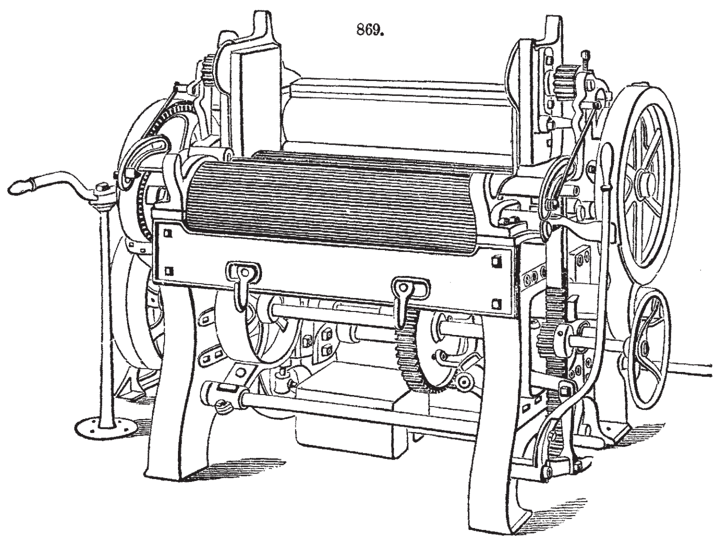


produce more perfect work: also, when the practice of sharpening is continued daily, it can be done in much less time; two men can easily sharpen 30 carding engines in the space of 4 hours. The card-belts being all fitted with buckles, no time is lost in making them long or short, for the purpose of reversing the motion of the cylinders. The tops are also brushed out and sharpened once a week.

Fig. 868 represents the carding engine ordinarily used in New England, as built by the Lowell Machine Shop, with Wellman & Woodman's improved self-stripper. The compound cam and mangle-wheel *B*, driven from the pulley *A*, traverses slowly from back to point of the card, and returns over its path by means of the semicircular mangle-rack *C*, stopping in its progress at each alternate top flat, which being raised from its seat by the spring bar *E*, driven from a cam on the opposite side of the card to the one shown in the drawing, the cleaner-comb *D* is passed under it, and on being drawn out removes the dirt and short cotton from the top flat, leaving it held by the curved wires shown in the drawing, until such a quantity has accumulated as to make it necessary to remove it by hand. This "stripper," which was introduced in 1856, has now become of universal use, not only saving a large amount of hand-labor, but also causing much less injury to the card-clothing than was caused by hand-stripping, from its even and steady motion. This motion is so arranged by cams as to strip the alternate flats, numbered 1, 3, 5, 7, etc., in its passage from back to front of the card, while on its return it cleans those numbered 2, 4, 6, 8, etc. By the form of the different cams and gears, the traverse motion of the stripper is arrested at each flat for the necessary length of time required to lift the flat, strip it, and return it to its seat before moving to the next one. The same form of card is used for both breakers and finishers, and the sliver of cotton is delivered from the doffer-comb into the "railway-box," a long box or trunk running the length of the section of cards immediately under the doffer, in which an endless belt, of leather or canvas coated with India-rubber, conveys the slivers from the section of cards in a parallel state to the railway or lap head, which is simply a set of rolls placed at the end of the section.

In the case of the breaker-railway or "lap-head," as it is called, Fig. 869, the slivers of a large number of cards, not often less than 64 or more than 96, are wound into a broad flat lap of the width

869.



of the finisher-card, to which they are transferred. This lap-head is shown in perspective in the engraving. The cards for this would usually be arranged in 4 or 6 sections of 16 each, according to the width of the mill, and placed longitudinally in the same; while at the end of each section a belt running transversely would receive the slivers from that section, uniting in one broad sheet at the lap-head, which would stand in line with the last section.

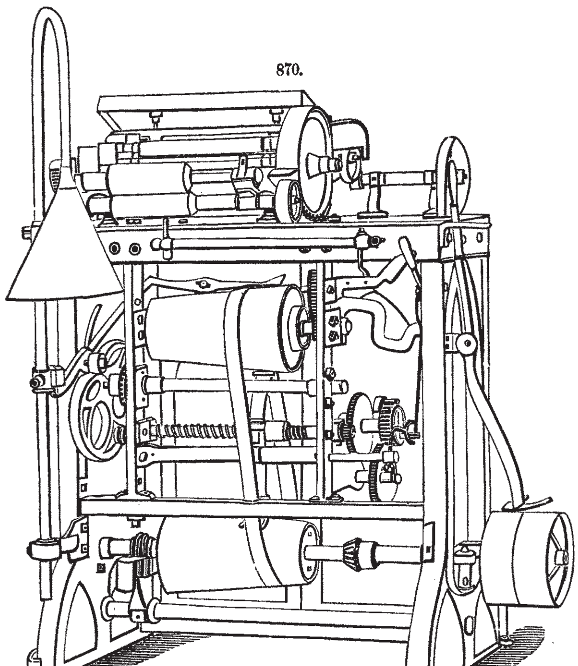
The section of finisher-cards is usually not less than 8 nor more than 16 cards, and the railway-head to the finishers consists of a set of drawing-rolls, as described in the "drawing-frame," usually with a draught of from 3 or 4 to 1. At this point the sliver is delivered into cans, which are carried to the drawing-frame. The number of cards in a section, and the draught of the railway-head, are regulated by the fabric to be produced, it not being considered advisable that the railway-sliver should weigh over 100 grains per yard. This sliver, on leaving the drawing-rolls, passes through a conical tube or "trumpet," accurately bored to a given size, which, by a system of levers acting on a belt in the interior of the machine, driven by one of a pair of conical drums or pulleys, so changes the speed of the front rolls that the sliver keeps its full size and weight when one of the cards is accidentally or intentionally stopped. This apparatus is known as "Hayden's railway evener and drawing regulator," Fig. 870. It is the invention of Newell Wyllis of Glastenbury, Conn., and D. W. Hayden of Providence, R. I., and has been improved by George Draper of Hopedale, Mass.

Still another form of card which has given successful results under practical test, invented and built by Messrs. Foss & Pevey of Lowell, Mass., is represented in Fig. 871. This, by using more flats, aims to produce the same result at one carding which formerly required two, thus saving one-half the room in the mill, and, as shown by the test annexed, one-third of the power and labor. The power required to drive cards varies with the amount of cotton carded per day, varying from one-sixth to one-third of a horse-power per card, including railway-heads, which respectively take about 1½ horse-power for the breaker lap-head, and one-half horse-power for the finisher-railway;

and the amount of cotton to produce the above results varies from 27 lbs. per day, single carding, to 60 lbs. per day, double carding.

The following gives the results of a power test of the Foss & Pevey under-flat cotton card, conducted at the Massachusetts Mill, Lowell, Mass., August 1, 1878: Eight top-flat breakers (old style) took 2.264 horse-power; eight top-flat finishers, with railway, 2.679; allowance for lap-heads, as by previous tests, .264. Sixteen top-flat cards, carding 520 lbs. cotton per day, took 5.207 horse-power; eight Foss & Pevey cards, including railway, carding 520 lbs. cotton per day, took 3.277; saving in power, 1.930, besides the saving in room and attendance, the quality and quantity of work being the same.

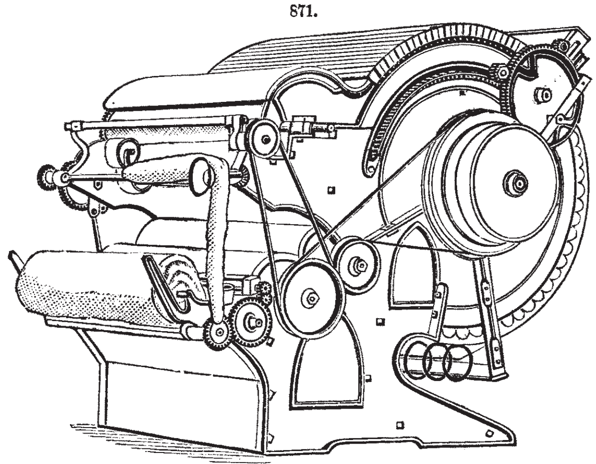
870.



The "top-flat" system of carding, as already described, is the one which has been generally adopted in the United States; but numerous important variations have been lately introduced, notably in the new combination card of the Whitin Machine Company, which adds the "worker and stripper," as used in wool cards, to a part of the top flats. In this case the cotton is taken from the feed-rolls by a licker-in, which delivers it to the main cylinder, and the flats, which it reaches first, collect the larger part of the leaf and shells before it reaches the workers, by which it is evenly distributed. This form of card is intended to work from 80 to 100 lbs. of cotton per day, or double the amount allowed to the flat card. A card is largely used in England, in which the positions of the parts are exactly reversed, the cotton being leveled by the workers and strippers before going to the top flats, which catch the dirt and waste.

Another form of English card is known as the roller card, and has no top flats at all, but uses the workers and strippers entirely. A card of this kind has been introduced in this country by the Messrs. Gambrill of Baltimore, and is known as the Gambrill card. One of these cards will turn out from 160 to 180 lbs. of cotton per day; it takes out less waste and cleans the cotton less thoroughly than the flat card, but is very serviceable with clean cotton or for coarse work.

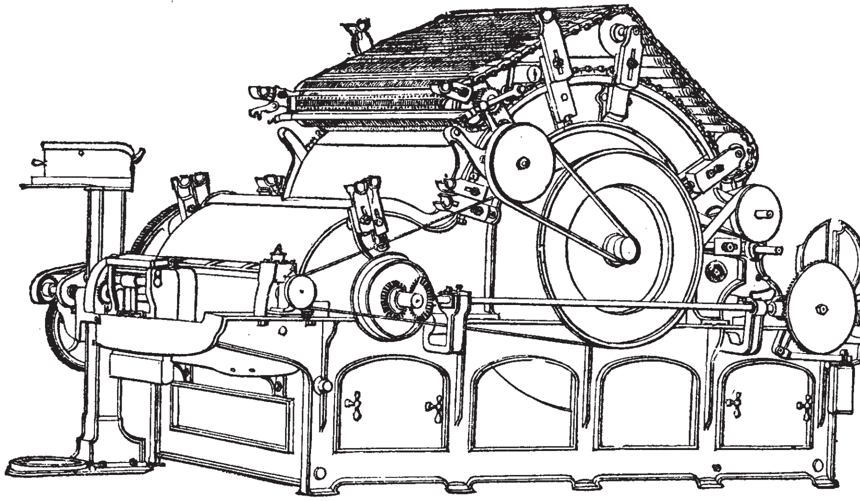
871.



Still another form of English card is represented in Fig. 872, in which the top flats are attached to an endless chain, which travels slowly in the same direction as the surface of the main cylinder, and by the operation of which, as shown in the cut, each card-flat is reversed in position as it leaves the cylinder to return to the starting-point. It is then stripped by a cleaner-card, which is stationary at that place.

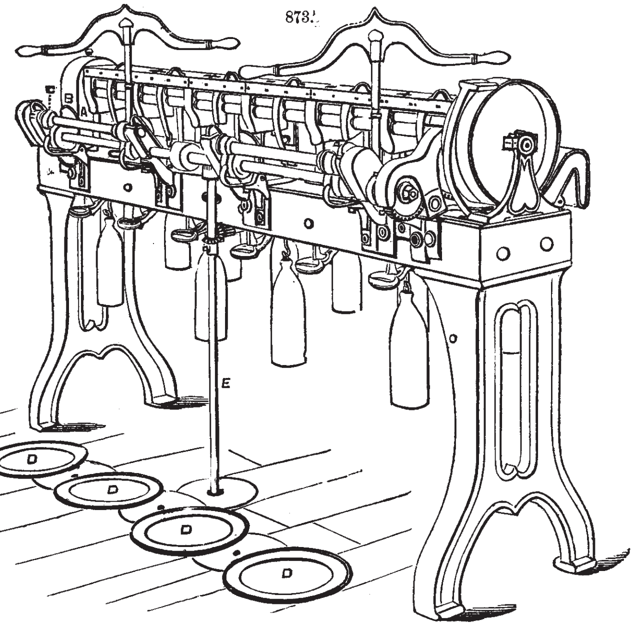
IV. Drawing-Frames.—The cotton leaves the carding engine in the state of a delicate, flat, narrow strip or ribbon, called a sliver; and these slivers have now to be converted into drawings by being elongated, narrowed, and thinned to a still more delicate condition. In the first place the slivers are collected in tall cans, from two to six in number, on one side of the "drawing-frame," and are from thence carried upward to two or more pairs 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 ribbon, because the more

872.



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 slivers are connected into one after leaving the rollers, and the united drawing passes through a kind of trumpet-shaped funnel, and thence is 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 per-

873.

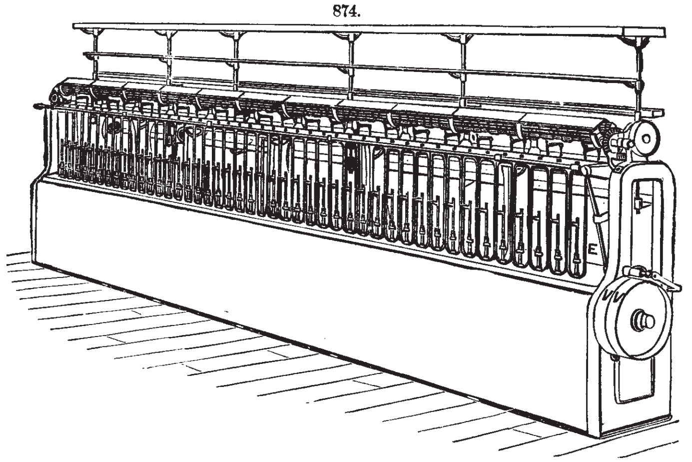


fectly equal in thickness in every part, and formed of parallel fibres; and in order to insure this, the drawing is repeated more than once, each narrow ribbon being "doubled" with others before each successive drawing.

The drawing-frame as built by the Lowell Machine Shop is represented in Fig. 873. The cans which have received the sliver from the railway-head, which is in reality a "first drawing," are placed behind the frame, and the attenuated sliver is delivered at the front through the rolls *A*.

Two or more of these slivers are united at the trumpet *B*, and compressed by the condenser-rolls *C*, and delivered again into cans which stand on the rotating plate *D D*, to which a reciprocating action from right to left and *vice versa* is given by the shaft *E*. The drawing-frame, as now usually built,

874.

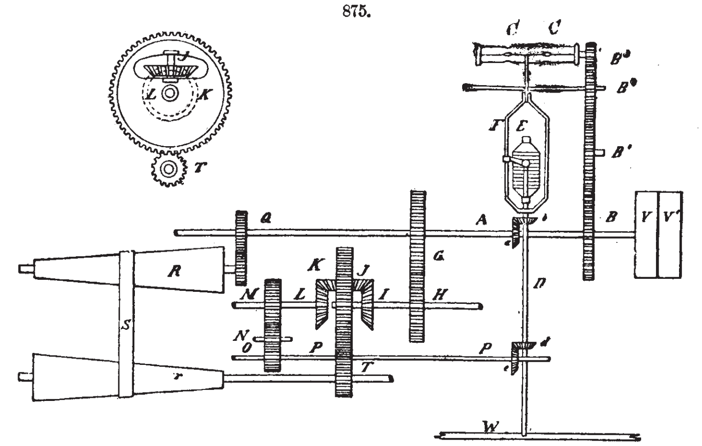


has 4 pairs of consecutive rolls, the speed of which varies according to the quantity and quality of the work desired. The draught or attenuation in the machine will vary, accordingly, from 3 to 4½ to 1, and the speed of the different rollers may be approximately stated as follows: first pair, 100 revolutions per minute; second pair, 125 revolutions; third pair, 130 revolutions; fourth pair, 300 revolutions. It will be seen by this that the draught is arranged to come between the first and second and the third and fourth pairs of rollers, the last being the greatest, and that between the second and third pairs barely sufficient to keep the fibres in tension. The average power of the drawing-frame may be taken at one-tenth horse-power for each delivery.

Roving-Frames.—Two sets of drawing-frames, known as first or second drawing, are usually employed, and from the second, Fig. 874, the sliver passes to the roving-frame, where it is brought to the state of *roving*. 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.

The "bobbin-and-fly frame" 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

875.



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. Instead of the bobbin-and-fly frame, in this country the speeder and stretcher are more commonly used, especially on the coarse yarns. The principal difference in the two machines is that, while in the fly frame the flyer is like an inverted U, and is screwed to the top of the spindle, requiring to be unscrewed and replaced each time the bobbin is dropped, in the speeder it is in the form of a flattened ellipse, as shown in the engraving, and of double the length of the bobbin, thus permitting the removal of the latter without disturbing the flyer. From two to four of these machines are successively employed to reduce

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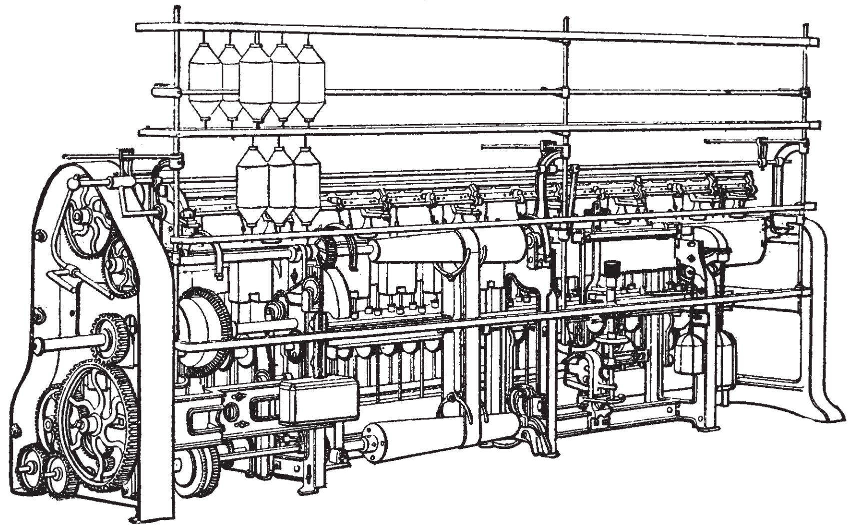
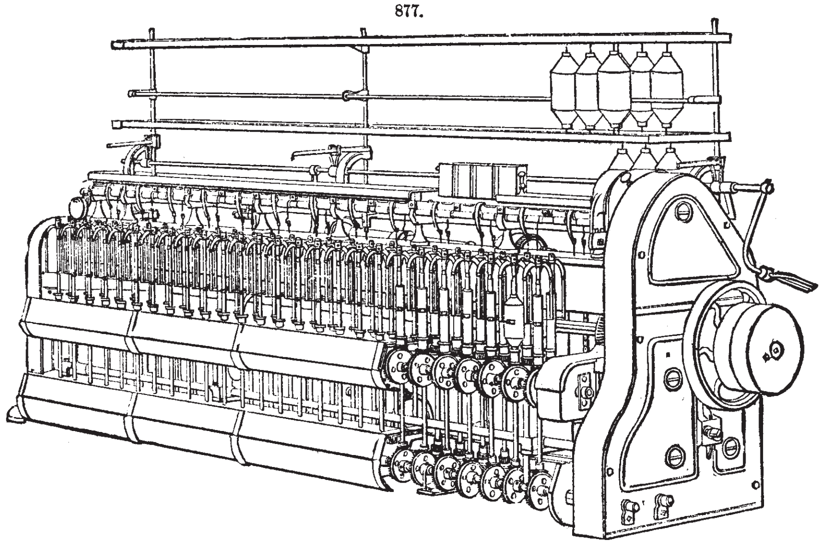


the roving to the proper size for the yarn to be produced, doubling the roving to insure greater evenness before drawing at each operation.

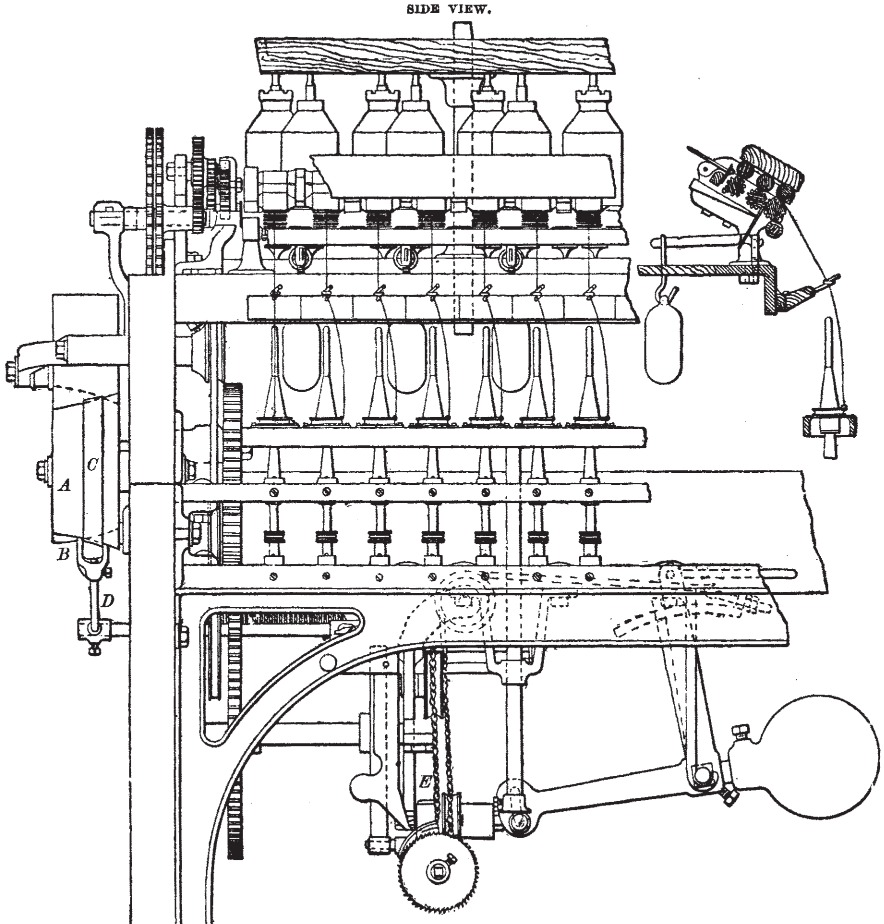
The mechanism of the Lowell speeder, as generally adopted at present in the United States for

877.



coarse yarns, is essentially the same as that of the fly frame, its principal feature consisting of the "differential motion," so called, invented by Aza Arnold of Providence, R. I., in 1823, and introduced by Henry Houldsworth in England in 1825. By this motion the velocity of the surface of the bobbin, which is continually increasing in diameter with each successive layer of roving, is kept uniform, and takes up the roving exactly as fast as it is delivered by the presser or finger of the flyer. This differential motion may be briefly described as follows, by reference to Fig. 875: *A* is the main or driving shaft of the machine, to which power is given through the pulleys *V V'*. The train of gears, *B*, B^1, B^2, etc., transmit motion to the drawing-rolls *C*, C^1, etc.; and the small bevels *a* and *b* carry the flyer *F*, which is always driven at the same speed, the amount of twist being regulated by the speed of the rolls *C*, C^1, which can be varied by changing the gears *B*, B^1, etc. These motions are positive and uniform during the operation of the machine on any given size of roving. The roving, coming from the rolls *C*, passes downward through the hollow tube of the flyer to a presser, by means of which it is wound on the bobbin *E*. As this bobbin increases in size with every layer that is wound upon it, a variable motion must be given to it to keep the surface velocity the same, and thus avoid breaking the tender roving. This is accomplished as follows: A gear *G* on the shaft *A* drives the bevel-gear *I* through the pinion *H*. *I* communicates motion through *J* to *L*, and thence through *M*, *N*, and *O* to the shaft *P*, which, by means of the small bevels *c* and *d*, drives the spindle *D* and the bobbin *E*. Were the bevel-gear *J* stationary, the motion transmitted would be the same as that received, only reversed in direction; but, in order to accomplish the desired result, it is given a motion around the centre of the shaft *H I* by having its own axle inserted in the web of the large gear *K*, which moves freely on the shaft *H I*, and to which motion is given by the pinion *T*, which is driven from the shaft *H* by the gears shown at *Q* and the cone-pulleys *R* and *r*, and the belt *S*. Now, if the gear *K* be made to revolve around the shaft *H I*, carrying with it the fulcrum of the bevel *J*, it is obvious that the motion of the bevel *L* and its consequent train of gears will either be advanced or retarded, according to the direction given to the gear *K*. In order to retard the revolutions of the bobbin in proportion to its constantly increasing diameter, the gear *K* is therefore made to move in the same direction with the bevel *I*; and, as each successive layer of roving is put on to the bobbin, its velocity is increased by the shifting of the belt *S* from left to right on the cone-pulleys *R r* by a ratchet motion not shown here, but which is operated by the same action which lifts and lowers the bobbin for each successive layer. This is done by raising and lowering

878.
SIDE VIEW.



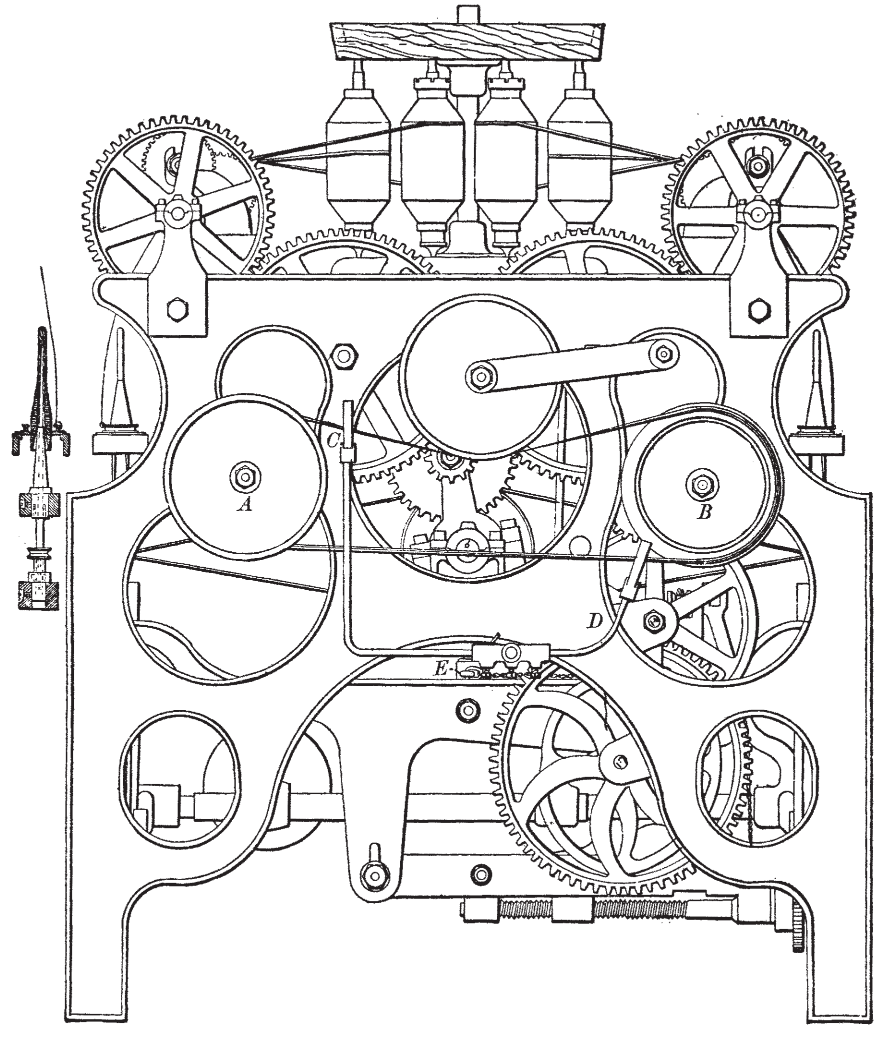
the rail *W*, in which the spindles are stepped, the spindles being splined, and sliding up and down through the driving-gear *d*. The exact proportions are not given in this drawing, the object being only to explain the motion, which is one of the most beautiful and important in its effects of any in the process of cotton-spinning.

Fig. 876 is a rear view of the ordinary form of English roving-frame, exhibiting the general arrangement of the gearing; and Fig. 877 is a front view, showing the spindles and the gears by which they are driven. These machines are built by nearly all the principal makers of cotton machinery in the United States, and are generally used for fine yarns.

Draper's filling-frame, Figs. 878 and 879, the invention of Messrs. George Draper & Sons of Hopedale, Mass., is designed to accomplish the object of spinning a soft-twist bobbin of weft, like the mule "cop," for use in the shuttle. The great difficulty in previous attempts to accomplish this

879.

END VIEW.

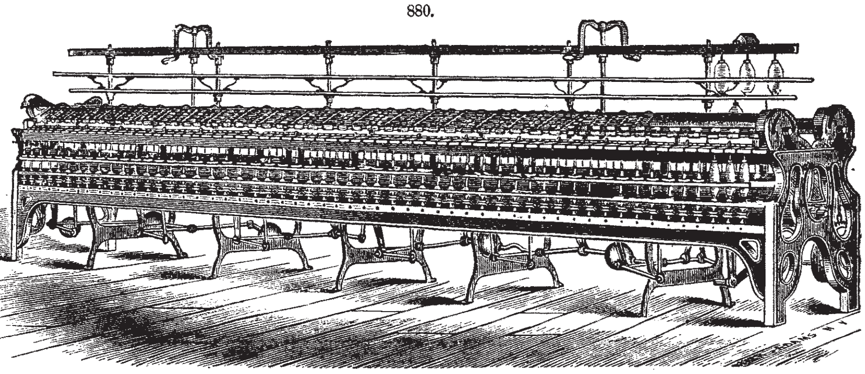


purpose has been that, when the yarn was being wound on the spindle at the extreme or "nose" of the cop, the pull on the traveler was so directly radial that it reduced the size of the yarn, by stretching it, to a finer number than when it was winding on the base of the cop, where the pull was more tangential. This objection the Messrs. Draper seek to obviate by diminishing the speed of the front rolls at the time the yarn is winding on the small barrel of the bobbin, so as to give less draught at that time, and consequently a coarser yarn is delivered from the rolls; but it is reduced to its proper size by the tension between the traveler and the bobbin. This is accomplished by the use of the cone-pulleys *A B*, by which the front rolls are driven independently of the others, and the driving-belt on which, *C*, is traversed from right to left by the shipper *D*, which in turn is moved by the chain *E*, connected with the lift motion, which gives the traverse to the ring-rail in such a manner that, when the rail is up at the top of the wind, the front rolls are receiving a slower motion than when it is down on the base of the cone. The drawings will fully explain all the details. This frame, though a very recent invention, is being widely introduced, as it produces a soft-twist weft, similar to that spun on the mule, with great rapidity, and occupies but one-half the floor space of the mule in a mill, while it can be tended by a cheaper class of operatives.

All previous attempts to spin weft in the frame directly upon the spindle without the use of a bobbin have proved failures eventually. The use of the bobbin also saves 50 per cent. of the waste.

Spinning-Frames.—The roving, having been reduced to the proper size for the intended number of

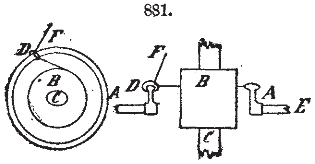
880.



yarn, now goes to the spinning-machine, which may be a throstle or mule; the ring-throstle being generally used in the United States for warp, and the mule for weft, though either machine is occasionally employed for both purposes. Fig. 880 shows the ring spinning-frame of the latest pattern, as built by the Whitin Machine Company.

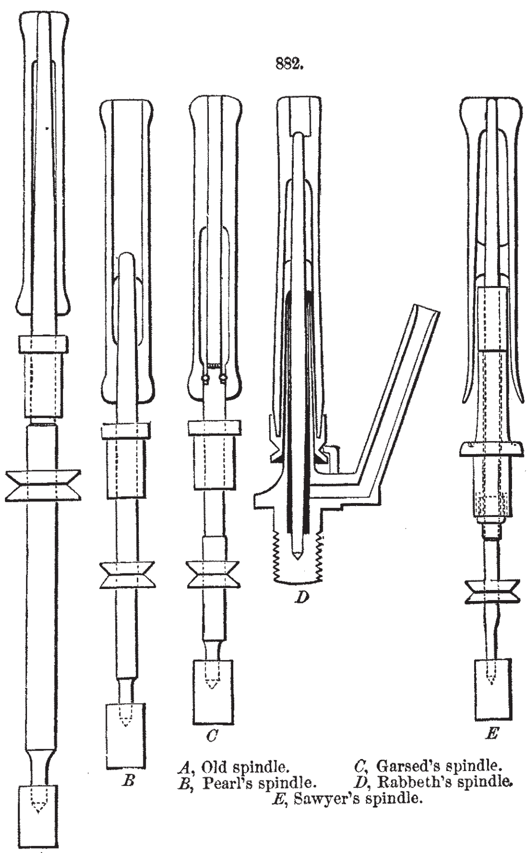
The principle of the ring spinning-frame is very simple. The spindle is driven by a band from a central cylinder, and the bobbin is held upon the spindle by a slight friction, and revolves with it,

881.



the yarn being wound upon the bobbin by the friction of a "traveler" or small metal hook, which is carried by the yarn around a ring of hardened iron, which is concentric to the spindle, as in Fig. 881, where *A* represents the plan and section of the ring, *E* the ring-rail which carries it, and which rises and falls to give the traverse to the yarn on the bobbin *B*, which is carried by the spindle *C*, and gives the proper twist to the yarn. *D* is the traveler, which is carried by the thread *F*, and the resistance or "drag" of which winds the thread on the bobbin as fast as it is delivered by the spinning-rolls, the operation of which is identical with that of the rolls in the drawing and roving processes, being the fundamental principle as invented by Arkwright.

882.



A, Old spindle. *B*, Pearl's spindle. *C*, Garsed's spindle. *D*, Rabbeth's spindle. *E*, Sawyer's spindle.

Great improvements have been made since 1870 in the construction of the spindles and bobbins. The first of these was the invention of Oliver Pearl of Lawrence, Mass., and consisted in cutting off 2½ inches from the top of the spindle, thus lessening the tendency to vibration, boring out the bobbin to a thin shell, and then strengthening it by reënforces, or bushings, at the bottom, top, and centre, the centre bushing being at the height of the top of the spindle, and by its adhesion thereto, combined with the adhesion of the bush at the bottom, getting friction enough to be carried around with the spindle. This reduction of weight above the bolster admitted of a much larger reduction below, so that the weight of the spindle was reduced from 12 or 13 ounces to 5 or 6 ounces, and the bobbin from 1¼ ounce to half an ounce, saving one-third of the power required to drive the spinning in a mill, or one-sixth of the whole power required in the manufacture.

A reference to Fig. 882 will show the difference from the old form of spindle, and also the forms of the Sawyer spindle, which was patented by Jacob H. Sawyer of Lowell in 1871, the Garsed spindle, and the Rabbeth spindle.

In the Sawyer spindle the bolster, or upper bearing, is at the top of a tube, which reaches half-way up into the bobbin, the latter being chambered out to receive it, and supported on the spindle by two "bushes," or reënforces, one at the top of the bobbin, and one just above the tubular bolster. By this arrangement the centre of gravity of the full bobbin is brought down close to the fulcrum, and the vibration of spindle and bobbin lessened still further than by Pearl's patent, with a somewhat greater saving of power, the spindle being, as before, reduced to 5 or 6 ounces.

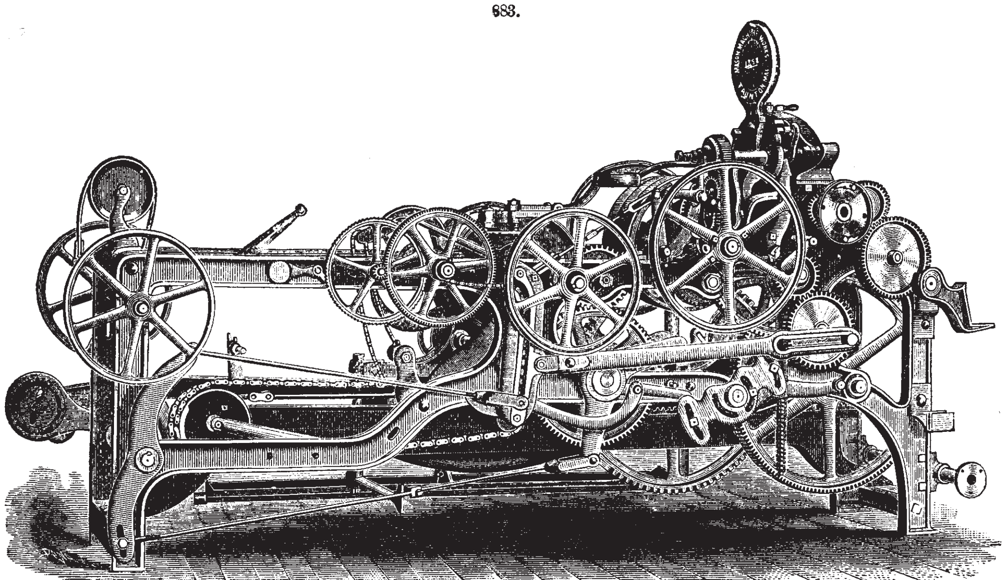
Another light spindle was introduced by Richard Garsed of Frankford, Philadelphia, in 1872, in which the bobbin is chambered out for half its height from the bottom, or nearly to the top of the spindle, and a reënforce inserted at the bottom, two steel wires passing through, forming a clutch, which engages on a squared shoulder on the spindle, just above the bolster, and driving the bobbin by a positive motion, the pit of the bobbin at the top of the spindle not being tight enough to cause friction.

Still another form, introduced in 1871–'72, is the "Rabbeth" spindle, built by Fales & Jenks of Pawtucket, R. I., in which the bobbin is similar to that of the Sawyer, but in which the spindle runs in a tube full of oil, a sleeve carrying the driving-whorl, on its lower end, being so attached to the spindle as to overhang the tube, and with it be introduced into the lower half of the bobbin, which is partially supported and driven by it.

Many thousands of each of these forms of light spindle are now in operation, saving from 33 to 40 per cent. of the power formerly required, or admitting of being used at such increased velocity as materially to increase the product of a given number of spindles with the same power as before.

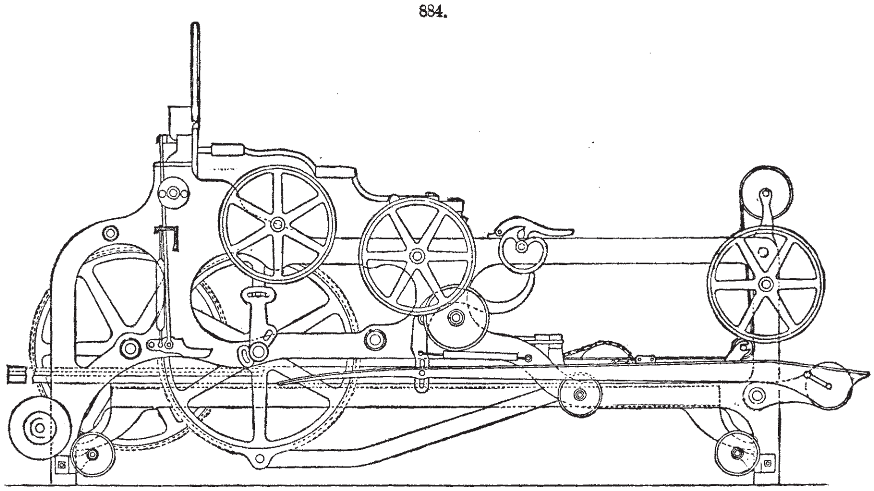
V. Mules.—In these machines the rovings are delivered from a series of sets of drawing-rollers to spindles placed upon a carriage, which travels away from the rollers while the thread is being twisted, and returns toward the rollers while the thread is being wound. The drawing and stretching action of the mule-spinner makes the yarn finer and of a more uniform tenuity than the mere drawing and twisting action of the throstle. As delivered by the rollers, the thread is thicker in some parts than in others; and the thicker portions, not being so well twisted, are softer and yield more readily to the stretching power of the mule, by which means the twist becomes more equable throughout the yarn. Throstle-spinning is seldom employed for numbers higher than 40 or 50 hanks to the pound, because smaller yarn would not have strength enough to bear the drag of the bobbin; but in mule-spinning the yarn is built upon the spindles without subjecting it to appreciable strain. The mule-carriage carrying the spindles recedes from the rollers with a velocity somewhat greater than the

883.



rate of delivery of the reduced roving, the rapid revolution of the spindles giving a twist to the yarn which stretches it further. When the rollers cease giving out the rovings, the mule-spinner still continues to recede, its spindles revolving, and thus the stretching is effected. The distance to which the spindles recede from the rollers while both are in action is called a *stretch*. This is usually from 54 to 56 inches. The space over which the carriage moves in excess of the paying out of the rollers is called the *gaining* of the carriage. The space traversed by the carriage after the paying-out action of the rollers is stopped is called the *second stretch ;* during this, the spindles are revolved very rapidly to save time. When the drawing, stretching, and twisting of the yarn are accomplished, the mule disengages itself from the parts of the machine by which it has been driven, and the carriage is returned to the rollers, the thread being then wound upon the spindle. The specific differ-

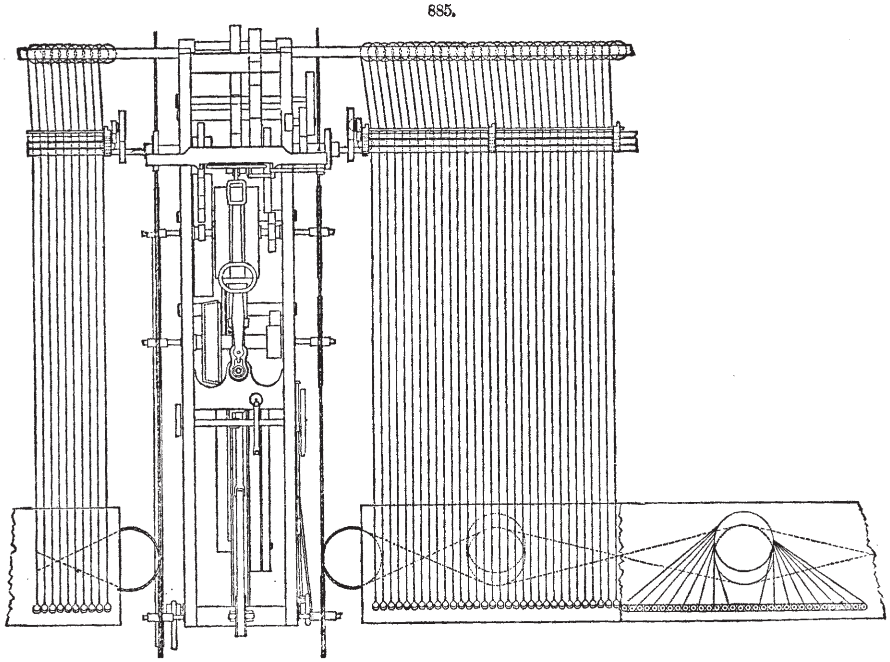
884.



ence between the action of the throstle and the mule is, that the former has a continuous action upon the roving, drawing, twisting, and winding it upon the spindle; while the mule draws and twists at one operation as the carriage runs out, and then winds all the lengths upon the spindles as the carriage runs in.*

The Mason Self-Actor Mule.—As an example of the best form of American construction of this

885.

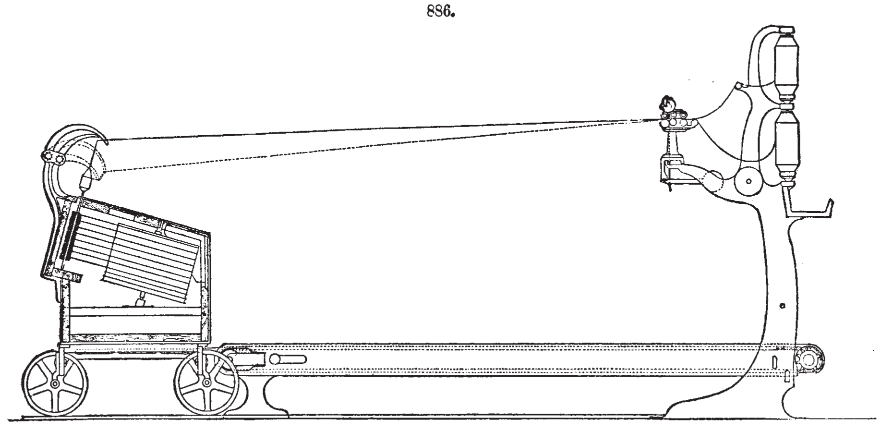


machine, we present in Figs. 883 to 886 views of the self-actor mule constructed by Mr. William Mason of Taunton, Mass. Fig. 883 is a perspective view, Fig. 884 an elevation of the opposite side, and Figs. 885 and 886 plan and elevation of carriage and drawing-rolls. This mule differs

* Knight's "Mechanical Dictionary."

from all others mainly in the manner in which all the movements appertaining specially to a self-actor are produced. In most other varieties the carriage is run in by means of a rope being wound upon a kind of spiral scroll-wheel, the grooves in which the rope winds commencing with a small diameter on one side, and increasing in diameter until the carriage has arrived at the middle of its course, and then diminishing on the other side of the scroll until the carriage reaches the end of the stretch. The carriage is then hauled out by another rope wound on a grooved cylinder that is uniform in diameter. These ropes need constant adjusting, as they are liable to stretch and vary with the changes in the weather. In the Mason mule the carriage is run in by a crank motion. A crank-pin is fixed in a large wheel, which by a pitman or connecting-rod is attached to a rack, the rack plying

886.

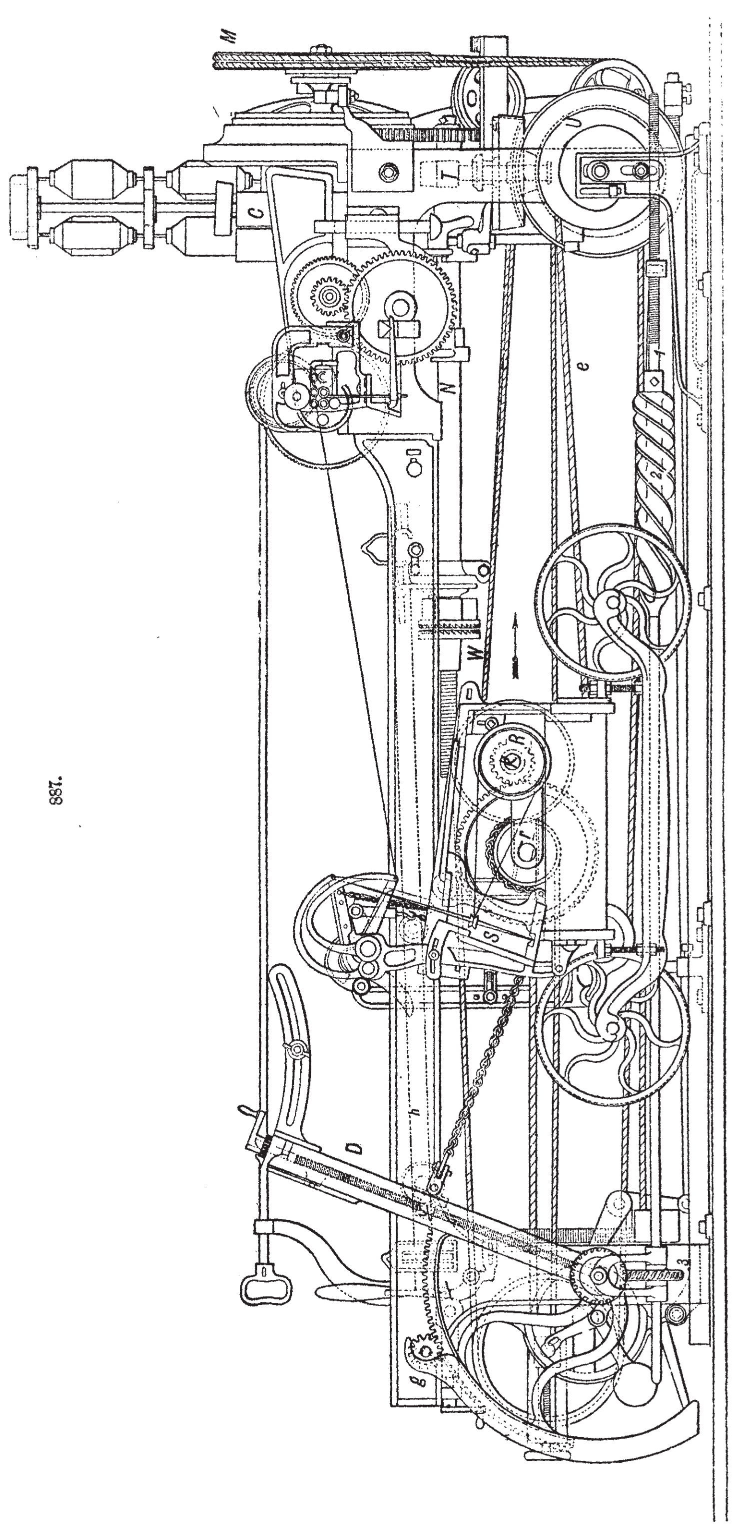


into a pinion-wheel, on the shaft of which is a large wheel that gears into another pinion on another shaft that extends the whole length of the mule on its back side near the floor. On this back shaft are a number of small chain-wheels, carrying endless chains that pass under the carriage and around small pulleys at the front of the machine. These chains may be two, three, or four in number, according to the length of the carriage and number of spindles. The carriage, being attached to the chains, is not only run in through the intervention of the train of machinery leading back to the crank, but is also drawn out by the same train independent of the crank, as will be described further on. The chains also hold the carriage perfectly square and straight. Thus the crank in running half a revolution will, through this train, run the carriage in and give it the same motion over its course as that of the piston of a steam-engine, which is the sweetest reciprocating motion that can be produced. The carriage can be run in in less time with this motion than any other, and it starts and stops at a dead point without the slightest concussion or jar. The drawing-rolls are driven from the main shaft through a train of gear-wheels, and the band-pulleys that drive the spindles are on the same shaft. The carriage is driven out by gearing extending from the front drawing-roll to the same train that runs it in. Thus, when the carriage arrives out, the crank has returned to the proper position to run it in again. The back-off motion and the depression of the faller are also produced by a crank through the medium of the necessary devices, which enables this operation to be performed quickly and smoothly without jerking or shaking. In the winding, a small quadrant is employed in combination with a cam, the shape of which is so arranged as to correct the imperfections of the quadrant as it is ordinarily used. These mules work very quietly and smoothly, without shocks or concussions, and can be run rapidly, and, it is claimed, with from 49 to 50 per cent. less power than other varieties.

The space required for a pair of mules depends upon the number and gauge of the spindles, and the relative position of the heads. If the latter are not set opposite to each other, a pair of mules can be erected in a width of 16 feet from outside to outside of creel-box; 18 feet gives ample room. To ascertain the length of a mule with any required number of spindles and gauge, multiply the number of spindles by the gauge and add 58 inches.

The Parr-Curtis Mule.—This mule, Figs. 887 to 890, is representative of the best English practice, and is built by Messrs. Curtis, Sons & Co., Phœnix Works, Manchester. It is based on, and improved from, the original mule of Richard Roberts. The motions are as follows: The rollers deliver the yarn, the carriage is taken out, and the spindles are turned by bands from drums to which motion is given by the twist-pulley *M*. The next motion is backing off the spindles to uncoil a sufficient quantity of yarn to allow the faller to descend, and carry with it the yarn to the point where it is to begin to be wound upon the spindles. The carriage is then drawn in, and the spindles receive the yarn, so distributed as to form a cop. Fig. 887 is a side view of the headstock, with the carriage in position of half stretch. Fig. 888 is a plan of the headstock, with a portion of the rollers on each side, and of the carriage in the same position as in Fig. 887. Fig. 889 shows the details of the regulator, and Fig. 890 the change-clutch mechanism.

Motion is given to the machine by the driving-pulleys *C*, which drive the twist-pulley *M* by the rim-shaft *I*, which, by means of the bevel-gears *A*, Fig. 888, also gives motion to the roller-shaft *B*, and through that, by the gears *n*, to the taking-out shaft *K*, on which a drum carries the band *L*, which passes around a carrier-pulley on the front of the headstock, and returns to the front of



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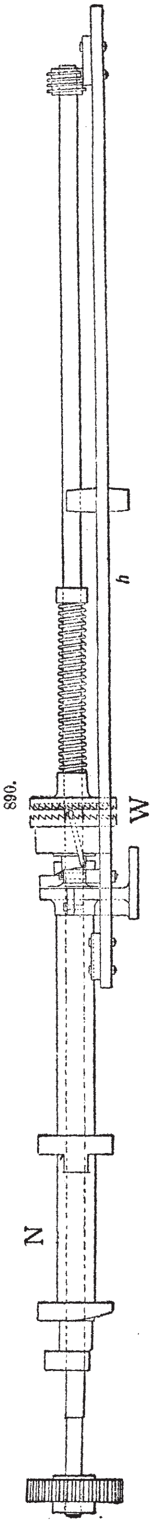
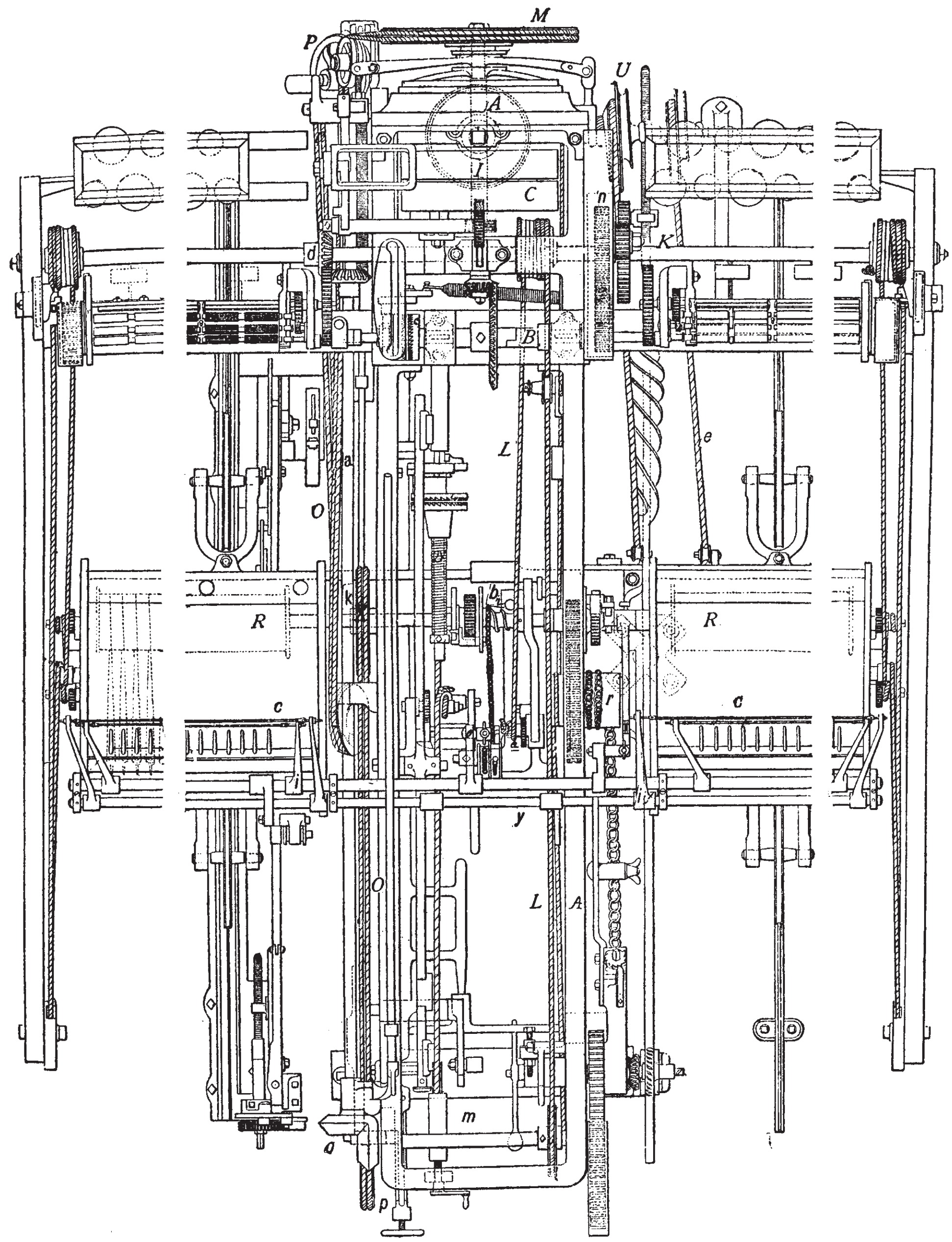


890.

the carriage; the other end being also fastened to the back of the carriage at *a*, and similar drums at each end of the shaft being connected to the ends of the carriage. The twist-band *e* passes from the twist-pulley *M* to the front of the headstock around the carrier-pulleys *P p*, driving in its passage the pulleys *k* on the drum-shaft *R*, from which smaller bands are carried directly to the spindles *S*, Fig. 887. The upright shaft *T*, Fig. 887, is driven by bevel-gears on the hub of one of the pul-

888.



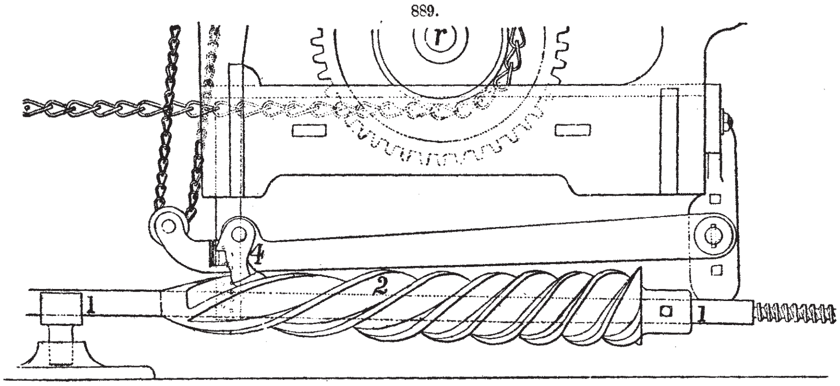
leys *C*, and, through another bevel-gear, gives motion to the winding-scroll *U*, Fig. 887, around which the band *e* passes through the carriage, and is made fast to a take-up ratchet on the front side, and draws in the carriage to the roller-beam, when the stretch and twist are completed. When the belt is on one of the pulleys *C*, the carriage is drawn out, and the rollers are put in revolution, by the shafts *B* and *K*, driven by the rim-shaft *I*; and when the stretch is completed, a spring shipper throws the belt upon the other pulley *C*, which by the bevel-gear drives the shaft *T*, and by means of the scrolls *U* draws back the carriage to its starting-point. While the drawing-out shaft *K* is in operation, the shaft *a*, driven from it by the bevel-gears *d*, drives through the gears *o* the cross-shaft *m*, a pinion, *g*, Fig. 887, which works in the segment-gear *g* of the quadrant arm *D*, raising it to a perpendicular position. Down this arm runs a screw, as seen in Fig. 887, on which moves a nut to which is attached a chain, the other end of which passes round and is fastened to the drum *r* in the carriage, which is geared to the drum *R*, which drives the spindles. When the carriage is drawn in, this quadrant holds back on the chain, thereby revolving the drum *r*, and through it the drum *R*, giving motion to the spindles *S*, Fig. 887, and winding up the yarn already produced; the change of position of the nut on the quadrant, as the latter drops over to a horizontal position, increasing the tension of the chain, and consequently the speed of the spindles, as the yarn is wound from the larger diameter of the cop down to the smaller one of the spindle itself. By means of a ratchet and click the screw in this quadrant is given a rotatory motion, which carries the nut at each stretch further toward the end of the quadrant, thus describing increased arcs, and thereby causing the spindles to turn at each stretch more slowly at the beginning and more quickly toward the end of each winding-on, the faller-wire beginning the winding-on each time at a higher point on the spindle. When the double cone which forms the base of the cop is completed, the winding-on, guided by the quadrant *D*, remains constant, as the nut does not move any more, while the faller after each stretch continues to lay on the yarn successively at a higher point on the spindle. The faller and counter-faller shafts are shown at *y*, Fig. 888, operating arms *i i* and wires *c*. Motion is given to these from the scroll *b* on the drum-shaft, through the chain and lever shown. Their operation is too well known to need further description.

On a cam-shaft, driven from the upright shaft *T* by the bevels and pinion, are cams (not shown) for engaging and disengaging the clutch, which stops and starts the rolls as required, and also for stopping and starting the drawing-out motion. The change-clutch *W* (see Fig. 890) on this shaft, which effects these changes, is operated by the lever *h*, attached to the inside of the headstock, the cams on each end of which are struck and moved by rollers attached to the carriage as it reaches each end of the stretch, and which engages and disengages this clutch, one-half of which is fast to the sleeve *N*, sliding on the shaft, and the motion of which shifts the belt on the pulleys *C*, and effects the other changes mentioned above.

The backing-off motion is given to the twist-pulley *M* by a friction-clutch, which is put in operation for a few seconds when the belt is shifted from one pulley *C* to the other.

The regulator-shaft 1, with the snail 2, shown in detail in Fig. 889, is operated by a dog or finger

889.

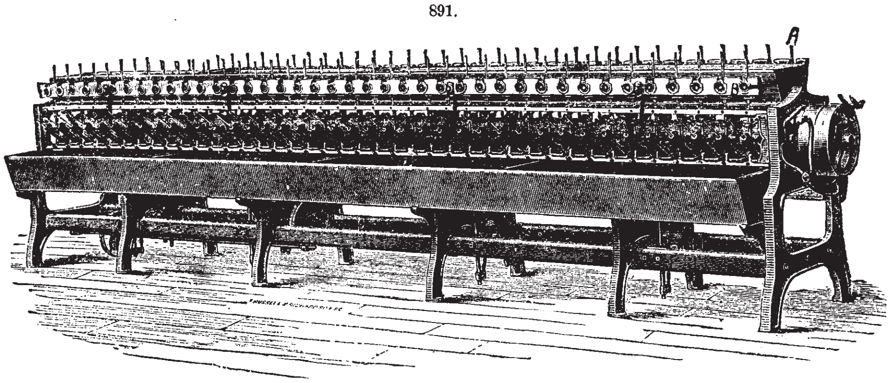


4, which is attached to the carriage and connected with the counter-faller. Should the yarn be wound too tight on the cop, the strain on the counter-faller depresses it, allowing the dog 3 to fall, so as to engage in the snail 2, and give a rotary motion to the shaft 1, which is communicated by the gear 3 to the screw on the quadrant, and releases the nut *v*, so as to slacken the strain a little. The screws on the quadrant *Q* and the regulator-shaft 1 are run back by hand when the cop is completed. It is impossible to describe all the details of the motions without a great number of engravings of parts; but it is believed that the above description will convey to a mechanic a sufficient idea of the operations of this mule.

VI. Spooling.—The yarn, having been taken from the spinning-frame, is now to be prepared for the loom, which is accomplished by the use of three consecutive machines, forming parts of one system, the first of which is the *spooler*, as represented in Fig. 891. This machine has a two-fold purpose: first, to transfer the yarn from the small bobbin on which it is spun, containing from 1,200 to 1,800 yards, to a large spool, holding from 18,000 to 20,000 yards, which is done to save labor in the next operation of warping, by putting so many yards of yarn on the spool that the warper will not have to be stopped to piece ends; and second, by passing the yarn through a fine slot in the guide which leads it on to the spool, to detect lumps or weak places, either of which will break the yarn at the guide, and which being removed, and the sound thread tied with a firm and even knot, leaves it in condition to run through the warper without breaking.

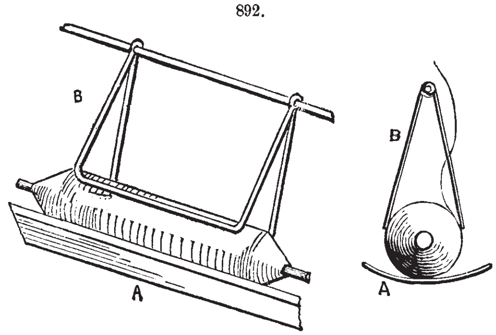
The construction of this machine is very simple, consisting of merely a main cylinder or drum, driving from 60 to 120 strong upright spindles carrying the thread spools, with the accompanying bobbinholders and thread-guides. The "Wade bobbin-holder," the invention of A. M. Wade of Lawrence, Mass., is a recent and valuable improvement, by which a semi-cylindrical cup or trough, *A*, Fig. 892, is substituted for the spindle formerly used to hold the bobbin from which the yarn is to be wound.

891.



The bobbin is simply laid in this cup, from which it is prevented from "jumping" by a pair of bent wires *B*, hung loosely from a pivot a few inches above, but allowing perfect freedom of rotation. This permits bobbins spun on any spindle to be spooled off equally well in the same spooler. The loosely hung wires close together as the bobbin is unwound, always keeping it in its place, but are so light as to cause less friction than was due to its rotation on the spindle formerly used. A spooler of 100 spools will require one-quarter horse-power, and spool off 2,000 lbs. of 30 yarn per week.

892.



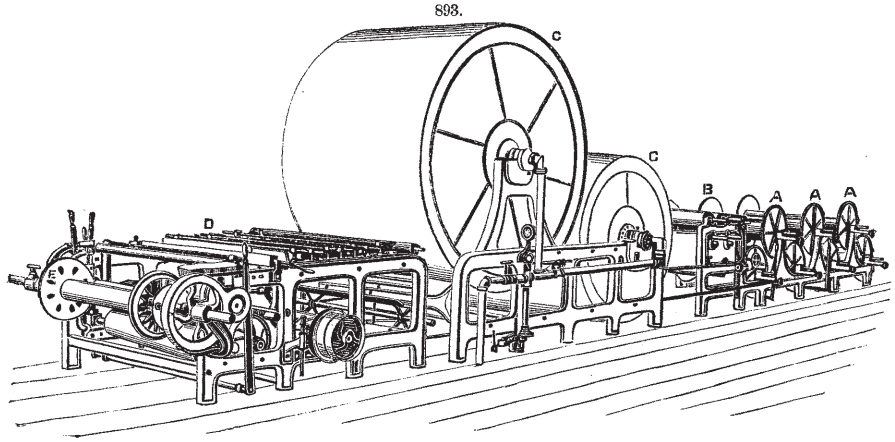
VII. Warping.—The next machine is the *warper*, which prepares the yarn for the *dresser*. In the improved form of warper made by Messrs. George Draper & Son of Hopedale, Mass., a V-shaped frame, called a "creel," receives a sufficient number of the large spools, already filled, to form from one-eighth to one-fourth of the proposed warp, usually between 300 and 400—this being as large a number of threads as can be properly attended to at this machine. From this creel the threads are brought together into a flat sheet between a pair of guide-bars drawn through a "reed," which spaces them at equal distances, and then pass between a pair of light rollers over a movable or rise roll, through a second pair of rolls, and then through what is called the warper-box, which consists of a frame carrying a number of light hooked wires equal to the number of threads to be warped. In this machine as described these wires are loosely hinged, in such a manner as to fall backward when not kept in a nearly perpendicular position by the friction of the threads, over one of which each wire is hooked. From the wires the yarn goes to the "section-beam," so called, on which it is wound, and to which is communicated the power to drive the machine.

So long as all the threads are unbroken, the machine once started runs smoothly; but if one thread breaks, its wire falls backward to a horizontal position, and catches in a light "vibrating bar," the interruption of the motion of which, by means of a spring and lever, throws off the driving belt and stops the machine. The "rise-roll" now comes into operation; and being so hung in slotted guides at either end as to have perfect freedom of motion perpendicularly, and so balanced by weights underneath as always to lift with gentle pressure, it at once rises sufficiently to "take up the slack" of the yarn, which for an instant continues to be delivered by the spools, the motion of which is not arrested by the stopping of the machine. After the broken thread is mended by the attendant, the wire is lifted to its place, and the machine is again started. When the section-beam is filled, it is removed and taken to the dresser.

VIII. Dressing.—The dressing machine at present entirely superseding all others is an English invention, known as the "slasher" dresser; and Fig. 893 represents the most improved form as built by the Lowell Machine Shop, in which *A A* are the section-beams, as taken from the warper, *B* the size-trough and "squeeze-rolls," *C C* the drying cylinders, *D* the lease-rods, and *E* the loom-beam on which the warp as finally prepared for the loom is wound.

The section-beams, having been filled at the warper, are taken to the "slasher," where four or more, as required to form the warp, are placed in their positions, and the yarn from them is then carried through hot starch, kept so by a steam-pipe, in the size-box *B*; and the superfluous size being squeezed out, while the body of the thread is by the same pressure well filled, it passes around the large drying cylinders *C C*, made of copper or galvanized iron, then through the lease-rods *D*, where the threads are separated, and is finally wound on the loom-beam *E*. In order to form the "lease," so called, by which the threads are separated into two equal parts or "sheds" for the weaver, a piece of thread or string is passed between the threads coming from the section-beams, at the first start, so as to divide 2 from 2, or 3 from 3, as may be; after passing the drying cylinders one of the iron lease-rods is substituted for this string, and the different threads of each half are further subdivided by the successive ones, so that no two threads shall be stuck together by the size. As each beam is filled a fresh lease-string is run through for the use of the weaver. Another form

893.



of slasher, instead of drying cylinders, passes the yarn through a closed box heated by steam-pipes, in which the air is kept in circulation by a fan. This form is by some considered preferable for fine yarn.

Works for Reference.—"Hand-Book on Cotton Manufacture," Geldard, New York, 1867; "The Science of Modern Cotton-Spinning," Leigh, London, 1876. S. W.