COTTON-SPINNING MACHINERY. To show more plainly the advance in cotton-spinning machinery during the past ten years, it may be well first to state in a general way the operations that are at the date of this work in use in converting the cotton in the bale to the warp on the beam, or the filling on the cop or bobbin, ready for weaving. The cotton is received at the mills in compressed bales, containing about 500 lbs. each, and generally confined by ropes or iron bands, and sacking. In this cotton is a very considerable amount of leaf, sand, and seeds, and sometimes other foreign substances. The first operation is the opening of the bales and the mixing of cotton, which is done by hand, so as to secure a comparative evenness of fiber. A number of bales are opened at once, and the mixing is supposed to be thorough. From the heap of cotton so mixed it is taken to an opener, where it is subjected to the action of beaters and fans, and delivered in rolls called laps. Two or more of these laps are then fed to a finishing lapper, where the beating operation is again gone through, and the lap from this machine is the completed product of the picker-room. The cotton at this stage has been freed from the larger portion of the foreign matter, and the fibers have been thoroughly disentangled.

The next operation is that of carding, which is a very important one, and perhaps not yet thoroughly understood. The lap from the picker is slowly fed into the carding-machine, in which is a revolving cylinder covered with clothing, containing teeth, by which the cotton is carried past either stationary or movable surfaces, also containing teeth, and deposited upon another cylinder called a doffer, from which it is taken off in a thin sheet by a comb. The card continues the cleaning of the cotton, and thoroughly disentangles the fibers, and places them in a condition in which they can be easily straightened.

It is stated, in most books of reference, that the cards straighten the fibers; but any one who will examine with a glass the sheet that comes from the doffer will be satisfied that the fibers lie in anything but parallel directions. They are so disposed, however, that straightening becomes an easy process in the drawing to which the fibers are afterward submitted. Where carding is well done, the fibers are thoroughly disentangled, and the sheet is free from lumps, technically called mits. There are two kinds of cards in large use on cotton: the stationary flat card, and the revolving flat cord; the latter being quite generally known as the English flat card, though now manufactured by several American shops. The revolving flat card is said to do the largest quantity of work, but that is asserted by the friends of the other card to be due to the use of larger cylinders. It is also claimed that the revolving card makes less waste. There is no doubt that there is a better feed in use on the revolving flat than on the ordinary card as previously built. Another important point is this: the flats of the common card have to be raised at stated intervals to be cleared from accumulations of dirt and fiber. When they are raised an opening is left, in which the flyings from the cylinder collect, to the detriment of the work when the flat is replaced. With the revolving flat the cylinder is always covered, and the flats not in use are thoroughly brushed out, between their service at the rear side of the cylinder and their next service at the front side. The cotton leaving the card is, with the revolving flat card, gathered together into a strand, and run into a can. Where the ordinary card is used, the strand is fed into what is termed a railway-box, where, with other strands, a sheet is formed, which is carried by a belt to what is termed a railway-head, where it is reduced in size of strand by drawing-rolls, and subjected to the action of an evener.

The next operation is known as drawing, which is done to complete the straightening of the fibers of the cotton and to reduce the sliver, the technical name for the strand in this condition in size. Besides this, the strands are doubled over and over again before being drawn, to equalize the diameters of the resulting strand. The theory is that by doubling, large places in one strand are likely to come opposite small ones in another strand, and the general average of size be improved. Too much drawing, however, weakens the material, and there is considerable question among manufacturers as to the proper amount. Where the English card is used, the cans from the card are set up behind the drawing-frame; and where the railway-head system is used, the cans from the railway-head are placed in that position. The material is delivered from the cans on one side of the frame through the drawing-rolls to cans on the other; the diameter of cans being generally reduced with the diameter of the strands. The process of drawing was the invention of Arkwright, and it consists in subjecting the material to the operation of several pairs of rolls, the front ones of which revolve more rapidly than the rear ones, and thus elongate the sliver and correspondingly reduce it in diameter. From one to three sets of drawing-frames are now in use in most mills. The sliver at the last drawing-frame is made as small as it is sure to hold together in being drawn out of the can. To enable it to be still further reduced, it is necessary to introduce twist in the next processes. Machines by which this is done are called, in general terms, roving-machines, and their product is known as roving. These machines, like the drawing-frame, draw the cotton still smaller, and communicate twist to it by means of revolving spindles with their fliers, and wind it upon bobbins.

Of the two kinds of roving-machines in use, viz., the so-called speeder and the so-called fly-frame, the fly-frame during the last ten years has gained upon the speeder, especially on fine work. The roving, in being prepared for spinning, passes through from two to four of these machines successively, and at some of them it is doubled, for the purpose before stated in referring to drawing-frames. The final result is a soft cord, having a slight twist in it, and weighing on ordinary work about four skeins, or two miles to the pound. For coarser work it is heavier, and for finer work lighter. This is the last process of the carding-room, which embraces, in all factories, opening, carding, drawing, and roving machinery, and changes the cotton from its crude condition in the bale into fine continuous strands wound upon bobbins ready for spinning. In a mill where cloth is manufactured, roving is divided in its destination, part for warp and part for filling. The warp yarn is spun with much greater twist, because, in the first place, of the extra strength which it requires in weaving; and, second, because the less twist of the filling, gives a soft appearance to the cloth, and is of advantage in dyeing or printing. The warp yarn is spun upon what are known as ring-frames, previously described, which receive the roving from the carding-room, and convert it into yarn of the size desired. The reduction in size is made by drawing-rolls, as before, and twist is given as in the fly-frame, by the rapid revolution of spindles; but, in the winding upon the bobbin, the ring and traveler previously described are substituted for the flier. The ring-frame has been improved during the last ten years more than any other machine used in manufacturing. The details of these improvements will be referred to later.

Following the yarn from the ring-frame, where it is wound upon bobbins, it goes to the spooler, where the yarn is unwound from bobbins and wound upon a large spool holding 20,-000 yards, more or less. As each bobbin is wound off, another is tied on, until the spool is full. The yarn in going from the bobbin to the spool is passed through what is called a spooler-guide, which cleans the yarn of many bunches and imperfections, which might better have been taken out in the carding-room, if possible. After spooling comes warping, in which a large frame called a creel is filled with spools, usually 300 or 400 in number. The ends from each of these spools are drawn together into a flat sheet, which is wound upon a beam, usually about 54 in. long and 24 in. in diameter of heads. Each one of these threads passes through an eye, which, with other mechanism, serves as a stop-motion for the machine, so that if one thread breaks it can be replaced, and the sheet of threads kept complete. The full beams are taken to a sizing-machine called a slasher, and there they are run through boiling size and dried upon a cylinder or over steam pipes, and wound upon a loom-beam at the other end of the machine. The threads are then drawn through loom harnesses and reeds, and the warp is ready for weaving.

Filling is spun either upon filling-frames or mules. During the last ten years the filling-frame has been gaining upon the mule on coarse and medium work, and also on fine work where considerable twist can be used, such as thread-yarns. The filling-frame, after spinning its yarn, winds it upon a bobbin, while the mule winds it in what is called a cop, with a paper tube for a base. These bobbins or cops are subjected to the action of heat or dampness to prevent kinking in, drawing off and are then ready for use in the loom-shuttle. Several times as much waste is made in weaving mule or cop filling as in weaving frame or bobbin filling. Some yarn for weaving, and almost all for other purposes, after being spun is doubled and twisted. This requires the use of the machine known as a twister. The twister is a similar machine to the spinning-frame, except that it does not draw the yarn. It takes two threads or more of completed yarn and twists them into one, and winds them upon a bobbin. The twisted yarn, if destined for weaving, is then spooled, warped, and dressed as usual. If destined for other purposes it is subjected to other operations, beyond the scope of this article. Considering the diversified field of manufacture from the cotton-bale to the loom, it is best to classify the different processes.

Opening and Picking.—In openers and pickers the changes are in the nature of improvement in the manner of utilizing old ideas rather than radical innovations. The clearing-trunk is being used in improved forms on openers, and so are automatic feeds and lap-eveners. A preparatory machine, called a bale-breaker, made by Platt Bros., of Oldham, England, breaks the matted cotton into small pieces before it comes to the pickers. This has also a new dust-trunk, through which the cotton is drawn by the exhaust opener. The cotton passes one way by means of a fan-draft while the grids travel slowly in an opposite direction.

Cards.—Although there has been much commotion of late years over this subject, it results rather from the increased use in this country of the English revolving flat card, old in principle but improved in detail, rather than from any important inventions. The adoption of a system in which single carding takes the place of double, and the coiler is substituted for the railway, is enough of a change to excite considerable agitation and discussion. This introduction of English ideas set our shops at work to reproduce and improve on the revolving flat, and also to further perfect the American card, so that it might stand comparison more favorably. No doubt quite a percentage of the improved results of the last few years in carding is due to the use of superior clothing. Tempered steel clothing, needle-pointed, is rapidly gaining ground, and the methods of attachment are better than formerly.

The first American revolving flat card (Fig. 1) was introduced by the Pettee Machine Co., of Newton Upper Falls, Mass. It was constructed after the best English models, and illustrates to advantage the general ideas in use. The Lowell Machine Shop has put an American revolving flat card on the market having several new improvements. The arch is so constructed that the flexible bend is placed close to the cylinder, and its method of setting with the shields prevents all fly from blowing out and packing itself around the bend and chain-blocks. In all revolving flat cards it is highly essential that the cylinder should be capable of perfect adjustment, and also that the flexible bends on which the flats travel may be set so that the flats will be perfectly concentric. As the teeth wear or become ground, this setting is necessary, and every part of the flat mechanism needs to be perfectly constructed in order that these slight variations may be made. Howard & Bullough have a very ingenious arrangement of conical concentric bends on which the flats rest, which are adjusted in position by screws and inclined surfaces. Each screw has a dial with a pointer, so that by turning each dial a definite distance the bends will all be adjusted alike. They also have a new way of attaching card clothing, using no rivets. Platt Bros., of Oldham, England, have lately adopted a new flexible bend with slots and screw adjustment which admit of the direct setting by the gauge of the flats to the cylinder. They are also so arranged that the flats are ground on the under side while in position.

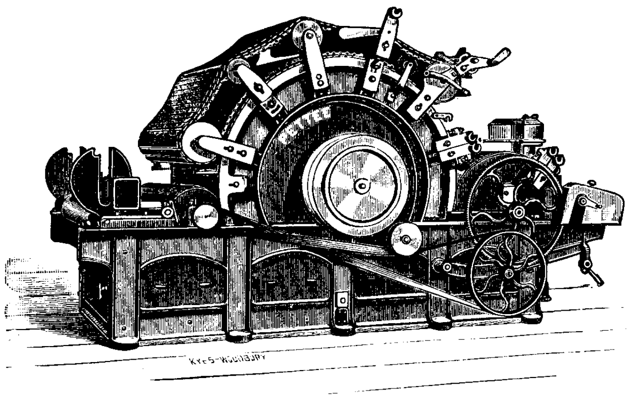

FIG. 1.—Cotton-card.

The Whitin Machine Works have endeavored to so improve the American top flat card as to enable competition in single carding with the English machine. This card (Fig. 2) will produce 100 lbs. and upward per day of fine carding with the minimum amount of waste. The sides and arches of the card are built entirely of iron, and the construction is simple, so that changes can be readily made. The main cylinder is 42 in. and the doffer 18 in. in diameter, measured without the clothing. Both are accurately ground, and are balanced to a speed largely in excess of that used in practice. The cylinder is clothed close up to either edge, securing a carding surface 37¼ in. wide. The clothed surface of the doffer is slightly in excess of this. The card is provided with 40 iron flats, the arc described by these being greater than formerly, and equal to fully two fifths of the circumference of the cylinder. The flats are now made 1⅜ in. wide, with clothed surface of $\frac{13}{16}$ in. They are planed and ground perfectly true to receive the clothing, and, being heavily ribbed are free from the possibility of warping or twisting. The ends of the flat are also planed, and thus their correct pitch with the surface of the cylinder is accurately and uniformly obtained. The device for adjusting the flats consists of a square steel body terminating at either end in a pin. The lower pin, having a fine thread cut upon it, passes through a rib in the card arch, and is secured on both sides of the rib by a nut. Thus any flat may be accurately and quickly adjusted. Mortises, accurately spaced, and planed into a second rib on the card arch, receive the square bodies of the adjusting-pins, thus preventing any lateral motion. The adjusting-pin is further secured by a screw passing through the square body into the arch. The top flat passes over the upper part of the adjusting-pin and finds a true bearing on a small collar turned upon the upper side of the body of the pin. They claim for this device great ease and nicety of adjustment, and perfect immovability when set. A quick stripper, that lifts, strips, and replaces a flat in less than four seconds, is used, and is geared at both sides to avoid torsion. A simple device is attached by which the feed may be instantly stopped, and also the doffer thrown out of gear with coiler and calendar rolls. Many American cards in use are being changed over to the coiler system, the Foss & Pevey cards especially, with better results. The latter card is being improved in addition by the use of the shell-feed.

Combing.—As combers are only used on very fine work, their field is somewhat limited. If some way could be devised to increase the production of a comber with no increase of expense, it might pay to use them to a much greater extent, as the advantage is obvious. Dobson & Barlow, of Bolton, England, have improved the Heilman comber by a change in the combing cylinder (Fig. 3). Formerly the cylinder possessed only one series of combs and one fluted segment. Thus it required one complete revolution of the cylinder to get one length of combed fiber. The manufacturers have succeeded in introducing a second series of combs and a corresponding second fluted section, which doubles production at the same speed; allows of a lower speed, which produces better results, and a largely increased production. The old-fashioned process of preparing comber-laps has been to take slivers from the card, put them through one process of ordinary drawing, and the slivers from the drawing were then put through a small sliver-lap machine and made into a lap for the comber. This old process makes a lap that consists of a series of slivers laid side by side, and is not of one uniform thickness, but first has a thick and then a thin place. It is obvious that the nipper of the comb can not act as well upon this lap as if the thickness were uniform throughout, and further that where the thin places are there is danger of good cotton passing through into waste on account of the defective nip; also, where the thick places come, the pins are required to do too much work, and the quality at once suffers.

When the patent ribbon-lapper is used, the system is as follows: The ordinary style of drawing-frame is thrown out entirely, and the card-slivers are doubled up into a lap directly on the small sliver-lap machine; then six of these laps are placed in the creel of the machine and are drawn through four lines of rollers in the form of a ribbon instead of a sliver, and by means of curved plates are placed perfectly even and level on a polished table.

Drawing-Frames.—Although the railway-head with evener, first introduced by George Draper & Sons, is hardly the same as a drawing-frame, its functions are near enough like it

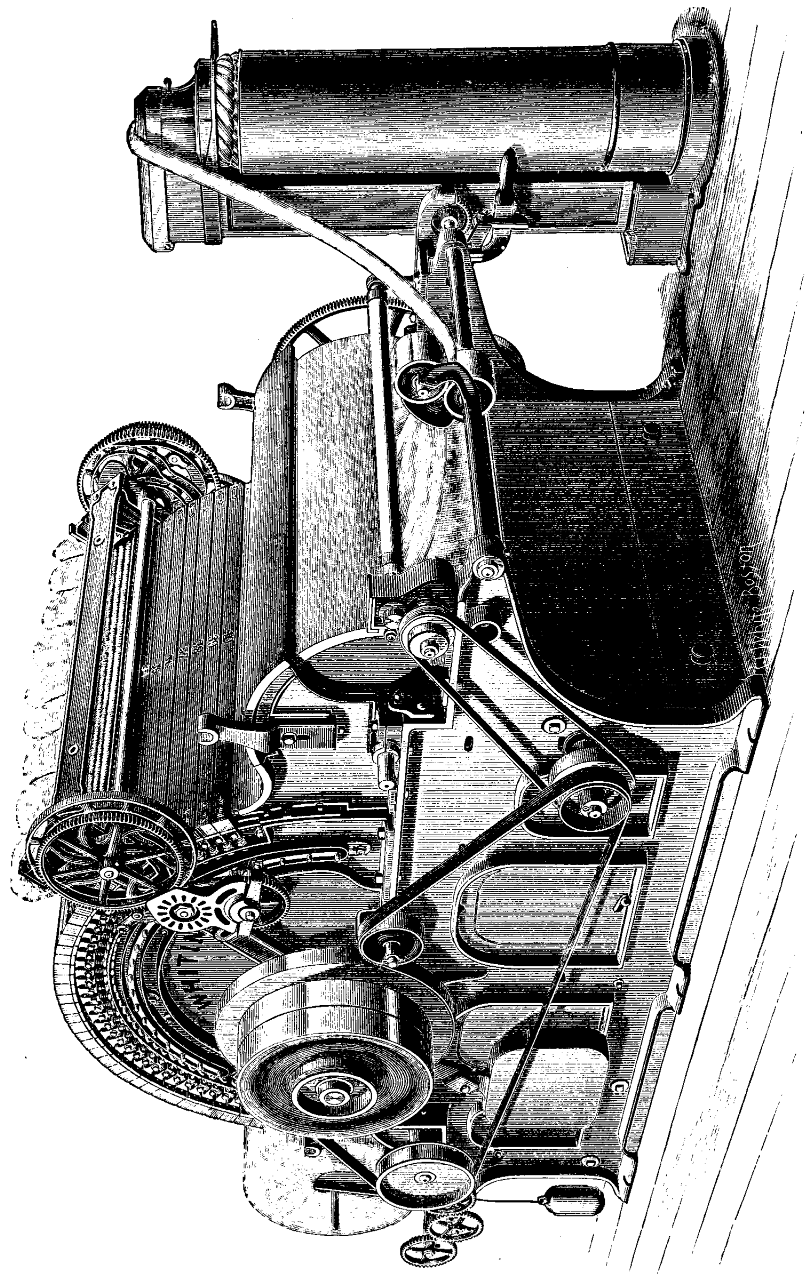

Fig. 2.—Whiting cotton-card.

for it to be considered in the same class. These machines have been perfected and made much more sensitive and accurate. It is of the utmost importance that the evening should commence as soon as possible after the detection of the fault. The Evans Friction Cone Co. have an evener on the market in which two cones with a friction-belt running between them regulate the variations, and are claimed to enable a change of speed far quicker than an ordinary belt running over cones in the usual way. Railway-heads and machines in the next class have of late been provided with steel fluted rolls, having collars to prevent the teeth meshing too

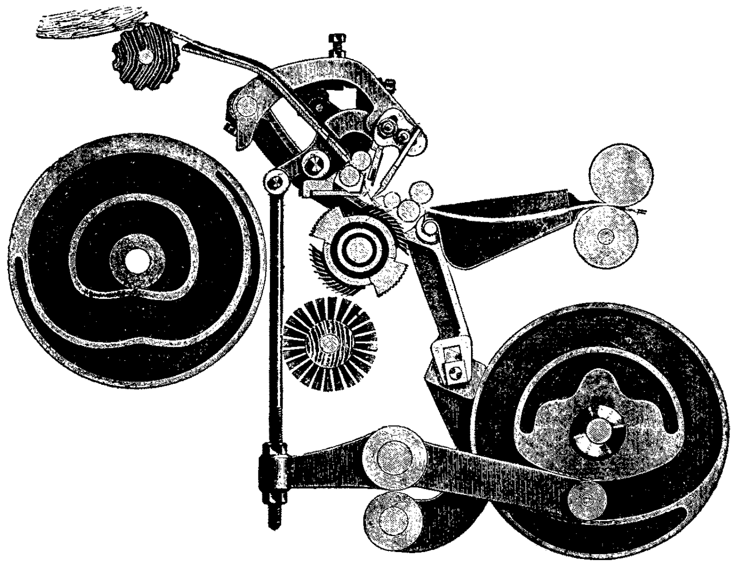

FIG. 3.—Combing-cylinder—detail.

closely, instead of the common leather-covered rolls. They have been pronounced a success in certain instances, but their use is hardly extensive enough as yet to give an opinion as to their advantages. The advantages claimed are less weight required on the saddles, and no expense for roll-covering. This is being introduced by the Metallic Drawing Roll Co., of Springfield, Mass. The drawing-frame, having come into more extended use on account of the addition of the coiler system, is receiving considerable attention.

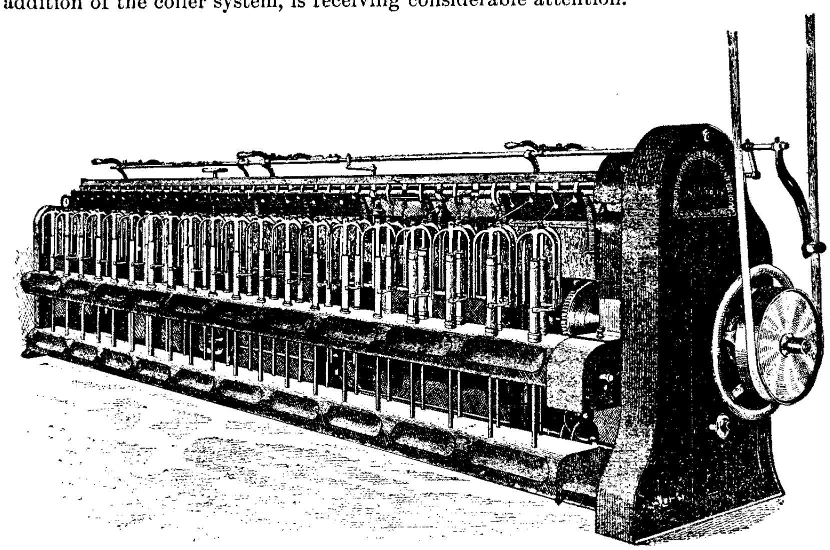

FIG. 4.—Roving-frame.

The electric stop-motion, as applied by Howard & Bullough, is an innovation, especially as it marks the first successful adaptation of electricity to cotton manufacturing. This has had an extensive introduction, and as applied does more than the ordinary stop, as it detects four faults, viz.: (1) A sliver breaking before it reaches the drawing rollers, (2) a sliver breaking at the front between the drawing rollers and coiler, (3) a stop for a full can in the coiler, and (4) a stop when cotton laps around the drawing rollers. Fales & Jenks, of Pawtucket, R. I., are the American builders of this machine.

The Whitin Machine Works are introducing a new drawing-frame with single-bossed rolls, which is an improvement on the general class.

Roving-Frames.—Fly-frames and speeders have undergone considerable general improvement, although much of the machinery now offered to the trade is of the same type and style as that of ten years since. The gradual trend of opinion has turned in favor of fly-frames rather than speeders. Fig. 4 represents the 40-spindle stubble of the Providence Machine Co., of Providence, R. I., and Fig. 5 the Hopedale Machine Co.'s improved roving-frame. In fly-frames one of the improvements is Tweedale's differential motion. In this the revolutions of the various wheels are all in one direction—saving in friction, power, and wear and strain on the cone-strap. Howard & Bullough, besides controlling the above, have applied an electric stop-motion to prevent single breaks necessitating the stopping of the machine. As to the merits of fly-frames and speeders now in use, making four-hank roving or coarser, it is found that the roving can be made cheaper on the speeder and better on the fly-frame. The only reason for the better work of the fly-frame is because the spindle and flier gyrate together when there is gyration, and so the roving is not stretched between the flier and the bobbin, while in the form of speeder now in general use, the spindle and flier being separate, and the spindle and bobbin being sure to gyrate more or less, thin places in the roving must result. The Hopedale Machine Co., of Hopedale, Mass., have made a new speeder which removes this objection.

The common form of spindle in machines of this class is cut off below the top of the bobbin, its support being at the bottom of the flier. This construction limits the speed at which the machine can be run, and even at the ordinary speed the bobbin as it fills shows in many cases a marked variation from true running. The spindles carried to and into the top of the flier, thus making a bearing at both ends of the spindle, and making a much higher speed both possible and practicable, and at the same time improving the quality of the product by avoiding both gyration and vibration of the bobbin, which are so damaging in their effect on the evenness of the roving by straining and stretching it as it follows the movement of the spindle; in other words, because the spindle is held at both top and bottom, it can not gyrate, and the result is even and substantially perfect roving. The lower part of the spindle is tubular, is connected with the driving-gear on the lower shaft, and extends through the base of the flier, where it is provided with lugs to carry the upper part, which is slotted for a sufficient portion of its length to receive and carry the flat or traversing part of the spindle, which rests on the traverse rail and carries the bobbin by a toe which projects from its top outside the slotted part of the spindle into the base of the bobbin. The spindle is solid above the slot, and continues upward through the flier to its nose, where it is held by an ingenious lock. The top section of the spindle, the tubular or lower section, and the flat traversing part can be removed at any time by taking off the bobbin and without disturbing either flier or flier-plate. When the bobbins are full and ready to doff, the frame is stopped with the toe carrying the bobbin projecting from the back or front side of the spindle, and with the traverse rail at its lowest point; the bobbin is raised until it strikes the lock and lifts it, unlocking the spindle and allowing it to tip forward and the bobbin to be removed; the empty bobbin is put on, and with the spindle returned to an upright position, lifting the lock as in removing the bobbin. This movement locks the spindle in place, and with the bobbin set firmly on the projecting toe the frame is ready to start. This operation of doffing requires no more time than the old method, one motion removing

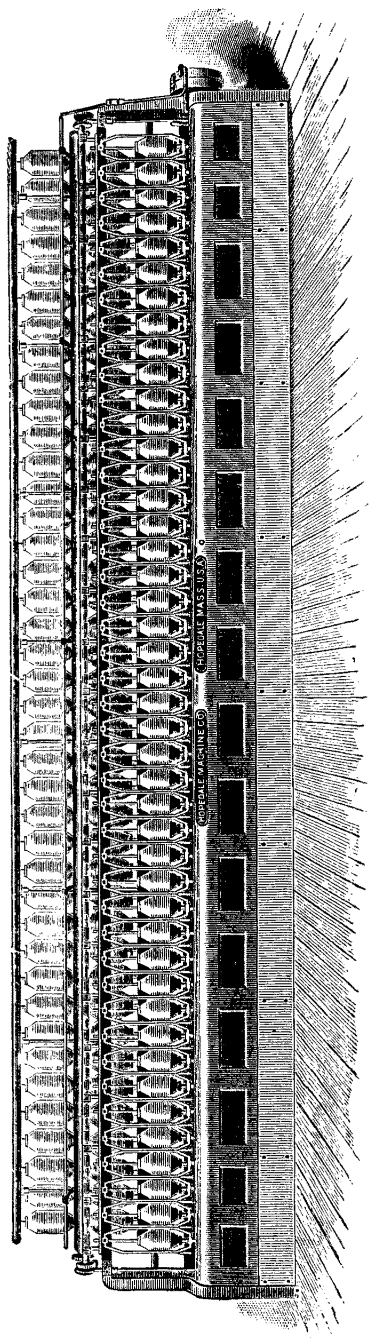

Fig. 5.—Roving-frame.

the bobbin and another replacing it. Supporting the spindle at the top prevents vibration and allows the bearings to be made smaller, which reduces the friction and the power required to drive a given number of spindles, besides allowing a much greater speed. The bearings are made as small as is consistent with durability, can be conveniently oiled, and are thoroughly protected from accumulation of dirt. A spindle can not become bound or tight in its bearings, and may be removed and wiped in a moment. The spindle and flier can be oiled when running. From 15 to 30 per cent increase in speed is gained in this frame, with a product which is as much better in quality, so far as evenness is concerned, as it is greater in quantity.

Spinning.—In this department the change in the last ten years has been radical, with greater proportionate results than those obtained in any other class. Spinning is divided into warp and filling, almost all the warp in this country being spun on ring-frames, and the greater proportion of the filling on mules. Taking the frame first as the most modern, the great advance has been in speed, production, saving of power, and less attendance per product. This results almost wholly from the invention of the top spindle by Mr. F. J. Rabbeth, about 1878. The Sawyer had been having an almost uninterrupted sway, as it was such an advance over the old common type in production, saving in power, etc. The Rabbeth, however, has proved as far superior to it as it was, in turn, the superior of its rivals. The name "top spindle" was afterward changed to "self-centering" spindle. Spindles of this type have since come to be known simply as "Rabbeth" spindles, although every spindle with a sleeve-whorl, before the minute differentiation of modern types, was known as a "Rabbeth" spindle both in this country and abroad. The particular features of this so-called "top" spindle were: First, the above-mentioned sleeve-whorl; second, the loose bolster, supported in a tube which held both bolster and step-bearings, and formed an oil-reservoir to lubricate them; third, the elastic packing, ordinarily composed of woolen yarn which surrounded this bolster, shown in the cut at *D*; fourth, the flat top step on, rather than in, which the rounded bottom of the spindle moved with the bolster; fifth, the snout oil-chamber, which insures a better supply of oil, and keeps the reserve at a higher level than any other form yet tested. This feature had been before embodied in the Rabbeth-Sawyer spindle. The spindle was called the "top," or "self-centering," spindle on the theory that the spindle acted like a top, and found its center of rotation under an unbalanced load. This theory has since been discarded by experts, it now being thought that the advantages of the Rabbeth spindle are derived, first, from the cushioning effect of the loose bearing; and, second, from the additional cushioning effect of the packing interposed between the bolster-bearing and the surrounding case, both taken in connection with a sleeve-whorl surrounding the tube containing the bearings. The spindle does not center itself, but runs out of center with less jar and vibration and heat, and thus is enabled to bear a greatly increased speed, and to run with less power. The Sawyer spindle was limited in speed. With an unbalanced load it would vibrate and gyrate, at more than 7,500 turns per minute, so as to become useless. The Rabbeth spindle, on the contrary, will bear any speed desired, and the limit of production of the frame is transferred from the speed that the spindles will bear to the speed with which operatives can make good piecings of yarn broken in the operation of spinning. From 9,000 to 10,000 revolutions per minute is the speed at which they are customarily run on medium yarns. The power required to drive them at a speed of 9,000 does not exceed the power required to drive the common spindle at a speed of 5,500.

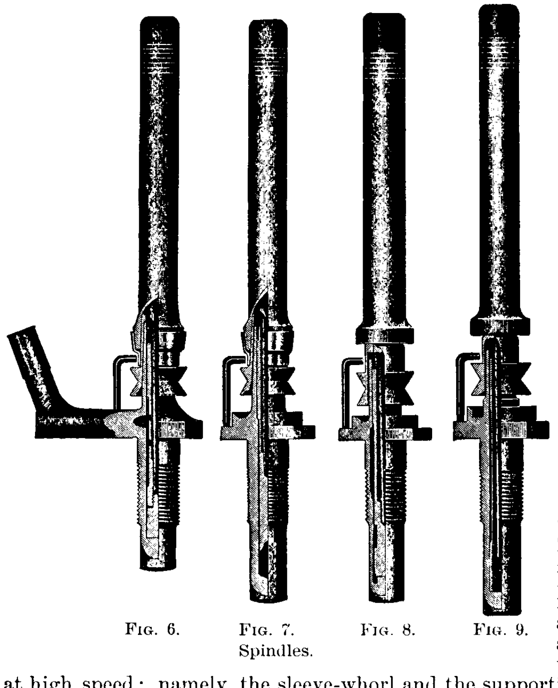

FIG. 6. FIG. 7. FIG. 8. FIG. 9.
Spindles.

Four forms of Rabbeth spindles are being made by American builders at the present time. These are known as the Rabbeth proper, or the No. 49 D Rabbeth (Fig. 6); the Sherman (Fig. 7); the Whitin (Fig. 8); and the McMullan (Fig. 9). They all possess the characteristic features which permit the spindle to be run at high speed; namely, the sleeve-whorl and the supporting tube within it, containing loose bearings, and serving as a reservoir for the oil to lubricate them. The present Rabbeth has many improvements over the original form. The bolster has a head to limit the extent of movement, keeping the spindle in the center of the ring at all times. The spindle proper has been lengthened and made with a tapered bearing. By means of an adjustable screw-step, the fit in the bolster may be made looser or tighter, taking up wear, and enabling the proper conditions to be found for steadiness. This is the chief improvement in spindles since the introduction of the Rabbeth. The Sherman is a type of Rabbeth having its bolster and step in one piece and using no packing. It has had an extensive introduction. The Whitin is very similar to the Sherman, the main difference being in the fit of the bolster in the supporting tube, the Sherman bolster being loose and the Whitin having supposedly a sliding fit opposite the bolster-bearing. The McMullan has a separate step loose within the bolster, and is the latest spindle on the market. The value of the introduction of these spindles to the community has been enormous. The figures below will show approximately this value, though they are believed to be low, as many incidental gains are not reckoned. The average speed of common spindles, before the invention of the Sawyer, did not exceed 5,500 revolutions per minute. The average speed of the Sawyer spindle may be considered as 7,500, and that of the Rabbeth as 9,000.

The production of yarn is substantially in proportion to the speed of the spindle. It has been found that the increase of production in altered frames was greater rather than less than the increase in speed, owing to the greater steadiness in running. On the basis of the speed, however, 5,000,000 Rabbeth spindles produce as much yarn as would more than 8,000,000 common; 3,000,000 Sawyer spindles produce as much yarn as would 4,000,000 common. It follows that, had the new spihdles not been introduced, more than 4,000,000 additional common spindles would have been required to produce the yarn now spun in this country. The cost of spinning-frames, complete. per spindle, is about $3. It is estimated that a square foot of floor-space is required per spindle to give suitable room for spinning-frames and alleys. This costs, at the lowest estimate, 65 cents per square foot. The necessary plant in and for shafting, heating, lighting, belting, etc., for this room would carry the cost for machinery and room above $4 per spindle. At this figure, therefore, the saving in room, machinery, etc., has been 4,000,000 spindles at $4 each, or $16,000,000. But this is not all. The old spindles, at 5,500 turns, required as much power as the modern spindles, either Sawyer or Rabbeth, at the higher speeds run; hence, the power required to drive these 4,000,000 common spindles may be counted an entire saving At 100 spindles to the horse-power, this would amount to a saving of 40,000 horse-power, or more than three water-powers like that of Lowell, and worth, at $30 per horse-power per annum (surely a low enough price for steam-power in New England), $1,200,000 each year. Then, owing to the better running of these spindles, they require no more attention at their high speed than the common spindles at the low speed. The labor cost for spinning, including all employés, from the spinner to the overseer, is, in the best mills, about a cent and one tenth per spindle per week, or 57 cents a year. The labor saved per annum is therefore above $2,200,000. Then, again, the old-fashioned spindles required oiling twice a day, while the Rabbeth requires oiling only once in three or four weeks, making a saving which would be counted a large benefit were the other items not so enormous.

Capitalizing all these gains at ten times the annual saving, and omitting the minor advantages, the advantage to the community by the introduction of the rapidly running spindles is shown by the following figures:

Saving of machinery	$16,000,000
Saving of power............	12,000,000
Saving of labor............	22,000,000
Making a total of.	$50,000,000

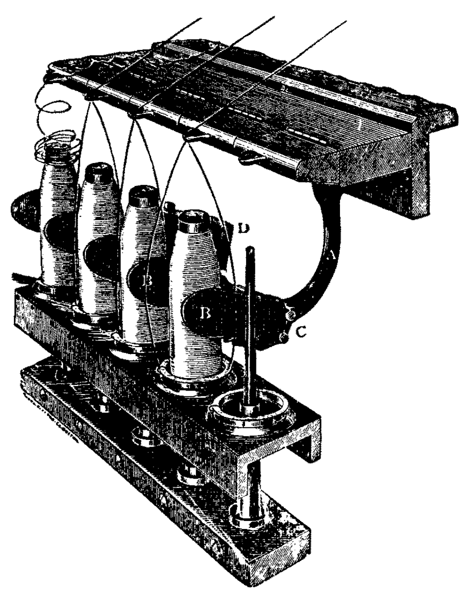

FIG. 10.—Spinning-frame- detail.

This is not all. The 3,000,000 Sawyer spindles will all, or nearly all, be changed to Rabbeth, while the remaining common and other inferior types of spindles must also be supplanted by the new types, and the gains from these changes, on the basis above stated, will be in the proportion above shown. Still again, the hundreds of thousands of new spindles per annum required by the growth of the country are substantially all of the Rabbeth type. By making similar calculations to those above, the future value of these inventions to the public may be calculated in the same way.

So far, we have only considered the advantage for this country. The Rabbeth spindle, in some of its varieties, is the only ring-spindle now built abroad, and it has already gone into use there to the number of several millions. There is no doubt that the advantage to the human race from the invention and introduction of these improvements in spindles has been, from 1871 to date, more than $100,000,000, and that it will go on as their use increases. All the modern spindles now in use are under the control of the Sawyer Spindle Co., whose agents are the firm of George Draper & Sons, Hopedale, Mass.

The other parts of the frame have also undergone considerable change. It has been found that with the high speeds the yarn is more liable to balloon out and whip together than before, and it has been found necessary to interpose a blade or separator, as it is called, between the spindles to prevent ends breaking from this cause. There are several types on the market, but the original, the "Doyle" (Fig. 10), has received the most extensive introduction, 4,000,000 having been applied. This separator consists of a series of metal blades attached to two rods running parallel with the frame and hinged to supports on the roller-beam. As the ring-rail rises it tips the blades back out of the way, in which position they are also placed for doffing. There are many attachments to these separators to lift them without the ring-rail, to automatically raise them when ready to doff, etc. All the successful separators have the feature of withdrawing when the ring-rail is near the top. The rings now used are the double adjustable type, introduced by George Draper & Sons over twenty years ago. It has been found that by burnishing rings they will start up better and wear out less travelers. The use of hinges on the thread-boards, so that a whole side may be tipped out of the way for doffing by one motion, is being used the last few years universally on new frames. There are numerous designs of lifters and catches, about equally good. In the frames proper, greater care and attention to detail has improved the designs materially. The use of cut-gearing is now insisted upon. The chief difficulty with a frame is to get it perfectly fitted together and set up, so that there will be no cramping and the spindles will come vertical. The Mason Machine Works, in their new frame (Fig. 11), use adjustable legs and cross-bars, which tend to overcome this trouble in the most sensible way. The greatest source of trouble in running a frame is with the banding. Loose bands cause slack-twisted yarn, that makes havoc in the next processes if not discovered, and tight banding consumes power enormously and wears out the spindles. There are numerous tension devices to even the band tension, but the simplest and best way to regulate this evil is by using an invention that is applied to what is known as the Weeks banding-machine, which makes the spindle-bands. The device referred to is a marker which marks all the bands at the proper length, so that when one is put on it may be tied up to the mark, and all will come

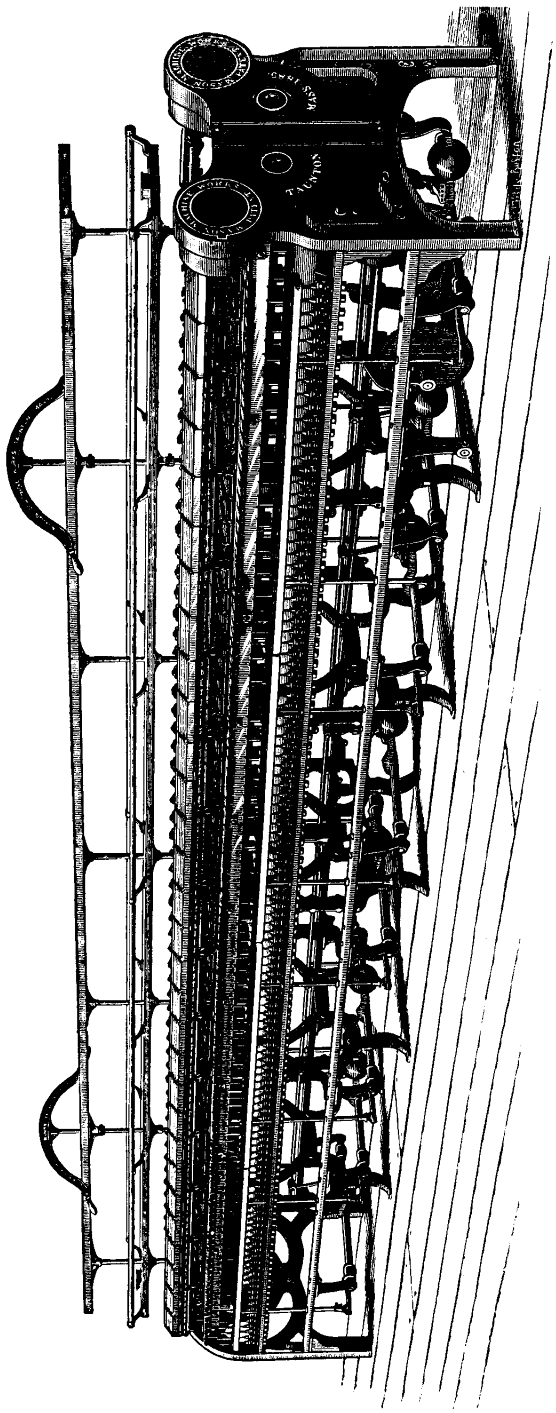

Fig. 11.—Mason spinning-frame.

uniform and correct. An annoyance of some magnitude in the spinning-room is caused by lint accumulating on the lifting-rods, causing them to stick and spoil whole sets of bobbins. The Whitin Machine Co. inclose their rods in a tube, which effectually prevents this difficul-

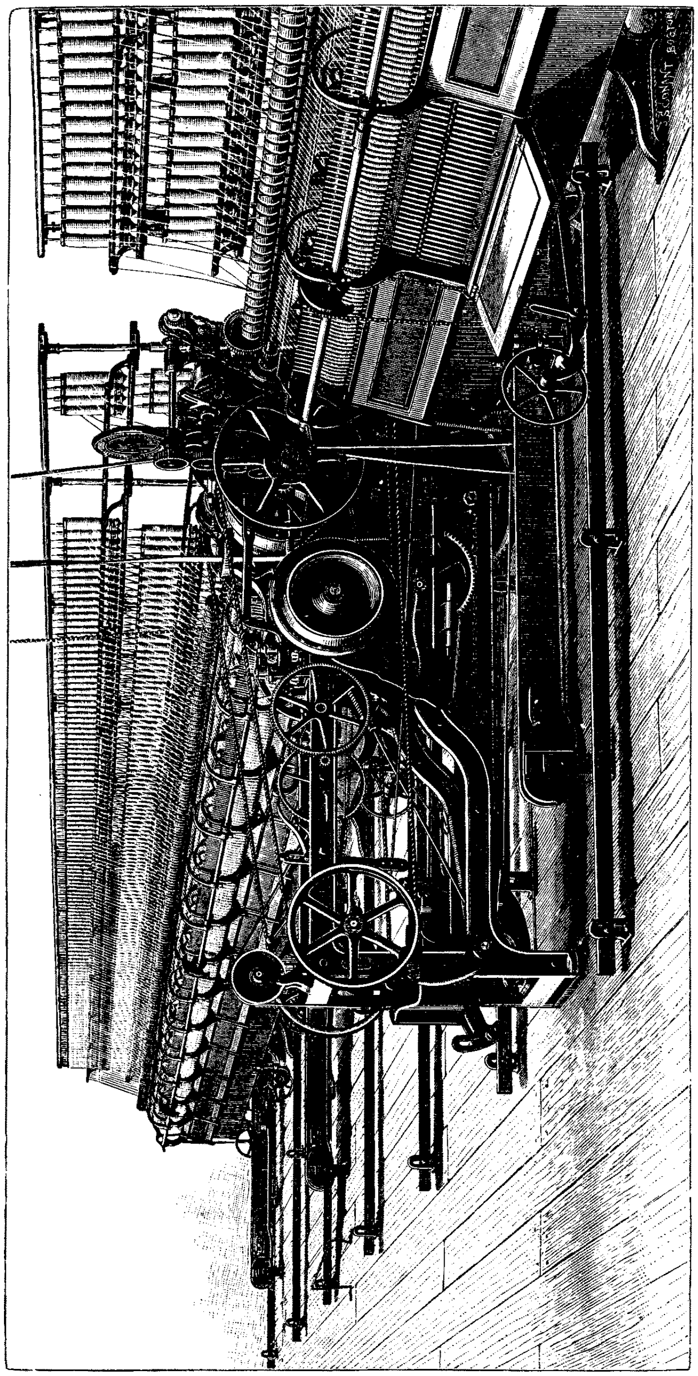

FIG. 12. Mason mule-jenny.

ty. The Shaw & Flinn lifting-rod cleaner is another device for the same purpose. As has been stated before, the use of the spinning-frame for filling yarn has been increasing rapidly, and while it has not seemed policy to throw out mules before they were worn out in order to adopt frames, the new mills are to a large extent adopting frame-filling on coarse and medium numbers. The evener of Mr. George Draper, described by us ten years ago, is largely responsible for this change in public opinion, as by the aggressive introduction of this improvement the help have been educated to run filling-frames.

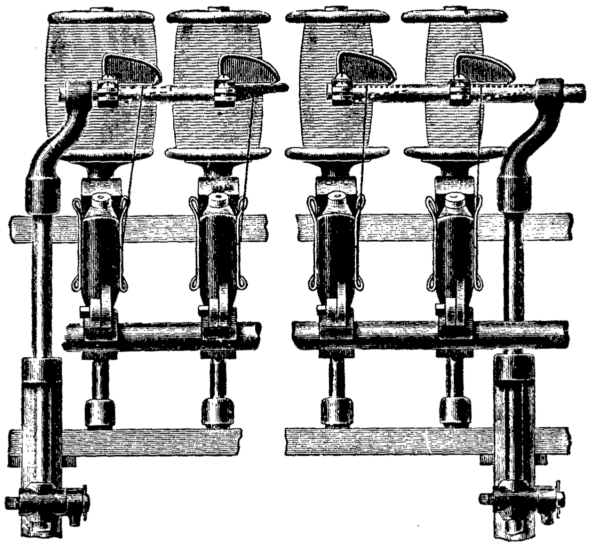

FIG. 13.—Wade spooling-frame.

The great improvements in frames have had their effect by spurring the mule-builders to greater efforts. Mules have undergone considerable change, the advantage gained being higher speed and saving in power. The Mason (Fig. 12) may be taken as the leading American mule, and the late improvements upon it are as follows: An adjustable momentum-brake to check the speed of spindles quickly, instead of allowing it to diminish gradually at the end of every stretch, before the direction of the spindles is reversed for the backing-off operation. By this means a perceptible saving of time is effected at every stretch or draw made by the mule. An improved nosing-motion was also applied to more fully assist the wind-motion to adapt itself to the taper of the spindle, and so prevent the winding on of kinks, when the diminishing diameter of the spindle would otherwise have caused it to fail to take up the yarn sufficiently fast for that purpose. An improved backing-off motion, applied for the purpose of giving a greater range to that particular function of the mule, rendering it possible to back off with equal facility and exactness cops of all sizes and degrees of fineness. A power-doffing motion, to enable the doffing-hands to work the carriage and fallers which guide the yarn, without having to pull the driving-belt by hand, or to leave the front of the mule. A simplified form of chain and chain-gear, for the purpose of drawing the carriage in and out. The flexible spindle-bolster, which rendered possible a much higher speed, and has proved of great value, like the high-speed frame-spindles. A new belt-shifting mechanism, which makes a gain in production of over 5 per cent by extra quickness. The 1890 mule, which is a combination of the best ideas in the English mules, with the improved features of the American, as above noted. The English features copied were the continuous cylinder and faller-rod connections, which runs in one direct line through the whole length. This necessitated a complete transformation in the driving-in and winding mechanism. It will be noticed that in this class of machinery there is plenty of push and improvement. The Lowell Machine Shop also has a new mule for which great saving in power is claimed. Speed and production are equal to the best English mules.

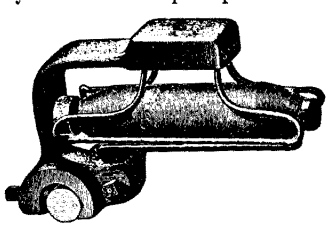

FIG. 14.—Spooler-guide.

The "Parr-Curtis," represented by Messrs. E. A. Leigh & Co., is an excellent representative English mule, and has many new advantages. Its chief feature is the method of driving the drawing-up motion, and the changes, which are worked by a helical spring instead of the cam-shaft, thus dispensing with the latter. The drawing-up and backing-off motion are driven direct by means of an endless band from a grooved pulley, rigid upon the loose pulley of the rim-shaft, the band also passing round a tightening pulley to take up the slack. The speed of the backing-off motion can thus be conveniently altered by changing the grooved pulley without altering the speed of the drawing-up. The American builders of the Parr-Curtis mule are the Saco Water-Power Machine Shop. Other builders have followed the general trend toward more spindles and higher speeds.

Spooling.—An ordinary spooler consists practically of bobbin-holders, guides, and spindles. Although the Wade holder (Fig. 13) is old, it has been improved in detail and mode of application. There are many new spooler-guides on the market, but the Northrop (Fig. 14), introduced by George Draper & Sons, who also introduced the Wade holder, is practically controlling the field at the present day. This guide is adjustable on a round rod, over which the yarn runs, and the slit is adjustable in width for different numbers of yarn. It is extremely simple. Some spoolers are being made with a traveling-belt through the center, to carry away the empty bobbins. George Draper & Sons introduced experimentally a most ingenious idea, consisting in a knot-tyer for each spindle that tied knots automatically. One of the great difficulties in weaving arises from the long ends of these knots tangling the warp. The automatic tyer cut these ends short and avoided this trouble. Drum-spoolers are still used, though in inferior numbers, and have been improved to quite an extent. Stop-motions for

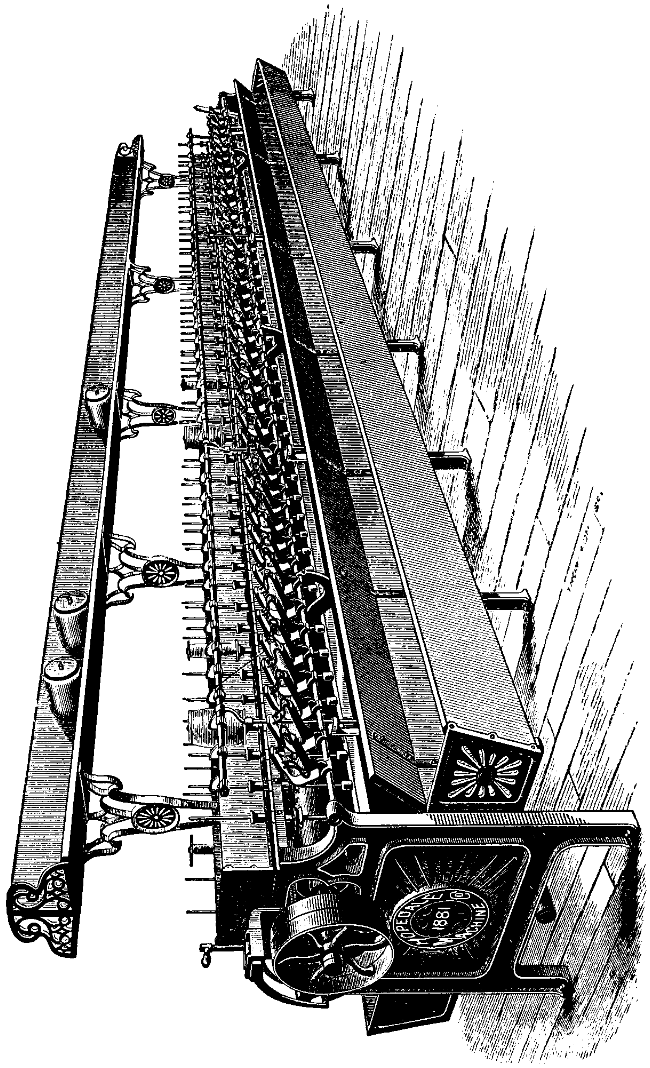

Fig. 15.—Hopedale Machine Co. spooler.

doubling spoolers of many kinds are being experimented with. The Hopedale Machine Co.'s spooler is represented in Fig. 15.

Warping.—The ordinary warper has undergone but little change in the last few years. The rising roll and the Walmsley stop-motion are used more extensively than ever. Improvements in details of creels, combs, etc., are hardly of enough importance to chronicle as embodying new principles. There is, however, a branch of warping that has received considerable attention, and that is the production of chain-warps to be linked or wound on balls. The great change of custom in the processes of dyeing have brought about the use of these machines, the old fashion of dyeing from skeins being entirely changed. The process of chain-warping, making a chain direct from the spools and linking it automatically, was the first innovation. The Walcott warper came into use for this purpose, and as chains of 1,000 yards were most commonly used, containing from 500 ends upward, it was admirably adapted for the purpose. The Denn warper also was used, especially where 2,000 ends or more were run

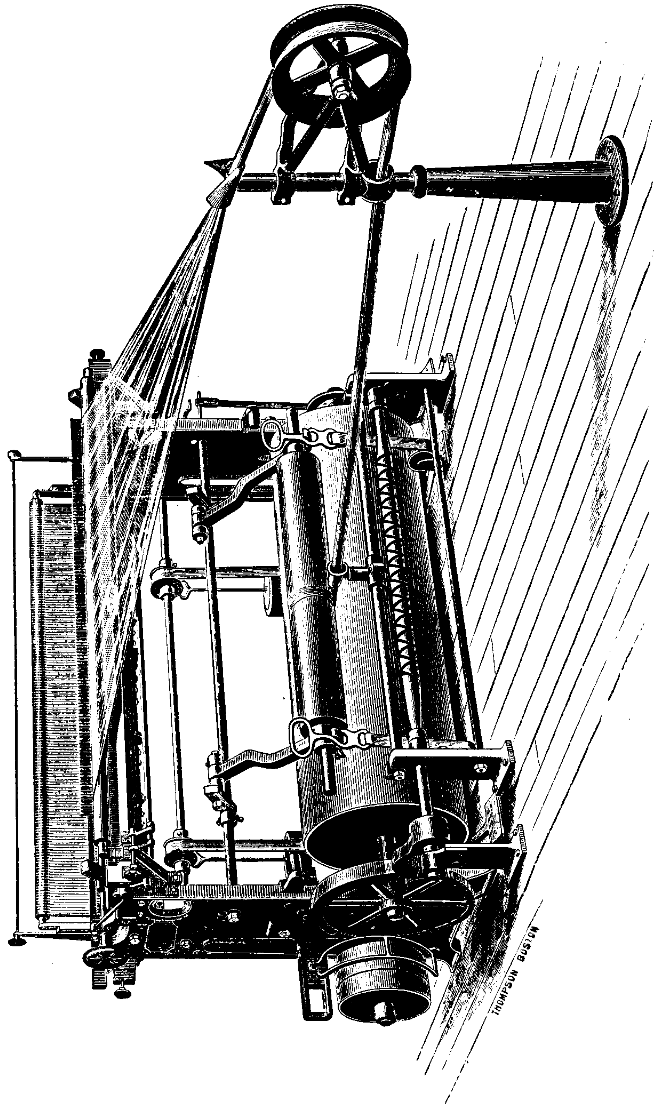

FIG. 16.—The Hopedale warper.

into a chain. Of late, however, the long-chain system is far in advance, on account of the greater cheapness in handling and dyeing. For these the Hopedale warper, with the Straw leasing-motion, and Clarke balling-machine (Fig. 16), is unequaled. In these, long chains from 350 to 500 ends are run.

The operation of this balling-machine is very simple: The ends are taken from spools in a creel through the regular slasher-warper to the front comb, in place of which is a Straw leasing-motion; after passing through this the ends are brought together in the trumpet and carried over the pulley as a chain and back to a trumpet which traverses the length of the ball back and forth, on the same principle as the card-grinder. The chain is carried diagonally round a shaft which forms the center of the ball, and rests against the cylinder of the warper, being held by weight.

Many improvements have been made in this machine since its introduction, and it is now much easier handled and attended.

Twisting.—In twisters the same radical change has taken place as in frames—that is, higher speed, by the introduction of the modern type of spindle. The Sherman form of the

Rabbeth type has been most extensively introduced, and, although they are of necessity much larger and heavier than spinning-spindles, the same principles seem to apply with equally good results. The Hopedale Machine Co. was the first to equip twisters with improved spindles, as they started with the Sawyer. Their machine (Fig. 17) is a good illustration of steady improvement. It is very heavily built and most conveniently arranged for changing twist. Besides the spindles, they are lately introducing a marked improvement, in the form of a stop-motion, the simplicity of which can not but commend itself. Other stop-motions in

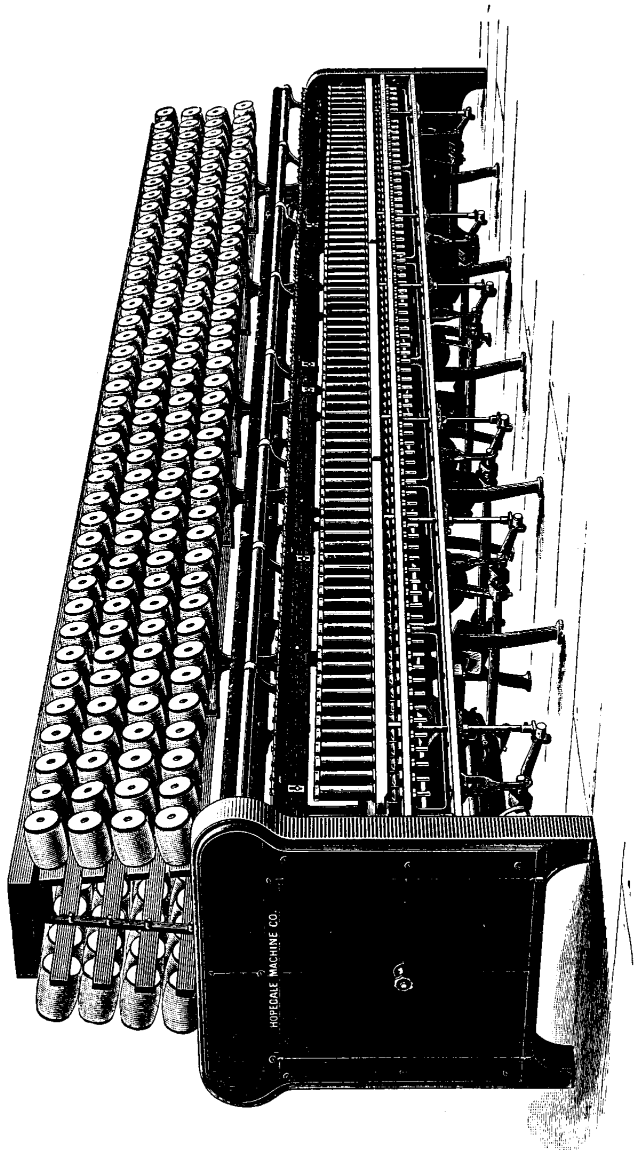

Fig. 17.—Cotton-twisting frames.

use are of such a complicated nature that their introduction has been extremely limited. This one is applied where a single bottom and top roll are used, the top roll having bearings on an inclined track so arranged that if the thread breaks between the spindle and the roll, the roll will run down the track and stop the delivery, preventing roll waste and damage resulting from winding on the lower roll. With two-ply yarn it will act if either strand breaks back of the roll. They also have a new ring-rail for wet twisting, which is made of a strip of rolled brass having flanges so arranged that the rail is reversible.

Reeling, Quilling, etc.—Very little change is noted in reels and quillers of the usual sort, but a new class has arisen, first introduced by Mr. Straw, of the Amoskeag Co., who invented a machine for quilling from a chain. This is used on colored work, and does away with the custom of reeling and quilling in the old way. The Whitin Machine Co. have introduced a chain-quilling machine (Fig. 18) having novel features. The chain of yarn that comes to the machine from the dry cans is placed on a turn-table and passed over friction-drums the same as in ordinary chain-beaming, and is then wound upon bobbins in this machine. The arrangement of the spindles allows a very compact machine to do a large amount of work. Lapped ends can not

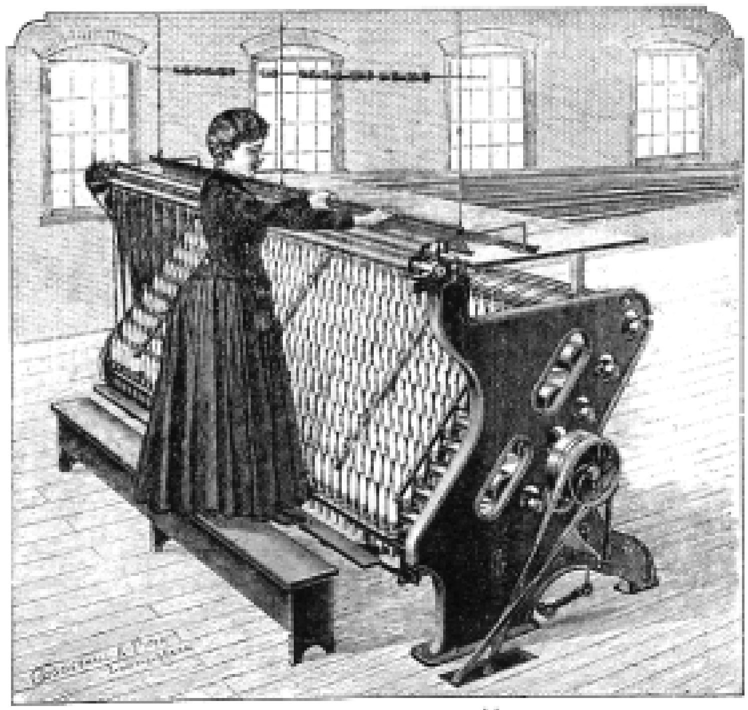

Fig. 18.—Chain-quilling machine.

be made, consequently bobbins will weave from start to finish without break of yarn. There is no friction device, therefore the color is left clean and bright on the yarn—a marked advantage.

The above practically covers the whole field of ordinary cotton manufacturing up to the process of weaving. Of course, for special instances, special machinery has to be invented, but its interest is of a local character. There is no doubt but that the industry of cotton manufacturing has advanced materially in the last ten years, and more by improved machinery than in any other way.