SPIN'NING (from AS. *spinnan*, to spin). The art of drawing, twisting, and combining either animal or vegetable fibres so that they are formed into continuous threads for the further operations of weaving, knitting, or sewing. The principal textile fibres are silk, wool, flax, jute, and cotton (q.v.), and the method of spinning each of these differs slightly from the rest.

The most ancient instruments for spinning were the spindle and distaff, pictured on the earliest Egyptian monuments. The distaff was a staff upon which a bundle of the prepared material was loosely bound, and which was held in the left hand or stuck in the belt; the spindle was a smaller tapering piece to which the thread was attached. By a twirl of the hand the spindle was made to spin round and at the same time recede from the spinster, who drew out between the forefinger and thumb of the right hand a regular stream of fibres so long as the twisting of the spindle lasted. It was then drawn in, the new length of thread wound upon it, and the operation renewed. An improvement in this device was to set the spindle in a frame and make it revolve by a band passing over a wheel, driven by occasional impetus from the hand.

The Saxony wheel is said to have been invented in Nuremberg in 1530. This wheel, used only for flax spinning, contained the germ of Arkwright's invention, described later. A bobbin or pirn with a separate motion was placed on the spindle, which had a bent arm—a flyer or flight—for winding the yarn on the bobbin. The spindle and bobbin revolved at different speeds, revolutions of the spindle giving the twist, and the difference of the speed causing the winding on. The two-handed wheel had two spindles and pirns a little apart, with the distaff stuck into the frame between them, and the spinster produced a thread with each hand.

During the last half of the eighteenth century three inventions were made which completely revolutionized the art of spinning. These inventions were Hargreaves's spinning jenny, Arkwright's throstle machine or roll-drawing spinning machine, and Crompton's mule spinner. In the spinning jenny a number of large reels of fibre, formed into a thickish coil, called a roving, were set on upright fixed spindles, and the ends of the rovings were passed between two small movable bars of wood placed horizontally and under the control of the spinner, who could thus make them press more or less on the roving, and consequently increase or decrease the draw upon it from the spinning spindles, set in a row at the other end of the frame, and all capable of being set in motion simultaneously by the wheel. The spinner drew out the rovings by moving the bars back and forth and at the same time turned the crank with his right hand to rotate the spindles. The throstle machine, patented by Arkwright (q.v.) in 1769, had for its object the drawing of the rovings through a succession of pairs of rollers, each pair in advance of the others, and moving at different rates of speed. The first pair receive the sliver, compress it, and pass it on to the second pair, which revolve at a greater speed, and thus pull it out to exactly the number of times greater length that their revolutions exceed those of the other pair, and as the first roving is passed through a second, third, and sometimes fourth

machine, the finished roving is 32 times longer than the sliver. As the roving issues through the last rollers of each machine it is received on spools or reels, calculated to hold a given quantity; and these are transferred to the spinning frames, which resemble the roving frames. Here the roving takes the place of the sliver, and, as it unwinds from the spool, is drawn through successive pairs of rollers, moving as before at different rates, each succeeding pair faster than the backward ones, so that the roving gets thinner and thinner, until tenuity is carried as far as desirable. It is then carried on to a rapidly revolving spindle, which, by means of a simple arrangement, is made both to twist the thread and wind it on the spindle ready for the weaver. Arkwright's machine was too heavy to be driven by hand, hence horse power was used at first, and later water power, which gave it the name of the "water frame." Steam power was applied to it in 1790.

It was found that the process of spinning by rollers produced too great a strain upon the thread in its progress to admit of its being drawn as fine as is wanted for many purposes; this led to the invention of the mule jenny by Crompton in 1779, with its traveling frame upon which the spindles are set, which in its modern form is described below.

During the nineteenth century many important improvements were made in the details of the construction of spinning machinery, but the general principles are those worked out a hundred years ago. The greatest improvements have been changes in the construction of spindles, allowing more rapid and free revolution. In the modern factory spinning is the final process in a series of operations necessary to convert the raw fibre into thread. Each of these processes has for its object the removal of smaller and smaller impurities and the production of a finer and stronger thread. These are: (1) opening and picking; (2) carding and combing; (3) drawing; (4) roving; (5) spinning. Other intermediate operations may be introduced.

The opener or breaker, picker or lapper is a similar machine to the intermediate or finisher lappers, as shown in Fig. 1 and described below. In the breaker lapper the cotton as taken from the bale is fed to it in a hopper or by some kind of automatic feed and delivered in laps which are then placed on the intermediate lapper, either 3 or 4 laps being doubled on the same and the cotton after being loosened and further cleaned is delivered in laps to be placed on the finisher lapper, 3 or 4 laps from the intermediate being again doubled and delivered in a single lap ready for the card. The function of the lappers is thoroughly to loosen the lumps of cotton as taken from the bale, to remove dirt and dust and as much leaf, trash, and motes as possible. There are usually three of these—the breaker, intermediate, and finisher lapper. Fig. 1 is a section of an intermediate or finisher lapper. The cotton enters these machines in a sheet made up from the laps, *A*, delivered onto the slowly moving apron, from which it is taken by the feed rolls and delivered to the rapidly revolving beater, which forces it against the grid bars, loosening the dirt and motes which fall through the grids into the mote box. The cotton is left in a light and feathery mass, drawn in between the squeeze rolls by suction of the fan, which also draws dust and fine dirt from the beaten mass, discharging them by the dust flue. The sheet of cotton from the squeeze rolls is taken by the calender rolls, and compressed and finally rolled into the lap *B*. The lap is about 1 inch in thickness, 40 inches to 48 inches wide, and usually from 48 to 52 yards long.

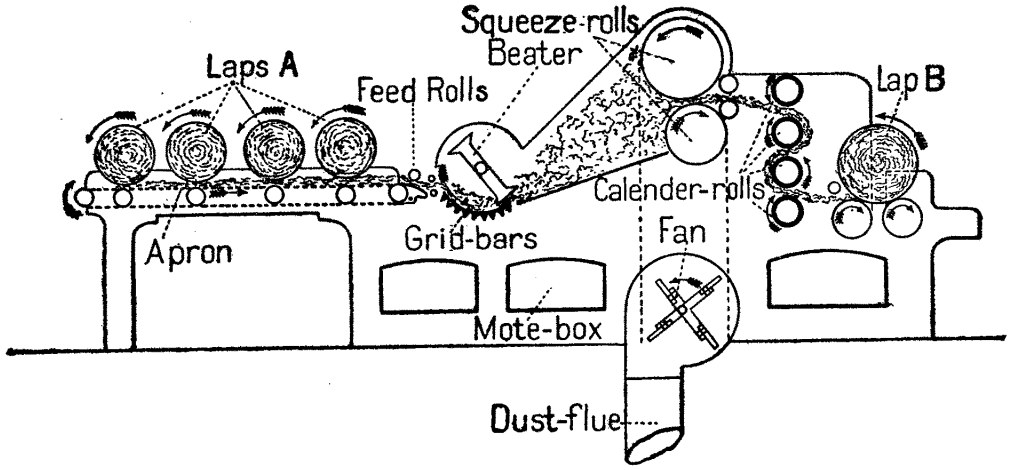

FIG. 1. SECTION OF INTERMEDIATE OR FINISHER LAPPER.

After the cotton has passed through the series of lappers the laps from the finisher lapper go to the card (Fig. 2). (See CARDING.) The cotton in the lap *A* is delivered to the feed roll of the card and is grasped by the teeth of the licker-in, or taker-in, from which it is taken in a thin sheet by the fine wire teeth of the card clothing on the cylinder *B*, and carried upward to come in contact with the teeth on the clothing of the top flats, and the fibres are combed into a degree of parallelism—the cylinder revolving rapidly, while the flats, which are in a chain, move slowly forward so that new flats are continually coming in contact with the cylinder—and much of the short and broken fibre is removed; the comb, *C*, removes the short fibres from the flats and they are rolled upon the rod, and the flats are further cleaned by the brush. The carded cotton is taken from the cylinder by the doffer

cylinder, the latter having a surface velocity somewhat less than that of the main cylinder, and is removed from the doffer by the comb, *D*, in a thin evenly carded film; this film is drawn

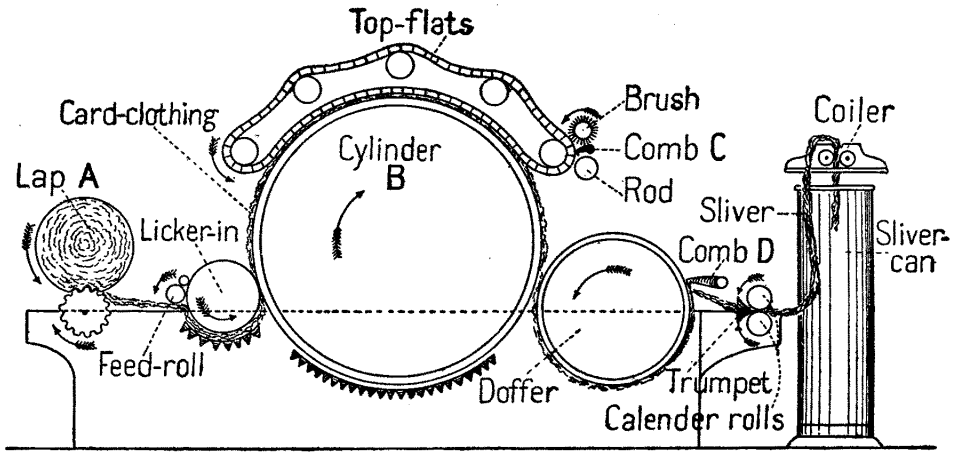

FIG. 2. SECTION OF REVOLVING TOP-FLAT CARD.

through the trumpet by the calender rolls, in a round strand about 1 inch thick called a sliver, which is automatically coiled in the sliver-can by the coiler.

As all the processes are arranged to double the mass of cotton and then reduce the mass in size by drawing it out to several times its

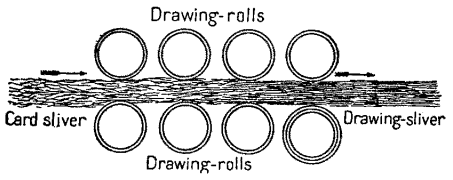

FIG. 3. DETAIL OF DRAWING PRINCIPLE.

original length until the yarn is finally produced, an examination of Fig. 3 will help the reader to understand how the drawing acts on the fibres. On the left is shown the sliver from the card, the cotton being in a more or less tangled condition, but after passing between the successive pairs of drawing rolls, 4.4′, the last or right-hand pair, revolving faster than the

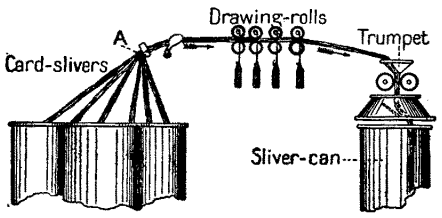

FIG. 4. SECTION OF DRAWING FRAME.

others, draws the fibres past each other and straightens them, bringing them into a nearly parallel position.

The card sliver goes first to the drawing frame, Fig. 4, and four to eight slivers, *A*, are combined by passing them through the drawing rolls as above described. The drawing sliver is carried through the trumpet and deposited in the can by the coiler the same as from the card. This drawing process is repeated two or three times as the work may demand, always doubling and drawing, but without putting in any twist.

After the drawing frames the drawn sliver is placed in cans, behind the first of the roving frames, which have rolls similar to the drawing frames, but have spindles by which the stock, then called roving, is twisted and wound on bobbins. The first of the roving frames is called the slubber, and is heavier than the intermediates and fine frames, as the other roving frames are designated. The full bobbins, *A*, from the slubber are placed in the creel of the intermediate frame, as shown in Fig. 5, and two strands

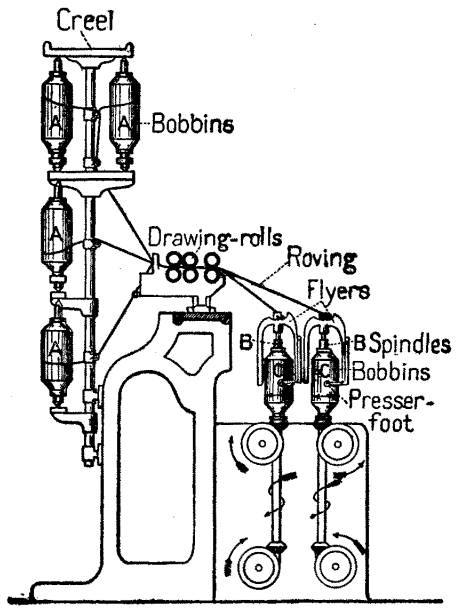

FIG. 5. SECTION OF ROVING FRAME.

combined are delivered to the rolls and drawn, the new strand of roving is carried to the top of the flyer, on the spindle *B*, is passed through one arm of the flyer, which is hollow, and delivered to the bobbin, *C*, by the presser foot. The

revolving of the flyer puts the twist into the strand of roving, while the difference in speed between the flyer and the surface of the bobbin winds the roving on the latter.

The fine frame is a similar frame to the above and delivers the roving finer and more even than

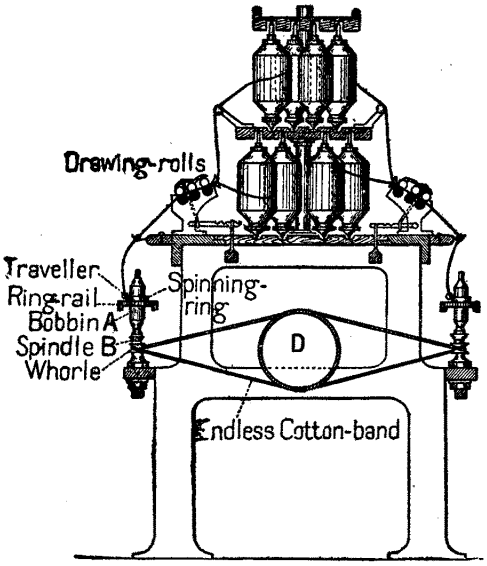

FIG. 6. SECTION OF SPINNING FRAME.

any of the preceding machines and ready for the spinning frame (Fig. 6). The roving may be doubled or run singly on the spinning frame, the rolls produce the drawing effect as on the preceding machines, and the revolution of bobbin and spindle puts in the twist. The bobbin, *A*, is fast on the spindle, *B*, and draws the yarn through the traveler, a small wire loop attached to and movable on the spinning ring, which surrounds each spindle. The spindles are made to revolve by an endless cotton band, which passes around the whorl of the spindle and is driven by

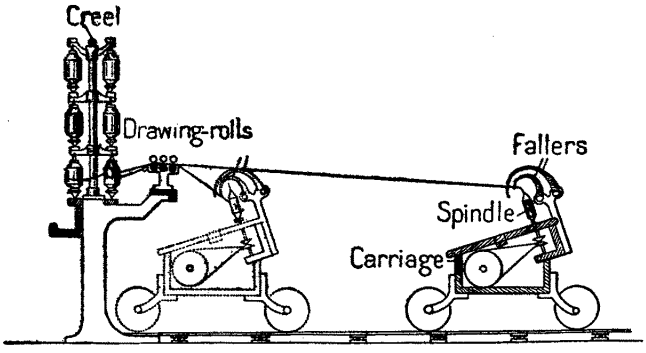

FIG. 7. SECTION OF SPINNING MULE.

the cylinder, *D*. The production of the spinning frame is technically frame-spun yarn, either warp or filling. This is wound on the bobbins by the moving up and down of the ring rail, which holds the spinning rings with the travelers, the pull or drag of the travelers winding the yarn on the bobbin.

Mule-spun yarn is produced by spinning the roving on a mule (Fig. 7), the roving coming from the fine frames as for frame-spun yarns, but the drawing and twisting being accomplished in a different manner. On the spinning frame the roving is drawn, twisted, and wound continuously, while on the mule it is drawn out while the twist is being put in and is spun intermittently, and then wound on bobbins or cops intermittently. The roving is placed in a creel and passed through the drawing rolls, as on the spinning frame, and carried to the spindles, which, instead of being in a stationary rail, are mounted in a carriage, which runs away from and back to the rolls alternately, traveling about 5 feet each way. As fast as the rolls deliver the roving, the carriage and spindles recede from the roll stand and the spindles revolving twist the yarn over the top of the spindles, where it is held by the fallers. In some cases the carriage travels several inches more than the delivery of the front roll and causes additional drawing. The movement out of the carriage is called stretch, and at the end of each stretch the rolls are stopped automatically, the required twist being completed, the spindles are stopped and reversed in motion, while the fallers guide the spun yarn away from the top of the spindle and wind it on the cop or bobbin, the carriage approaching the rolls again, after which the same movements are repeated continuously. The spinning frames are arranged with an average of 104 spindles to a side of about 27 feet in length, but this number varies according to the gauge, or distance between centres of spindles. The mules, not having spinning rings, admit of the spindles being nearly twice as near together, the average number per mule being 480, though some are built much larger.

In a general way the spinning of other textile fibres is the same as for cotton, the desire being to reduce the strands and to make them of uniform diameter throughout their entire length and to give them the requisite amount of twist. Woolen yarn is spun on a mule as described for spinning cotton, except that the carded roving comes to the mule in a different shape, being carded differently and without twist until spun on the mule. Worsted and some cotton yarns are produced by a combing operation which is a special drawing process to increase the parallelism of the fibres, the cotton being afterward worked on the roving frames, while worsted is spun on a frame not unlike the roving frame, the twist being put in by flyers, as the twist in the cotton roving. For the spinning of silk and other fibres, see special articles on those fibres.

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