

THE PROTECTION OF EMPLOYEES IN COTTON MILLS

By H. M. Crawford

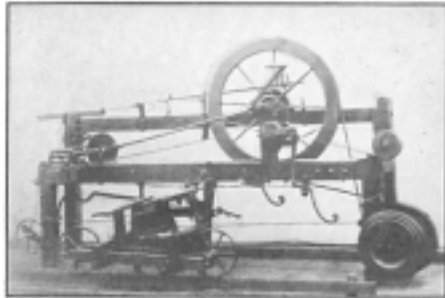


FIG. 1.—SAMUEL CROMPTON'S ORIGINAL MULE

“ACCIDENTS will happen.” This is a trite saying sometimes made as if accidents were unavoidable adjuncts of our industrial system. To some extent this doubtless is true, but it is also certain that a larger percentage than is generally imagined may be reduced from the casualty roll.

Cotton-spinning mills in England, France, Belgium, Germany and the United States have, for a century at least, been prolific sources of accidents arising directly from the machinery in use, as distinct from other causes. It was this prevalence of injury among cotton-mill workers on the Continent that called into being the Society for the Prevention of Accidents in Factories in Alsace twenty years ago, and excellent work has been carried on by this society and its ramifications among the cotton mills of Alsace, Lorraine and Rhenish Prussia. It must, in fact, be credited to that disinterested body of mechanics that they were the main pioneers of efficient safety devices for cotton machinery. During the last decade we in England have adopted several of these appliances,

improved on others, and from the inspiration given by those early efforts our engineers and machinists have invented many more which do good service every working day in the mill. The United States are now actively falling into line, and insurance companies are giving serious attention to the proper safeguarding of machinery in mills under their supervision.

The machine of greatest import in a cotton-spinning mill (Fig. 2) is the self-acting mule. This, without doubt, is the most complex piece of mechanism in the whole factory, has received greatest attention from inventors and machinists generally, and performs work on which the strength and dignity of a mill depends.

When Samuel Crompton launched his invention on the factory world little could he imagine that after the lapse of a century we should retain the main principles of his machine intact, and he could never have regarded his innocent carriage and headstock (Fig. 1) as becoming the chief source of the accidents that come to a cotton mill.

Yet the mule has for long, unfortunately, borne this unwelcome characteristic. In 1900 some 1,500 cotton-spinning mills were in operation in Great Britain with 50 million spindles, consuming 3 million bales of cotton; and the number of accidents from self-acting mules alone totaled over 800, or an equivalent of the casualties due to *all* other classes of machinery used in cotton spinning. Then efforts began for the express purpose of reducing this number considerably by the provision of safety devices on certain dangerous parts of



FIG. 2.—NEW AND OLD TYPES OF COTTON-SPINNING MILLS
(The large mill is the Majestic Spinning Mill at Oldham.)



FIG. 3.—LITTLE PIECER CLEANING

the mule. Up to this time no fencing whatever was applied to faller hammers, carriage wheels, middle scrolls on back shafts and rim pulleys on headstocks. "Impracticable and unnecessary" were terms applied to this generous scheme of fencing, but patience and inventiveness prevailed. Guards were devised which, if properly fixed and carefully used, could not do otherwise than diminish the risks then run by operative spinners and piecers. The machine makers at once rose to the occasion and produced guards for their own mules which would in no way hinder the mechanical operations nor reduce the output of yarn.

A cotton mule contains some 1,200 spindles, a pair of machines being tended by an operative spinner and his two assistants—a big piecer, generally over the age of 16, and a little piecer under that age. These operatives work in light clothing

(Fig. 3), such as shirt and trousers, often enough in shirt only, with no covering to the head, neck or feet. Statistics collected during several years proved that the majority of accidents arose from the following parts of mules: headstocks, tightening pulleys on headstock square, quadrant pinions, back-shaft scrolls, drawbands and their pulleys, faller hammers and carriage wheels. Efficient

guarding was, therefore, aimed at these items. Special regulations have also been provided for all cotton-spinning mills in the United Kingdom making it compulsory for the following parts to be securely fenced:

- (a) Back-shaft scrolls, carrier pulleys and drawband pulleys.
- (b) Front and back carriage wheels.
- (c) Faller stops.

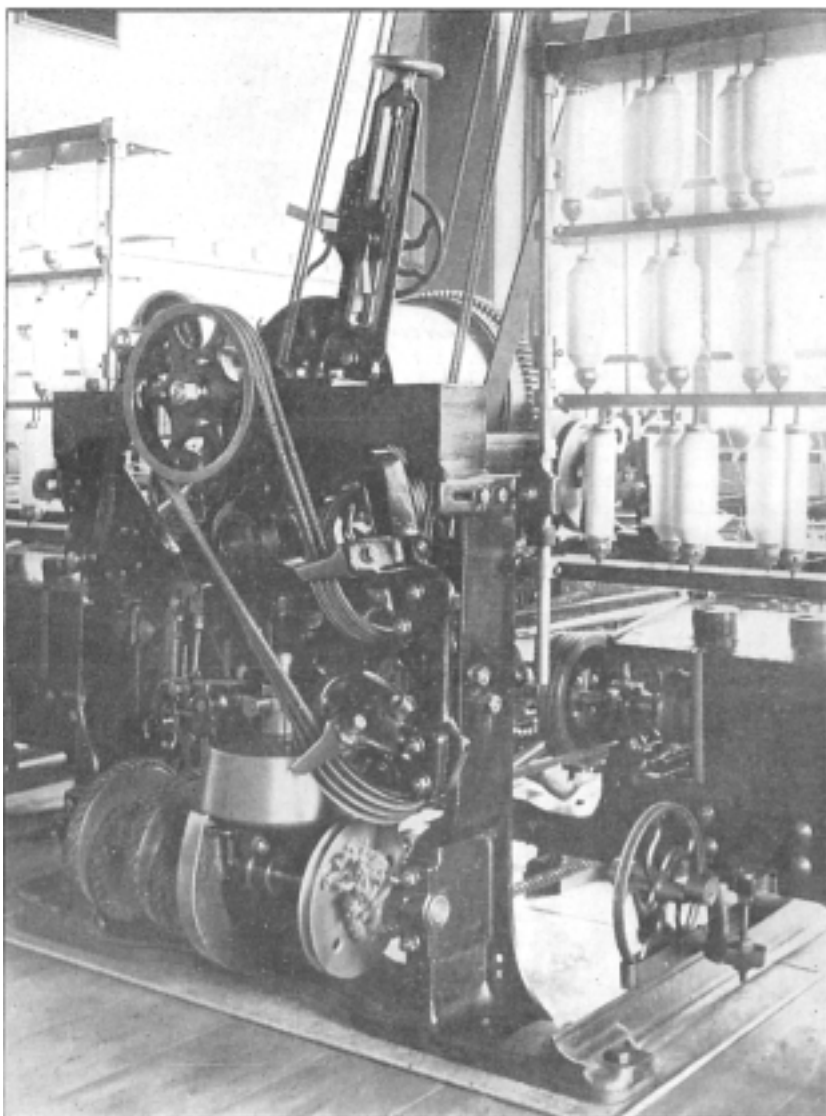


FIG. 4.—HEADSTOCK OF MULE

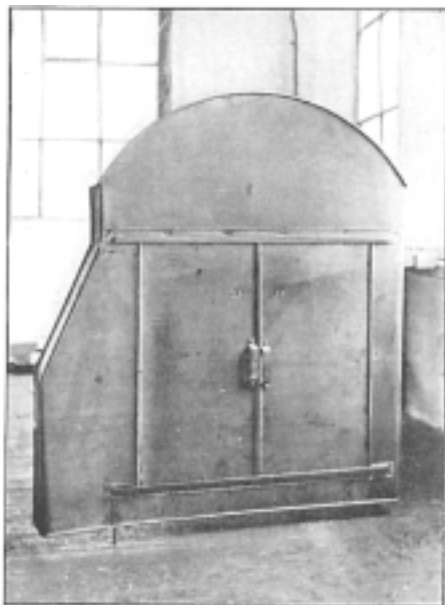


FIG. 5.—GUARD FOR BACK OF HEADSTOCK, WITH SLIDING DOORS

- (d) Quadrant pinions.
- (e) Back of headstocks, including rim pulleys and taking-in scrolls.
- (f) Rim-band tightening pulleys other than plate wheels, connected with a self-acting mule erected after January 1, 1906.

The headstock (Fig. 4) is the "mainspring" of the mule, from which all its evolutions are directed. At the back are dangerous pulleys and wheel-trains where piecers and spinners must pass many times in a day when changing bobbins in the creels. The main rim pulley and rim carrier pulleys make 750 to 800 revolutions per minute, and if any hand-brush or cleaning cloth comes into collision with these parts physical damage is almost certain. Boy piecers have thus been flung to the floor or against adjacent parts of the machine; arms and legs have been fractured, entailing heavy insurance premiums and compensation amounts out of all proportion to the cost of preventive guards. For 18 to 25 shillings an efficient guard (Fig. 5)

can now be supplied to the back of a mule headstock, covering all rim pulleys, bevel and spur wheels and the taking-in scrolls near the floor. Besides, the parts of the headstock required to be oiled periodically are made continually accessible by the inclusion of folding doors in the guard itself. The guard is so affixed to the headstock frame (Fig. 6) by means of latches that it can be moved bodily away in case repairs are required. No headstock guard is complete or efficient which does not adequately cover the scrolls near the floor.

At the front of the headstock—that is, in the "jenny-gate," where spinners and piecers spend the greater portion of their working hours, are the quadrant arm and its pinion (Fig. 7) on the right-hand side and the tightening pulley (Fig. 8) on the left. Both these parts have been prolific in serious accidents. The quadrant of a mule is reversible, like the movement of a carriage; its

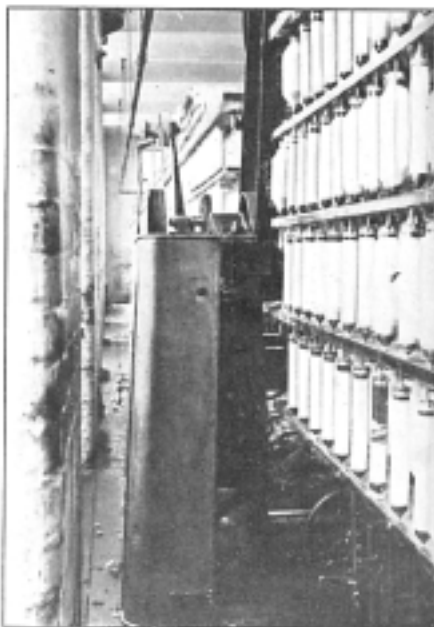


FIG. 6.—GUARD AFFIXED TO BACK OF HEADSTOCK FRAME

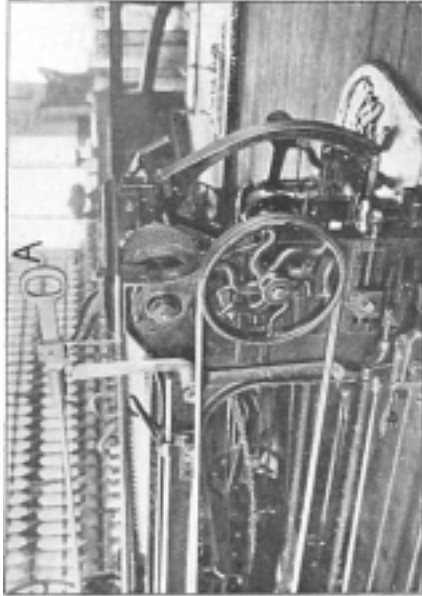


FIG. 8.—TIGHTENING PULLEY ON FRONT OF HEADSTOCK; ALSO STARTING ROD A WITH CHAIN AND FLUG

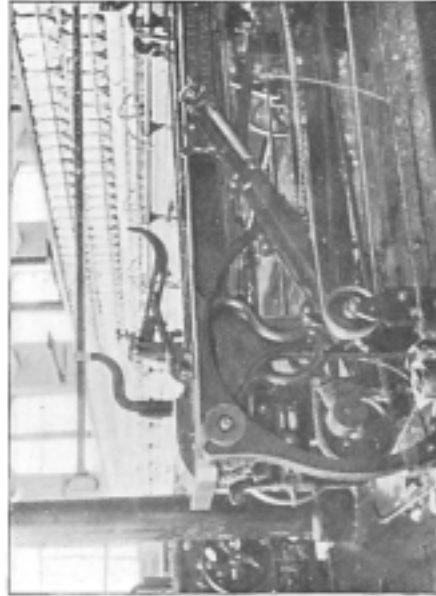


FIG. 10.—QUADRANT ARM OUTSIDE PLANE OF QUADRANT

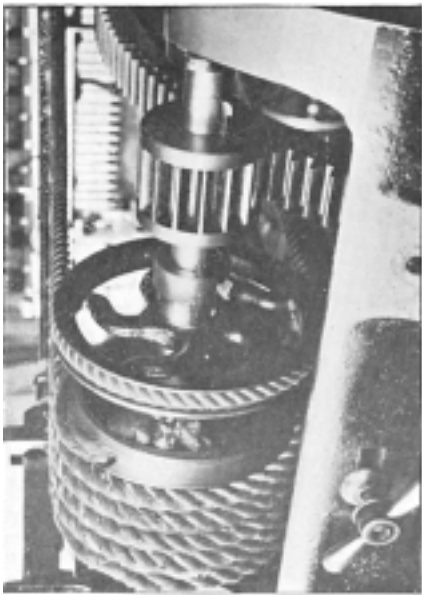


FIG. 7.—QUADRANT ARM AND SPURGEAR

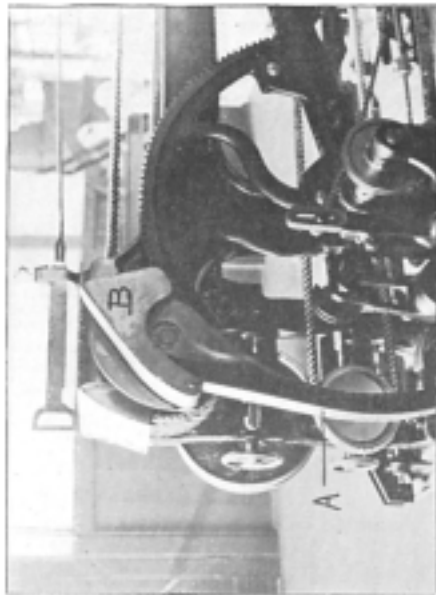


FIG. 9.—QUADRANT GUARD A (FIXED TO FRAME), AND GUARD B LEVERED ON IT

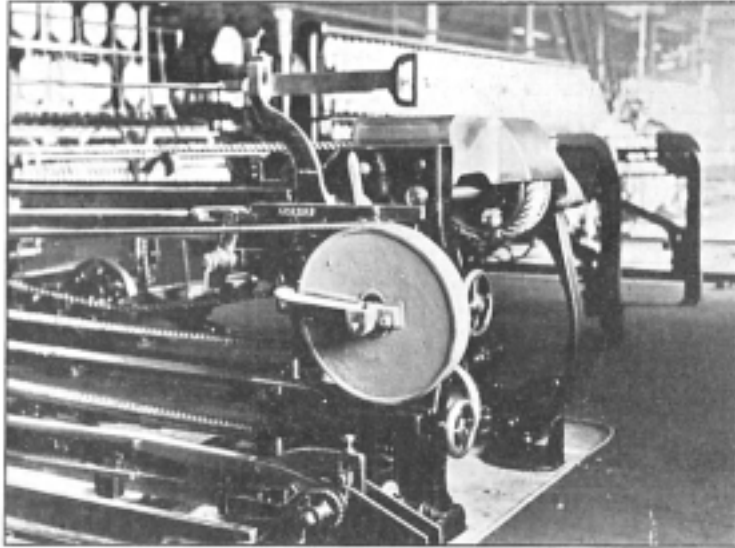


FIG. 11.—PLATE GUARD OVER RIM BAND TIGHTENING PULLEY

pinion, therefore, bites above or below, according to the falling or rising of the quadrant. When the quadrant is rising, the intake of the pinion is fairly protected by a trunk in which the quadrant runs; but when the quadrant falls its arm approaches so near to the pinion that fencing on this side has, up to recent times, been

omitted. Now, however, various devices are in use which cover as far as possible the space—1, 2 or 3 inches—hitherto unprotected.

The quadrant and pinion may work inside the headstock frame and be provided with a high hood, precluding all risk of accident. Or the quadrant and pinion may be outside

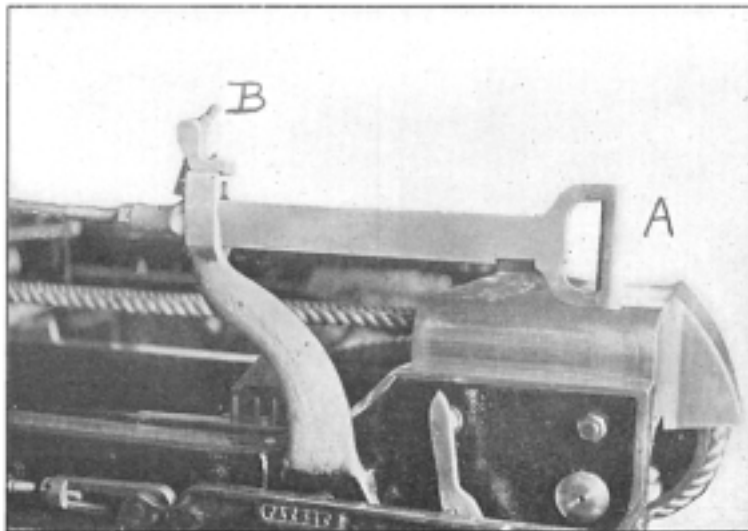


FIG. 12.—STARTING ROD A WITH DROP-LATCH B

the headstock frame, in which case the quadrant guard is fixed (Fig. 9), and to it is attached a pinion guard operated by the quadrant as it advances or recedes. When the arm advances the guard is raised on its fulcrum, and falls by its own weight when the arm recedes. The guard thus covers at all times the open space above referred to.

In both these types of mule the arm and quadrant teeth are in the same vertical plane. In some mules the arm is in a plane external and

spokes, and of a smaller diameter than formerly. Where armed-pulleys are used a simple form of plate-guard (Fig. 11) is devised, which effectively covers the dangerous spokes and allows the spinner to tighten his bands. The difficulties which have arisen with tightening pulleys have been two-fold. Workmen's arms have been broken by the spokes owing to accidental starting of the wheel, or limbs have been severely abraded and burnt by friction against the revolving periphery. Both these exigencies are

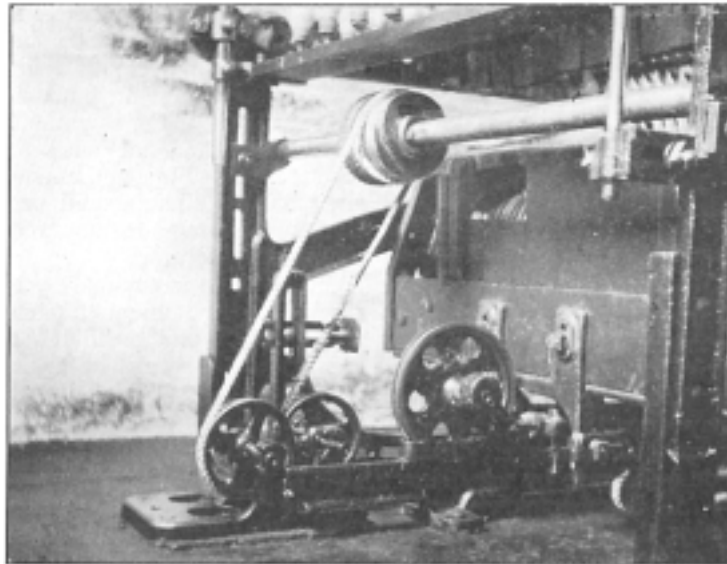


FIG. 13.—SCROLL-WHEEL AND ROPES UNPROTECTED

parallel to that of the quadrant (Fig. 10). In this type a guard is attached to the headstock frame, which covers the quadrant teeth entirely and allows the arm to travel by the side of the guard without impinging it in any way. Where, in the case of old machinery, the quadrant arm in its advance comes close to the pinion, a lateral plate-guard may be affixed, allowing the arm to pass inside.

Rim-band tightening pulleys, other than plate wheels, which have been erected since 1905 should be efficiently fenced. Several machinists now make these wheels without

provided for by the plate-guard, which covers the whole area in which the pulley is required to move in the process of tightening the band.

While noting parts in the square of the headstock, we should remember the importance of securing the safe working of the starting rod (Fig. 8). Serious and fatal injuries have frequently been caused by this rod escaping from its stopping point and thereby restarting the mule. The rod is, in all modern mules, provided with a notch about half an inch deep, which, on the cessation of the machine, falls on the lower side of a

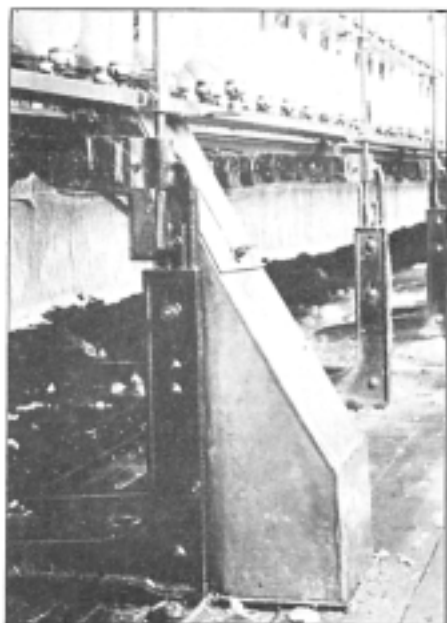


FIG. 14.—GUARDS COVERING SCROLL AND DRAWBANDS

slot in the rod guide. So long as this notch remains in the slot the machine is stationary. If by any means the notch is lifted from the slot the machine may start at any moment and do irreparable damage. Rods may be made quite safe by very simple means. It is customary for a wooden wedge to be inserted in the unoccupied portion of the slot when the notch is in place. In this way the rod cannot be lifted until the wedge has been removed. Another common practice is to place the notch in the slot, drill a hole through the rod and slot, and in this aperture fit a plug (Fig. 8) held by a chain to the machine frame. Similarly, by this plan the rod cannot be lifted from its safe-keeping until the chained plug is withdrawn. Another method is by means of a drop-latch (Fig. 12) which is so balanced that when it falls on the stopped rod this cannot be lifted from the slot until the latch is moved.

There are still in use in cotton factories mules of fifty years ago with round starting rods in place of the

more modern ones, which have an oblong section. These round rods have no notch at all, and are liable to cause serious casualties. They can be safely secured by drilling a concentric aperture through the rod and rod guide and treating to a plug and chain. There need then be no fear of a mule re-starting "from an unknown cause."

The back shaft of a mule claims careful and detailed attention in all cotton-spinning mills. The toll of fractured arms and hands, and of limbs torn from their sockets by this shaft and its scroll-wheels, is indeed serious. It is common knowledge that the roller weights lying within the line of the back shaft and parts adjacent are cleaned while the mule is in motion. And with the back-shaft scrolls (Fig. 13) uncovered, the risks are so obvious and unwarrantable that guards are now required in all British factories.

Every mule is divided by the headstock into two unequal parts known as "halves," and a "half" generally contains in its back shaft three scroll

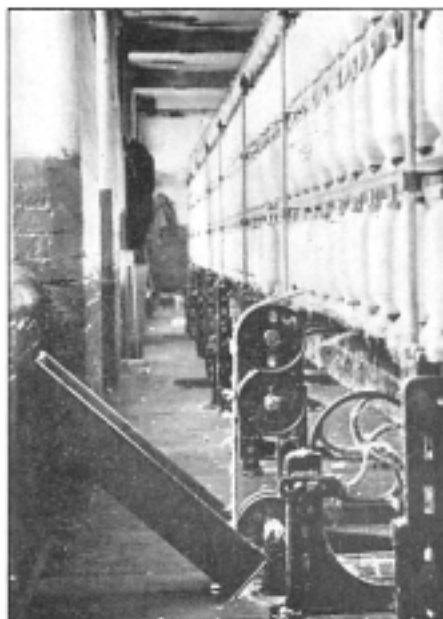


FIG. 15.—GUARD FOR CARRIER PULLEYS AND LOWER DRAWBAND PULLEYS

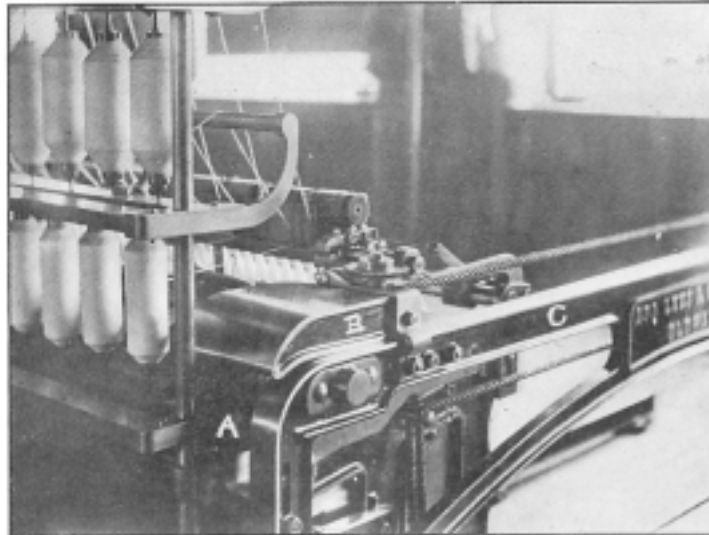


FIG. 16.—GUARD B OVER END SCROLL A

wheels, one close to the headstock, one at the end of the machine and a third about midway between the two just mentioned. The most serious accidents have come from the intermediate or "middle" scrolls and the bands or ropes running on them.

These scrolls are concerned in the



FIG. 17.—END DRAWBAND PULLEY WITH GUARD

traversing movement of the mule carriage. They are, therefore, reversible. Besides, they revolve at different rates, according to the directions in which the carriage is moving. If the carriage is moving outward—that is, towards the front of the mule—the revolution of the scroll is slow, about 8 inches per second. But when the carriage runs inward—that is, towards the creel of bobbins—the scroll attains a peripheral speed of 20 inches per second. If, therefore, a shirt-sleeve and then an arm get between the fast-moving scroll and its band, the limb is so fearfully twisted that amputation becomes necessary. To eliminate this grave risk guards are provided which encase the scroll on all sides. Fig. 14) except the inner and under sides; and in connection with it is another guard which encloses the carrier pulleys (Fig. 15) near the creel board and the drawband pulleys near the floor. We have thus a complete set of guards for the middle scroll and its bands. The end scroll is close to the terminal frame of the mule, and is covered with a guard (Fig. 16) the full breadth of the scroll. In former mules this

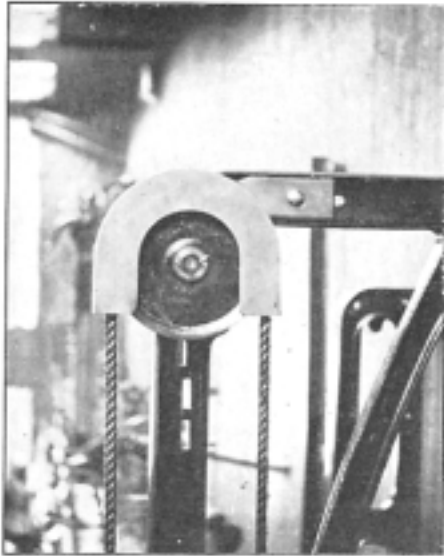


FIG. 18.—GUARD ON DRAWBAND PULLEY AT FRAME END

guard is too narrow and insecure; an additional plate is, therefore, riveted to this guard so as to bring it up to present-day standard. It has been urged in influential quarters that the under side of end scrolls should also be guarded, as a short band is connected to this scroll which draws inward when the carriage is at its greatest speed. If a boy piecer be picking "fly" from this short band when the carriage is on its inward run, he is in imminent danger of having his thumb or finger caught by the intake of the scroll and band.

It is seldom that accidents occur from the scrolls close to the headstocks. Covers are, however, made for these so as to minimize risk.

The terminal scrolls on the back shaft are connected by drawbands to grooved pulleys (Fig. 17) on the frame end of the mule. These pulleys are veritable traps if unfenced. Guards are provided which cover the intake (Fig. 18) of the bands so that casualties are obviated, except an occasional friction burn from handling the band itself. There are certain band pulleys in the centre of the jenny gate used for the purpose of

steadying the motion of the mule carriage. These pulleys on earlier mules revolve vertically, and, being reversible, often cause severe accidents to piecers when not properly fenced. A complete cover (Fig. 19) is devised for their safety. In recent mules the pulleys revolve horizontally near to the floor, and are enclosed in an iron casing (Fig. 20) hinged for inspection purposes.

The mule carriage wheels (Fig. 21) in an ordinary spinning mill of, say, 80,000 spindles, run into thousands. Every carriage contains from twenty-four to thirty-two wheels divided equally at the back and front. Each pair, fastened on one bearing under the woodwork of the carriage, runs on a raised iron rod or "slip" which lies in the jenny gate, attached to the floor, at right angles to the carriage front. In each jenny gate there are thus twelve to sixteen slips for each mule. The slips are oblong in section, being set up on the narrow edge, and stand about $1\frac{1}{2}$ to 2 inches above the floor. Each carriage wheel is grooved, having side flanges,

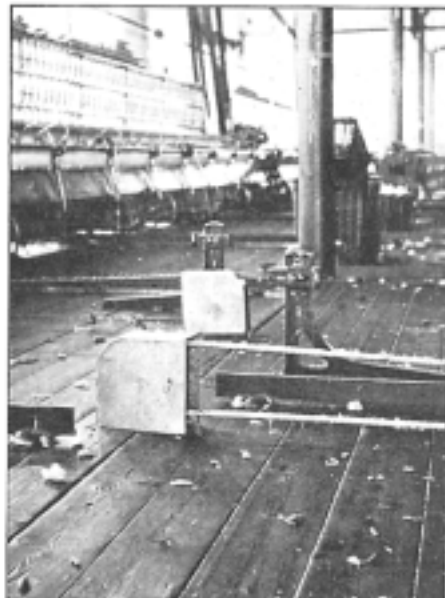


FIG. 19.—GUARDS OVER VERTICAL DRAWBAND PULLEYS IN JENNY GATE

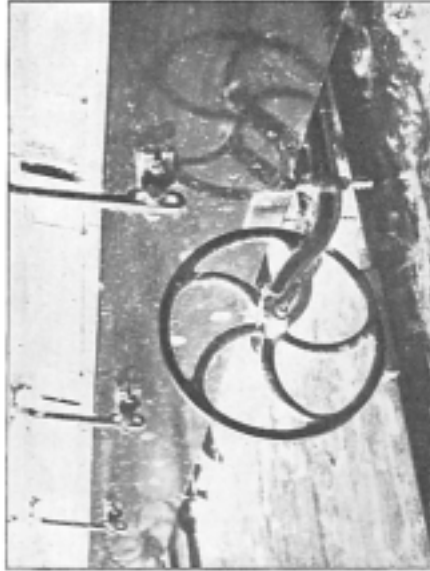


FIG. 21.—CARRIAGE WHEEL UNPROTECTED CARRIAGE RUNS TO AND FRO ON RAILS (SLIPS) INDICATED BY BOY'S FINGERS
FIG. 22.—WHEEL GUARD RESTING ON SLIP.

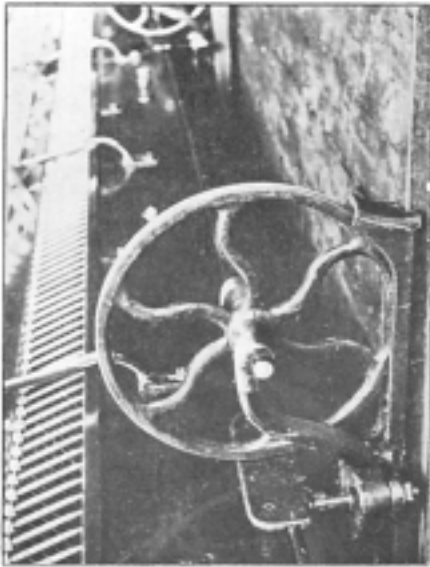


FIG. 20.—GUARD B FOR HORIZONTAL DRAWBAND PULLEY A, IN JENNY GATE
FIG. 22.—CARRIAGE WHEEL GUARD FIXED TO THE WHEEL BRACKET



FIG. 24.—GUARD WITH LIGNUM PLUGS AND SIDE PLATES, RESTING ON SLIP

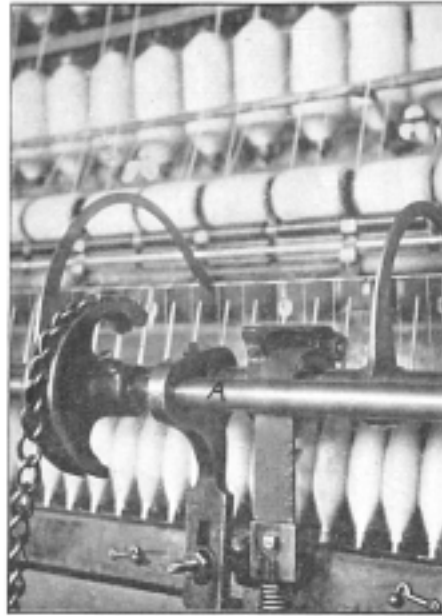


FIG. 27.—FALLER HAMMER ("MOUSE TRAP") READY TO FALL ON SHAFT A

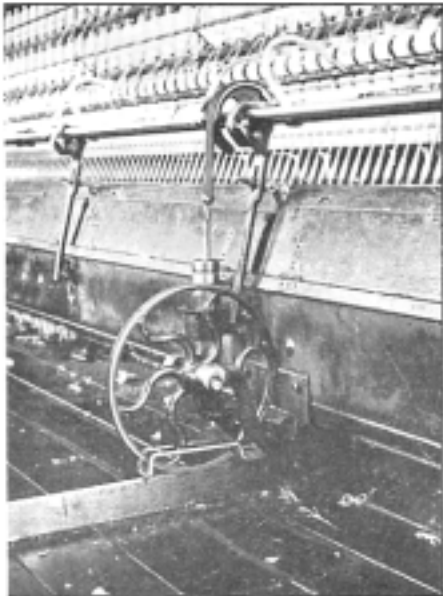


FIG. 25.—WIRE WHEEL GUARD FIXED TO WHEEL BRACKET



FIG. 28.—A GIRL AT THE COTTON MULE, PIECING THREADS

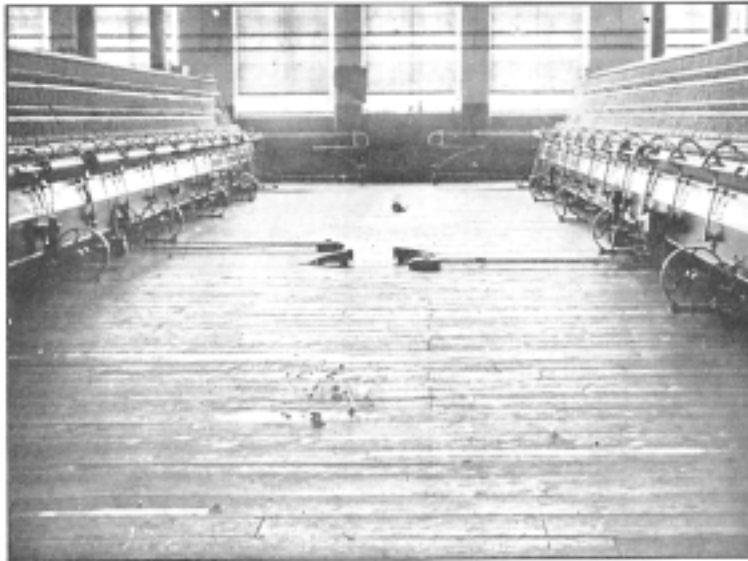


FIG. 26.—JENNY GATE WITH WHEEL PLATES (INSTEAD OF SLIPS), LEVEL WITH THE FLOOR

so as to run on the upper edge of the slip to and fro, as required. When yarn is being *twisted* the carriage runs outward; and when the yarn is to be *wound on* the spindle to form a cop the carriage runs rapidly towards the creel. These carriage wheels have

been frequent causes of accidents in cotton mills. It is not uncommon for even practiced spinners and piecers to slide on the greasy floor and fall across the wheel slips. If the carriage is then advancing, severe injury may follow. The bulk of carriage-

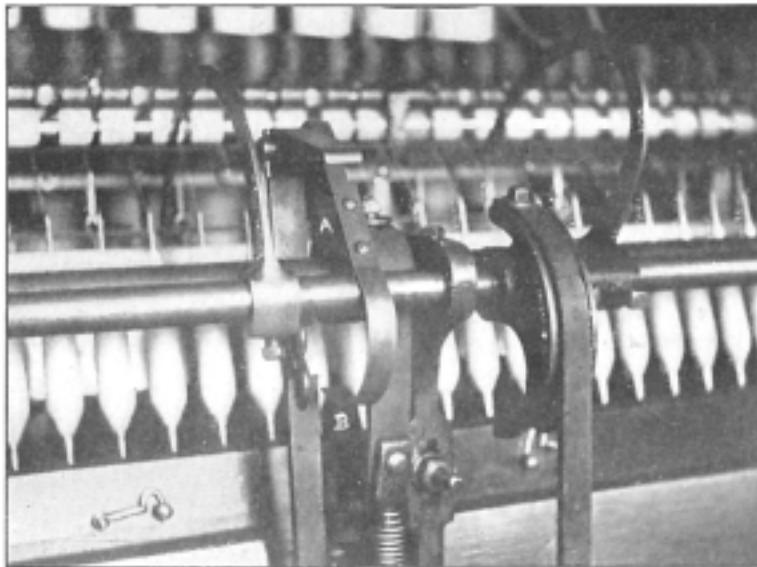


FIG. 29.—GUARD B FIXED TO FALLER HAMMER A

wheel accidents have come to piecers' fingers when picking loose "fly" from the rod itself or from the lowest part of the wheel. Preventive measures are varied in character. Some master spinners prefer a guard which is fixed to the wheel bracket (Fig. 22), and is thus held between the intake of the wheel and the iron slip on which it travels. In this case it does not touch the slip, being separated from it about $\frac{1}{8}$ of an inch. This

either suspended in two halves from the wheel axle, or they are attached to the wheel bracket (Fig. 25). If hung on the axle, they are coiled several times in front of the wheel so as to sweep away any feet or fingers that may be on the slip. This form of guard is particularly favoured when the slip is so short that the carriage wheel travels to its extreme limit. The guard can never fall over the end of the slip, as is sometimes

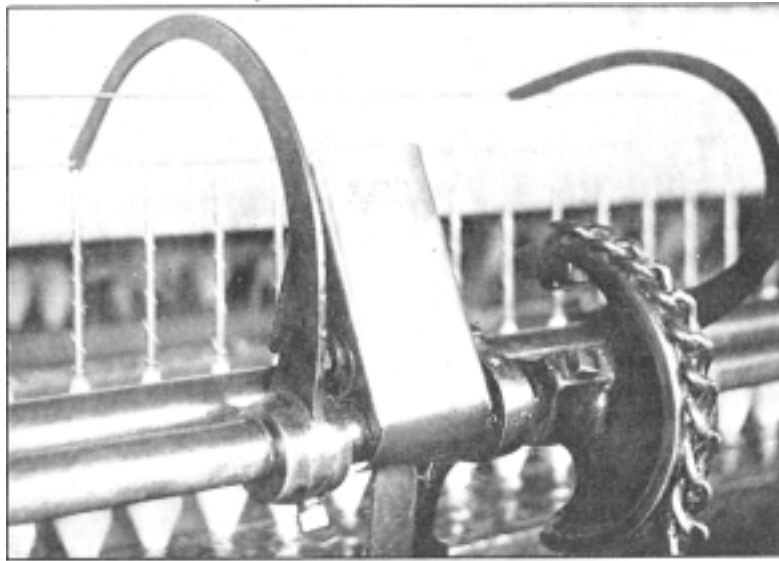


FIG. 30.—FALLER HAMMER GUARD FIXED TO THE SHAFTS. THE HAMMER IS FREE TO MOVE INSIDE

prevents any fingers reaching the intake of the wheel during its traverse. Other guards are devised to rest on the slip and be urged to and fro by the moving wheel. These are used in the form of one solid casting (Fig. 23); also, as a combination of side plates and end plates of *lignum vitae* (Fig. 24). The end plates are bolted to the side plates and may be renewed after wearing. It is significant, however, that in six months' work these wooden plugs have abraded not more than 1-16 of an inch.

There is, in some mills, a marked preference for strong wire guards for carriage wheels. These guards are

the case with the iron-plate guards.

There can be no doubt whatever as to the immense boon arising from these wheel guards. Accidents from carriage wheels have been reduced to the extent of more than 50 per cent. by their adoption. In the matter of wheel slips a notable innovation has been made in some English spinning mills where iron plates (Fig. 26) have been laid level with the floor and upright slips avoided altogether. The wheels running on these plates have plain-edged peripheries.

Faller hammers are familiarly known in Cotton Land as "mouse-traps," from an awkward knack they have of trapping unwary fingers.

Each mule carriage has two shafts, one behind the other immediately over the spindles; on the back shaft the faller hammers are levered and their noses made to fall smartly on the front shaft (Fig. 27) as the carriage moves to and fro on its traverse. If now a boy's fingers be resting innocently on the front shaft just under the lifted nose of the hammer he will be severely crushed when the carriage reverses and the hammer suddenly falls. Quite a large number of juvenile piecers, boys and girls (Fig. 28) have lost terminal phalanges of fingers from this cause. The guards provided eliminate the danger. Where guards are fixed (Fig. 29) to the hammer itself they curl under the front shaft and cover the dangerous space im-

mediately under the hammer. If not fixed to the hammer (Fig. 30) they are attached between the two shafts forming a hood within which the faller hammer moves independently. No fingers can then approach the hammers.

Every working day these simple devices prove their value. Faller hammer accidents have been entirely eliminated from many spinning mills, and where they do occur they are generally due to want of care or a faulty attachment of the guard.

By the aid of the fencing appliances the dangers of self-acting mules have been reduced to a minimum, and the working conditions of the operatives have attained to a degree of confidence and safety not known in the cotton industry before.

