



Hand Combing.

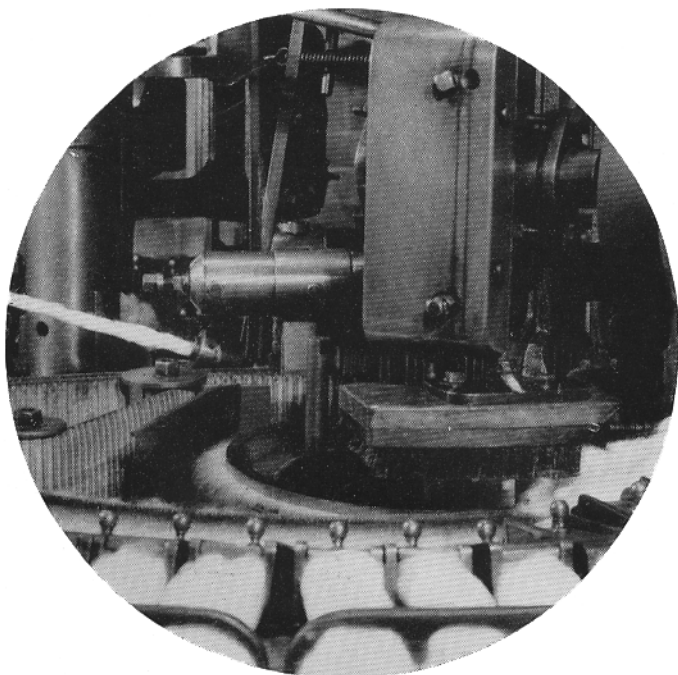
WOOL COMBING

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(Photos: Courtesy Wool (and Allied) Textile Employers' Council)

Mechanical Combing.



ALL wools designated for conversion into worsted fabrics must be combed through closely-set pins in their preliminary stages of manufacture in order to straighten out the fibres from a jumbled mass of scoured wool. In achieving this objective many fibres are broken and entangled. These must be separated as a by-product, known commercially as noil, which is used in the manufacture of felts, woollen yarns and woollen piece-goods. The long fibres which are retained are arranged parallel to each other in a continuous rope-like formation termed combed slivers. A number of these slivers put together for blending are gilled into tops.

The important feature of fibre alignment is the basic characteristic of worsted yarn manufacture. This parallel arrangement of the fibres is maintained during the drawing and spinning processes, thus producing smooth, clear, straight, strong and uniform yarns, capable of exhibiting clearness of design in the finished fabrics.

Moisture, heat and tension are essential in combing. These conditions facilitate the straightening of the fibres as they are drawn forcibly through hot pins.

HAND COMBING

In the early days of civilisation, hand spinning was done without any preliminary operations, but it was soon realised that if the wool were disentangled and the fibres made to lie parallel, spinning would be made easier. Even before the industrial era, it was a common practice to card the short and comb the long wools by using primitive tools.

In hand combing two large iron combs were used, each with two or three rows of long flexible pins. One comb was heated over a charcoal fire and temporarily fixed to a wooden post. Then scoured wool, with a touch of oil on it, was lashed into the pins, filling them almost to capacity. The other comb, heated in a similar manner, was drawn repeatedly through the dense fibrous mass till all the fibres were straightened. When combing was completed, the fringe of fibres projecting from the stationary comb was drawn off by hand in the form of a sliver. The short, broken, curly fibres remaining in the comb's pins were removed as noil.

EARLY MACHINES

Hand combing was universally practised until about 1840, and was the last operation in worsted manufacture to be mechanised. Other major processes had been mechanised successfully some forty years earlier. This may be taken as an indication that combing was the most difficult process to perform by mechanical means.

Some attention was given to this problem as early as 1790, when Dr. Edmund Cartwright, a clergyman and the inventor of the first power loom, made the first

attempt to comb wool by machinery. His efforts earned him the nickname "Bishop Blaize".¹ In his initial attempt he tried to imitate as closely as possible the hand process. He mounted a number of hand combs on a rotary drum, then, by means of a lashing device, the pins were charged with washed wool to be drawn off later by rollers. The machine was crudely designed and was driven by a horse. Cartwright's associates christened it "Big Ben". Unfortunately the noil left in the pins could not be removed during combing, so his invention did not succeed.

During the next twelve years, Cartwright constructed further models. His last machine, however, proved to be the most noteworthy because it contained five new ideas: a revolving circle with vertical pins, a steam-chest for heating the pins, a lashing motion for feeding the wool, strokers to turn the fibre ends towards the drawing-off rollers, and drawing-off rollers. All these features are used in combs today, but no machine uses them all. Although no modern combs bears Cartwright's name, it was his pioneer work that paved the way. From this point, the story of invention was crowded with achievement. Following Cartwright came Noble, Heilmann, Holden, Croft, Donisthorpe and others, who invented either new combs or modifications of the old models.

COMBING MACHINES

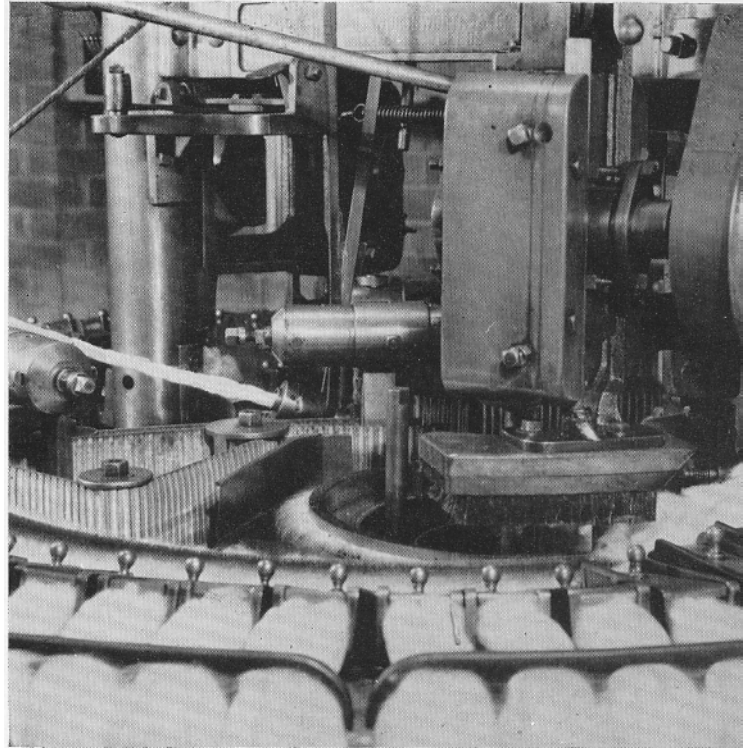
Three distinct types of combs have a wide commercial use in the worsted industry, and each is known by the name of its inventor – Noble, Lister and Heilmann. In each of these machines similar principles are employed, but different means have been adopted to put them into effect. In the combing procedure, five definite stages form the cycle of operations: feeding, initial combing, completion of combing, sliver formation, and noil removal.

In feeding, each type of comb has its own particular mechanism. The Noble is fed from specially made punch balls, the Lister is similar in construction to a gill box, while the Heilmann uses a reed motion.

Initial combing, which means combing out one end of the fibres, is performed by first creating a fringe, either by passing the slivers through rows of pins, or alternatively passing pins through the slivers. Each of the combs fulfils this requirement in a different way.

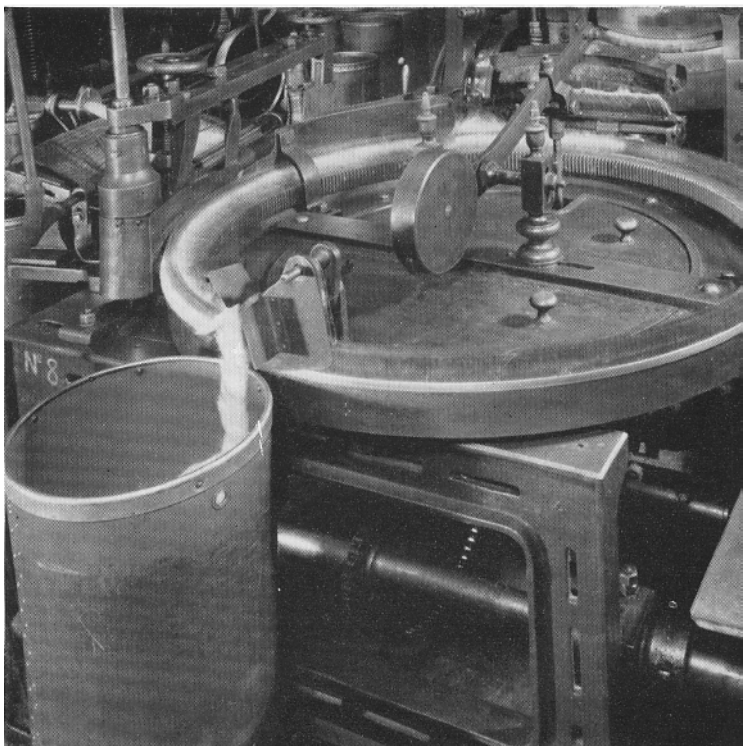
Completion of combing, as the name implies, is the combing of the remaining portion of the fringes. This is done by drawing the partly combed fibres through rows of pins by means of drawing-off rollers. Each type of comb performs this operation in a somewhat similar way.

When forming combed slivers, the successive fringes



The Noble Comb. The long fibres are laid parallel and separated from the short fibres. The combed wool is shown coming off as a sliver.

The Lister Comb.



1. Bishop Blaize is the patron saint of wool combers.

Fig. 1 NOBLE'S COMB

(Section of Feed)

Showing the slivers passing through the guides, trap boxes, and under the stationary feed knife. As the trap boxes rise, a short length from each sliver is drawn through these boxes. Soon afterwards the slivers are lifted, by inclined plates, out of the large circle pins and re-laid across the pins of both large and small circles prior to dabbing.

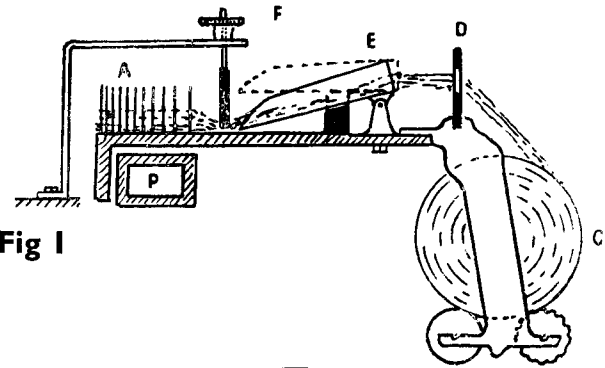


Fig 1

Fig. 2 PLAN OF NOBLE COMB

Showing the passage of the wool through the machine.

KEY TO PARTS OF COMB

- A — Large circle.
- B & B' — Small circles.
- C — Punch balls.
- D — Uncombed sliver guides.
- E — Trap boxes.
- F & F' — Feed knives.
- G & G' — Inclined plates.
- H & H' — Dabbing brushes.
- I & I' — Initial combing.
- J, J', J², J³ — Completed combing.
- K, K', K², K³ — Endless leather aprons.
- L — Revolving funnel.
- M — Combed sliver passing out of machine to coiler can. (Coiler can not shown.)
- N & N' — Noil knives, set between the rows of pins. (On small circles only.)
- O & O' — Noil cans.
- P — Steam chest.

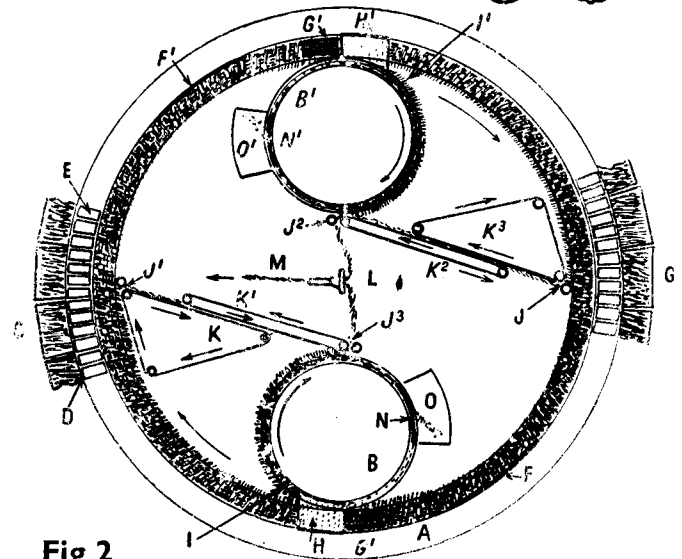


Fig 2

Fig. 3 PLAN VIEW OF LISTER'S COMB

Showing the transfer of the "initial" combed wool from the feed head to the circle, dabbing, and "completion" of combing by the drawing-off rollers.

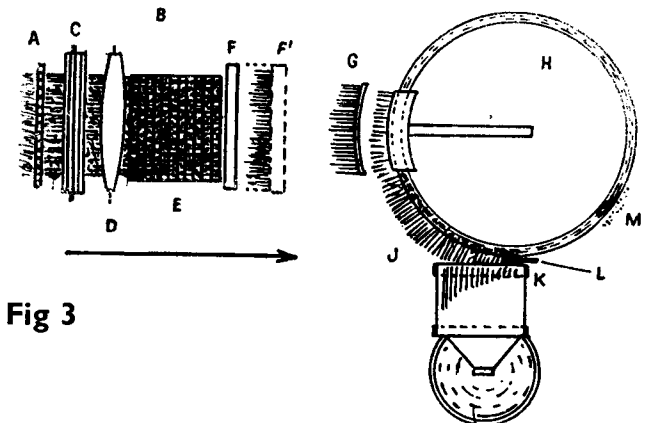


Fig 3

Fig. 4. SIDE ELEVATION OF LISTER'S COMB

To illustrate further the above procedure.

KEY TO PARTS OF COMB

- A — Uncombed sliver guides.
- B — Feed head.
- C — Feed rollers.
- D — Barrel shaped roller.
- E — Curved fallers.
- F & F' — Swing "nip" (two positions).
- F² — Fulcrum of swing nip framework.
- G, G', G² — "Carrier" comb (different positions).
- H — Comb circle.
- I — Dabbing brush.
- J — Successive wool fringes.
- K — Horizontal drawing-off rollers.
- L — "Cut-off" knife.
- M — Noil removal.

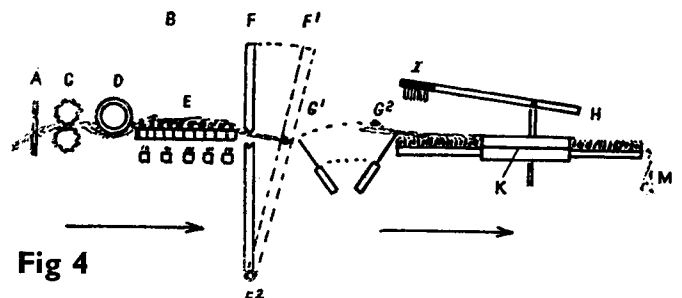


Fig 4

are placed together in an ingenious way, causing each one to overlap its predecessor. Some assistance, however, is obtained by endless leather aprons, operating round the drawing-off and ancillary rollers. These support the steady flow, promoting some regularity and strength before the united combed sliver passes out of the machine into the coiler can.

Noil removal is accomplished in Noble and Lister combs by drawing the long fibres away from the short ones. The Heilmann reverses this order by removing the short from the long fibres while the latter are held in a nip. In all instances, the noil is deposited in the pinned regions after combing has been completed, to be removed continuously by knives and brushes.

The choice of machine largely depends on the class or type of wool to be combed, as long or short fibre lengths require different treatment. Other considerations include style of top, ratio of top to noil, production of machine and cost of combing.

The main features may be summarised as follows. The Noble or Circular comb is the most popular type in the industry, because by interchanging the pinned circles it can be utilised to suit a wide range of qualities. This comb produces more than any other type, is automatic in action and requires little attention with the exception of feeding and removal of combed sliver cans.

The Lister, often referred to as the "nip" comb, has a good reputation for producing very smooth lustrous tops of excellent spinning properties. It is used exclusively for long wools and hairs.

The Heilmann or "French" comb deals successfully with short, tender and burry wools. A high ratio of top to noil is achieved, as it straightens out many fibres which would be rejected as noil on other machines. This type of comb is used particularly for the production of dry combed tops for processing on Continental drawing machinery. This comb occupies little floor space, but its productive capacity is comparatively low.

NOBLE COMB

James Noble of Leeds finally patented his comb in 1854 after some years of collaboration with Donisthorpe of Leicester. Working together, these two inventors had brought the machine to a state of perfection in principle. Since then, however, textile machine makers have modified the original construction to meet present-day needs for high-speed production.

The essential features of the Noble Comb (Figs. 1 and 2) consist primarily of three circles – two small circles B and B¹ of 16 inches diameter fitted inside a large circle A of approximately 43 inches diameter. All are geared to rotate in a clockwise direction. Each circle is covered with several rows of vertically-set pins, suitably mounted in brass foundations. On the large circle the pins graduate in fineness of setting towards the inner rows. In the case

of the small circles the position is reversed, the finer pins being set towards the outer rows. This arrangement is for the convenience of drawing off the long fibres at specific points.

The slivers are fed into the comb from eighteen punch balls C, previously prepared on an ancillary machine which assembles four slivers side by side under tension, for easy accommodation in the comb creel. The eighteen balls, each with four slivers, are required to fill the creel, making a total of seventy-two slivers which completely surround the large comb circle. The slivers arranged in this way are intermittently fed through guides D, trap boxes E, and pins forming a continuous fringe projecting inside the large circle. At two points, diametrically opposite, the slivers pass under feed knives F and F¹, to take in further supplies of sliver. Afterwards, the material is lifted from the large circle pins by inclined plates G and G¹, causing the extra length to spread over the pins of both large and small circles at the points of contact.

The dabbing brushes H and H¹, operating at about 1,000 dabs per minute, press the wool firmly into the pins. As the circles diverge by reason of their size and rotation, initial combing I and I¹ is achieved when two newly-formed fringes appear, one on the inside of the large circle and the other projecting outwards from the small circle, both fringes having passed through the other circle pins. The ends of these fibres still retained in the circle pins remain uncombed.

Completion of combing J, J¹, J² and J³ is carried out a few seconds later, as the circles rotate conveying their respective fringes towards vertical drawing-off rollers, where the long fibres are drawn continuously through the pins at four points, two at the large circle and one at each of the small circles. Endless leather drawing-off aprons K, K¹, K² and K³, running between the rollers, transmit the four slivers to a central funnel L, where they unite to pass out of the machine into a coiler can. Short fibres, "neps"² and vegetable matter remaining in the small circles are lifted out by stationary noil knives N and N¹ set between the rows of pins, and deposited into noil cans O and O¹ placed alongside.

LISTER "NIP" COMB

In 1849 Samuel Cunliffe Lister of Manningham, Bradford, patented his comb (Figs. 3 and 4) for long-fibred wool which had in most cases passed through a preparing set.

A number of slivers A, uniformly arranged in suitable guides, pass through the feed head B. This mechanism resembles an ordinary gill box, except that it contains curved fallers E carrying three rows of finely-set pins and that the front rollers are omitted. A barrel-shaped roller D receives the slivers from the fluted

2. Small knots of tangled fibres.

feed rollers C and guides them into the faller pins. A swing nip frame F and F¹, mounted in place of the front rollers, is constructed with two curved jaws which close upon each projecting tuft, after each faller has descended to the lower screws. This frame, which has its fulcrum F² at the lower end, swings away, drawing a broad fringe of straightened fibres, thus carrying out initial combing. As it reaches the extreme end of the traverse, the nip jaws open, permitting the long, slender pins of the carrier comb G, G¹ and G² to pierce the fringe. The duty of this carrier comb is to transfer the partly combed wool to the comb circle H. In doing so, it moves in an elliptical orbit, carefully placing the fringe over the pins, then steadily withdraws to return for further supplies. Accuracy of movement is essential for good combing, as faulty strokes at either end may cause defective work.

The dabbing brush I, operating in conjunction with the carrier comb, makes one dab for each fringe deposited. The comb circle, a little larger than in the Noble, revolves slowly at one revolution per minute, allowing each fringe to overlap its predecessor. Eventually a continuous fringe, projecting outwards, is formed. This meets the horizontal drawing-off rollers K, placed at a tangent to the circle, and completes the combing by withdrawing the fibres through the pins. The position of these rollers causes the longest fibres to be drawn away first, graduating by reduction to shorter fibre lengths across the roller face. This produces a "hen-wing" sliver. Before this sliver passes from the machine it is rolled with the aid of guide bars and air blasts in such an ingenious way that the shorter fibres occupy the core position with the longest fibres outside. The noil left behind in the circle pins is removed in a similar way to that of the Noble comb.

The ratio of top to noil is governed by the amount of throw-over of the fringe by the carrier comb and the position of a cut-off knife L situated between the drawing-off rollers and comb circle. Forward setting of the knife causes a greater proportion of longer fibres to be rejected as noil M, whereas a backward setting reduces the fibre length for noilage but provides an inferior top.

HEILMANN COMB

Although Heilmann of Alsace invented his comb for use in the cotton industry, it was soon modified for combing short wools which could not be treated satisfactorily on the English combing machines.

Twenty-four or thirty-two carded slivers are normally fed through a pair of fluted rollers into the reed motion. This contrivance is composed of three brass plates, working together in a four-fold movement. The lower and middle plates, grooved and slotted respectively, support the slivers as a series of pins projecting downwards from the upper plate pass through

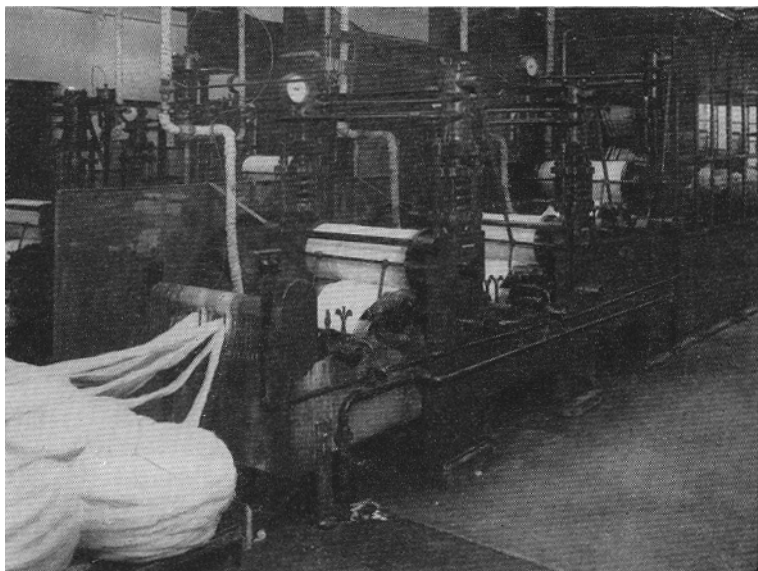
the slots to penetrate the slivers and move them forward into the nipper jaws. As the lower and middle plates move back together to their former position, the pin-plate is withdrawn to continue the cycle. The nipper jaws hold the sliver ends in the form of a fringe, as it is initially combed by a revolving comb cylinder, whose eighteen rows of graduated pins, fixed at a tangent to an arc of the cylinder, pass through to clear away the short fibres not held in the nippers. When the last row of pins has passed through, the nipper jaws open to release the partly combed fibres, while a pair of horizontal, spirally-fluted drawing-off rollers move forward to seize the fringe. Precisely at the same moment, a finely-pinned intersector comb descends to pierce the fringe. This ensures the complete clearance of any



The Heilmann Comb.

remaining short entangled fibres and burrs during drawing off.

It will be observed that combing is achieved by treating successive fringes or tufts of fibres which are detached in rapid succession from the slivers fed in. These tufts are reunited later by an ingenious action of the drawing-off roller mechanism. A reciprocating motion causes the rollers to reverse their direction of rotary movement as they swing forward into the drawing-off position, in such a manner that each tuft overlaps its predecessor by about two-thirds of the fibre length and forms a continuous combed sliver. The sliver is conveyed by an endless leather apron to a brass funnel leading to a pair of synchronised calender rollers mounted above the coiler can.

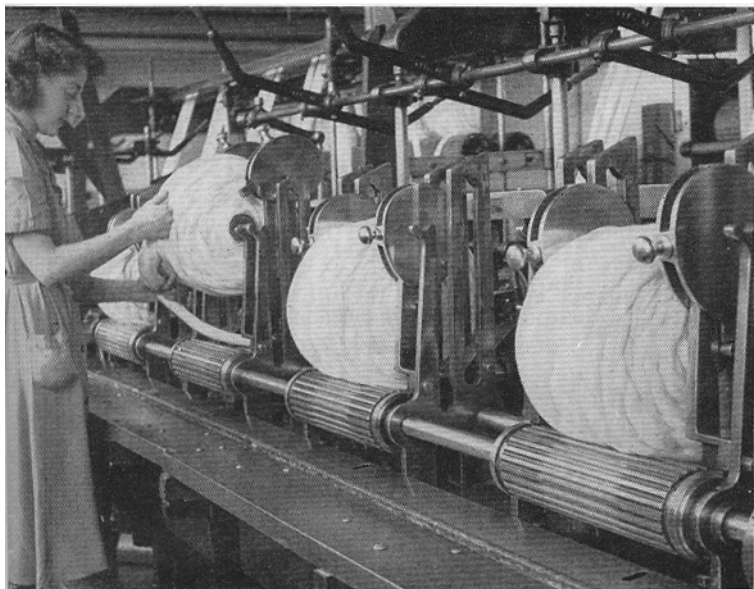


Backwashing, a secondary washing of the wool in sliver form to remove earthy substances left in the staples after the first cleansing.

The noil left behind in the comb cylinder pins is removed by a brush roller, whose long bristles penetrate deeply into the pinned sector and strip off the noil which falls into a box placed under the machine. Some assistance is given to the brush by a closely-set “garnett” wire covered roller and an oscillating picking knife.

Noil tearage can be altered within certain limits by adjusting the length of feed per cycle and the distance of the drawing-off rollers from the nipper jaws. An increased feed and/or increased setting distance of rollers from nippers will increase the amount of noil removed and vice versa.

Top finishing.



TOP FINISHING

The conversion of combed slivers into tops generally consists of two gilling operations performed by machines known as the Gill Finisher and the Gill Baller. The function of these machines is to blend the fibres thoroughly, to deliver a uniform weight per unit length of sliver, to add “condition” (moisture) according to standard trade allowances, and to deliver the material in ball form.

From all types of combs the slivers are irregular as a result of periodic fibre groupings peculiar to the methods of drawing off. If the best results are to be obtained in later drawing and spinning operations, it is imperative that fibres of various lengths should be blended evenly together throughout the resultant top slivers. This redistribution of fibres is accomplished by using adequate doublings together with suitable drafts on both machines.

Moisture is added to raise the regain of the wool to conform to trade standards for buying and selling. It is applied on the finisher box by passing the slivers over a conditioning roller revolving in a water trough. Adjustments to the roller speeds can be effected by change wheels to meet all requirements.

The final top sliver is assembled in ball form at the last box and made into a convenient size for easy handling. Two types of tops are built, ordinary and bumped. The former are firmly wound on a central spindle which is afterwards withdrawn and mounted on a pair of oscillating calender rollers. Tops made by this method are neat and compact, and are largely used for merino and fine, medium and strong crossbred wools. Bumped tops are first assembled in a can on the box, being coiled round a vertical spindle fixed to a detachable wooden base. When sufficient length has been run into the can, the spindle with the top sliver is lifted out, put into a small press and bumped. It is then secured with glazed string and the spindle is withdrawn. This method is restricted to slippery fibres such as long lustre wools and hairs.

The completed tops are now wrapped with soft paper and bagged ready for despatch to the worsted spinner for conversion into warp, weft or hosiery yarn. He may choose to process them as white to be yarn- or piece-dyed later, or he may arrange to have them dyed in order to blend several colours together to provide speciality-coloured mixture yarns according to manufacturers’ requirements.