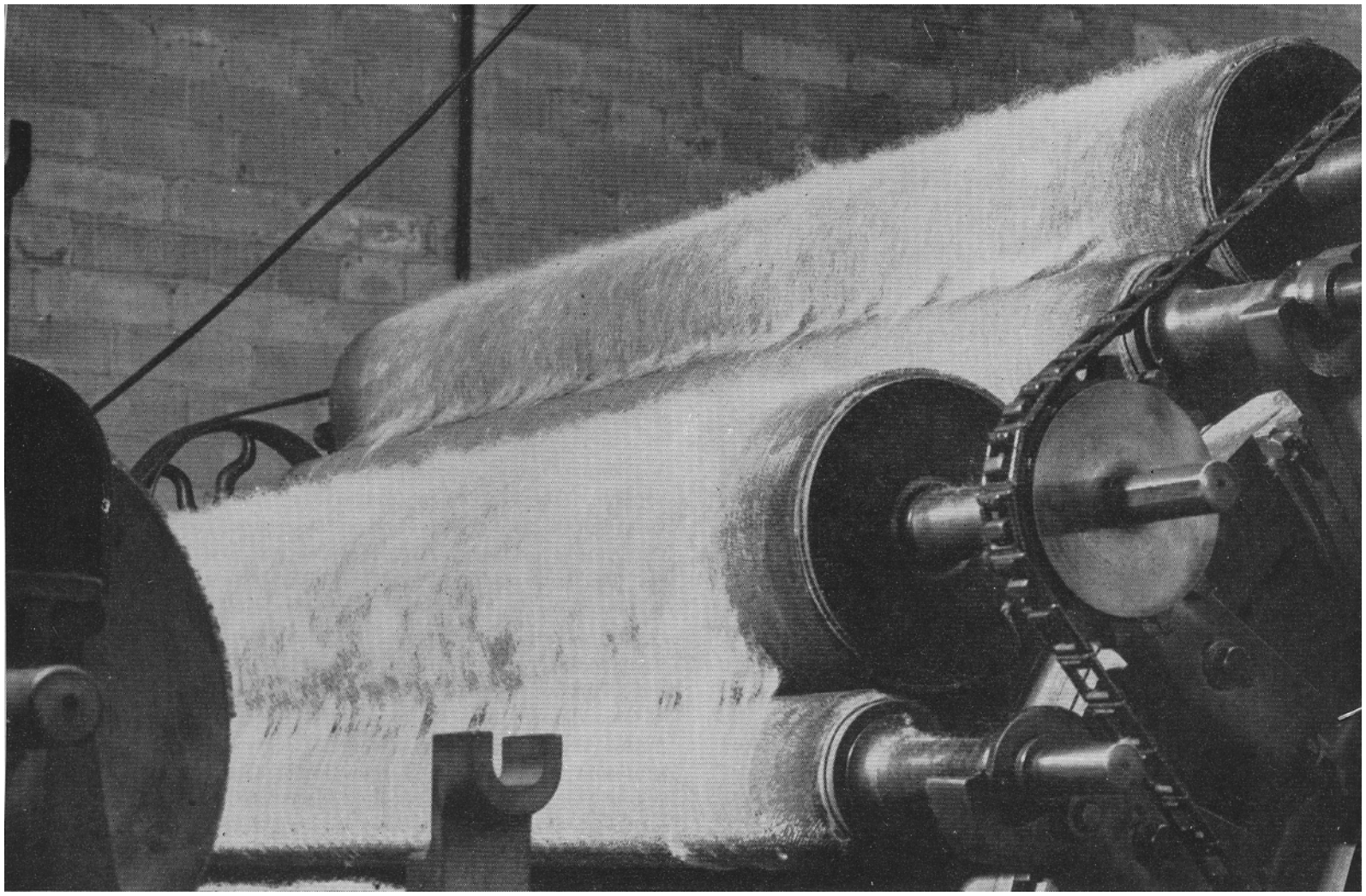

CARDING WOOL FOR WORSTED YARNS

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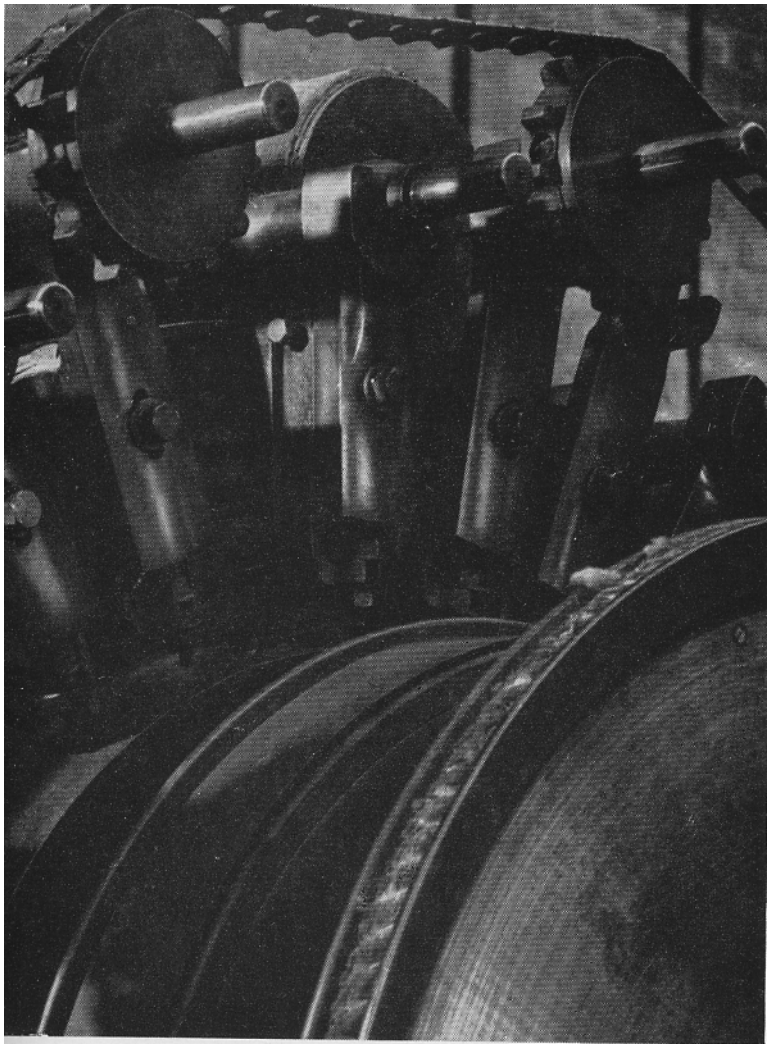
WORSTED yarns are made from virgin wool fibres. The wool must first of all be sorted, and in this process the many fleeces which go to make the blend are each divided, and portions having the same fibre characteristics of fineness and length are assembled to form a pile. In practice, it would be impossible to get together a sufficient quantity of wool for the one pile from one type of wool, and wools of the same quality but different types are often blended together at this stage. The blending process is followed by scouring and drying, to rid the wool of its fat, suint and dirt. The clean, moist wool then passes through one of two processes; it is either "prepared" or "carded". The choice is determined mainly by the fibre length; if this is longer than seven inches it is prepared, if shorter it is carded.

PREPARING PROCESS

In the preparing process the tangled clean wool is passed through a series of gilling machines, usually six, before it is combed. Each gill-box contains a pair of feed rollers which pass the wool forward to be partially straightened by a number of steel-pinned fallers, which rise up before the rollers and penetrate the material fed forward by the rollers. Having penetrated the fibres, the fallers move away from the rollers at a greater



Carding engine showing the wool being carded as it passes over cylinders covered with fine metal teeth.

surface speed than the latter, and so bring about a partial straightening. Eventually, the fibres in the fallers are caught by a pair of delivery rollers which run at a still greater surface speed than the fallers, and so they in their turn pull the fibres through the faller pins and add to the straightening action. The wool, in a more parallel order, is then passed forward by the delivery rollers to form an endless sheet, or is coiled into a can. The fallers, having given up their material to the delivery rollers, drop into a lower screw and return to the feed rollers. After six separate gilling operations the wool fibres are sufficiently parallel for combing.

The preparing process is used only for the longer-stapled wools, which, if carded, would suffer undue fibre breakage. This in turn would lead to much shorter fibred tops, and since the longer-stapled wools are valued primarily because of their lustre it will be seen that the presence of short fibres would detract from their worth. The volume of material prepared contrasted with that carded is quite small, for whenever the fibre length permits one always cards, this process being cheaper in manpower and more productive.

WORSTED CARDING

The other and more common method of transforming the loose discontinuous locks of scoured, dry wool to an endless sliver is by the use of the carding machine.

In the worsted industry the wool is always carded in the white state. If it has to be dyed, this process is carried out after top-making, spinning, or weaving.

The aim in carding is (a) to disentangle the fibres one from the other, so that they exist as separate entities; (b) to mix the fibres together so that the different types which were blended together in the sorting process will be more intimately mixed fibre by fibre, which of course could not be achieved in the previous processes; and (c) to deliver these fibres from the machine in an endless sliver form. This is ensured by passing the web from the last roller of the machine through a narrow funnel so that the web, which was originally sixty inches wide, is condensed to some four or five inches, finally to be deposited into a can or wound on to a ball. At the same time the worsted card is also responsible for removing from the wool a large proportion of the vegetable matter associated with it.

REMOVING BURRS

Many types of vegetable matter may adhere to wool, but briefly they can be classified under three headings: burrs of the hard-head variety, those of the mestiza variety and the grasses. The former consist of seed cases and are either circular or elliptical in shape, and can be as large as $\frac{3}{8}$ inch in diameter. This class is relatively easy to remove. The wool is pushed in between the pins of one of the carding rollers, which are set so close together that the burrs ride on the top of the teeth and so can be flicked off by a high-speed flanged roller which rotates in close proximity to the card-covered roller. The mestiza burr is more difficult to remove. It consists of a long piece of vegetable matter wound to a compact ball, which during carding unfolds to resemble a centipede-like form about one or two inches in length. Being brittle, this impurity breaks into small pieces and attaches itself to the wool by reason of its ragged edges. The only way to remove this impurity and the grass-like varieties, is to crush them and then allow the dust to fall from the card or in the subsequent gilling process. To this end a Harmel crushing device is incorporated in the cards which have to process wools containing this form of impurity.

The presence of vegetable matter, which may amount to as much as twelve per cent of the weight of the wool, tends to restrict the production of the card, for it is clear that efficient de-burring can be accomplished only when the stream of material passing through the card is thinner than is normally the case.

It might be thought that steps should be taken in

rearing sheep to eliminate the bush on which the burrs grow and thus reduce the problem of removing them, but the farmers tell us that this bush is a source of sustenance to the sheep in times of drought and cannot, therefore, be destroyed. Failing this possibility of dealing with the problem, it might still be thought that the vegetable matter should be removed chemically by the carbonising process after scouring, which is often practised in the woollen industry. But again the disadvantages would outweigh the advantages. Briefly, the inclusion of the carbonising process, in which the scoured wool and vegetable matter are subjected to a bath of cold sulphuric acid and later heated to convert the cellulosic matter to a form of brittle hydrocellulose which can then be beaten from the wool, would so matt the fibres and lead to such excessive breakage in carding that the amount of noil made in combing would be too great to make it a practical proposition.

Furthermore it would be very difficult to introduce the carbonising process into the industry with its present structure. The top-makers are responsible for sorting, scouring, drying, carding, gilling, combing and making the tops which are then sold to the spinner, who draws and spins them. Very few spinners make a yarn from one type of top. It is more customary to blend together at the first drawing process tops from various combers, but the carbonising process materially alters the reaction of wool to chemical processes, especially dyeing, so it would therefore be necessary for the top-maker to supply the history of each top in order that the spinner might blend the carbonised and uncarbonised. And the complexity would still further be increased because the spinner sells his yarns to the weaver who again passes the cloth on to the dyer. Further, any differences in degree of carbonising would be reflected in variation of shade in the subsequent dyeing process; so it will be seen that the present mechanical means of removing vegetable matter gives rise to the least complications.

THE WORSTED CARD

The actual carding process is accomplished by a machine similar to that shown in Figs. 1 and 2. The rollers are each sixty inches wide, but vary in diameter. Some idea of the relative sizes may be gained when it is realised that the two main cylinders of the machine, "N" and "a", are fifty inches in diameter, and the doffers "O" and "b" have a diameter of forty inches. Each roller is covered over its entire surface with card teeth. These are mounted in narrow strips of cotton cloth and wound in a spiral fashion round the rollers. It will be seen from Fig. 3 that the wire teeth are inclined; this assists in the various carding actions. In practice (Fig. 2) the card clothing is wound on the rollers so that the teeth incline with or against their direction of rotation, which depends on the action which the roller has to perform in the machine. The actual density or the number of teeth per square inch of roller surface increases from the first rollers in the machine to the last; thus the first licker, D, has 100 per square inch, the fourth licker, G, has 300, the first swift, N, 480 and the last doffer, b, 650.

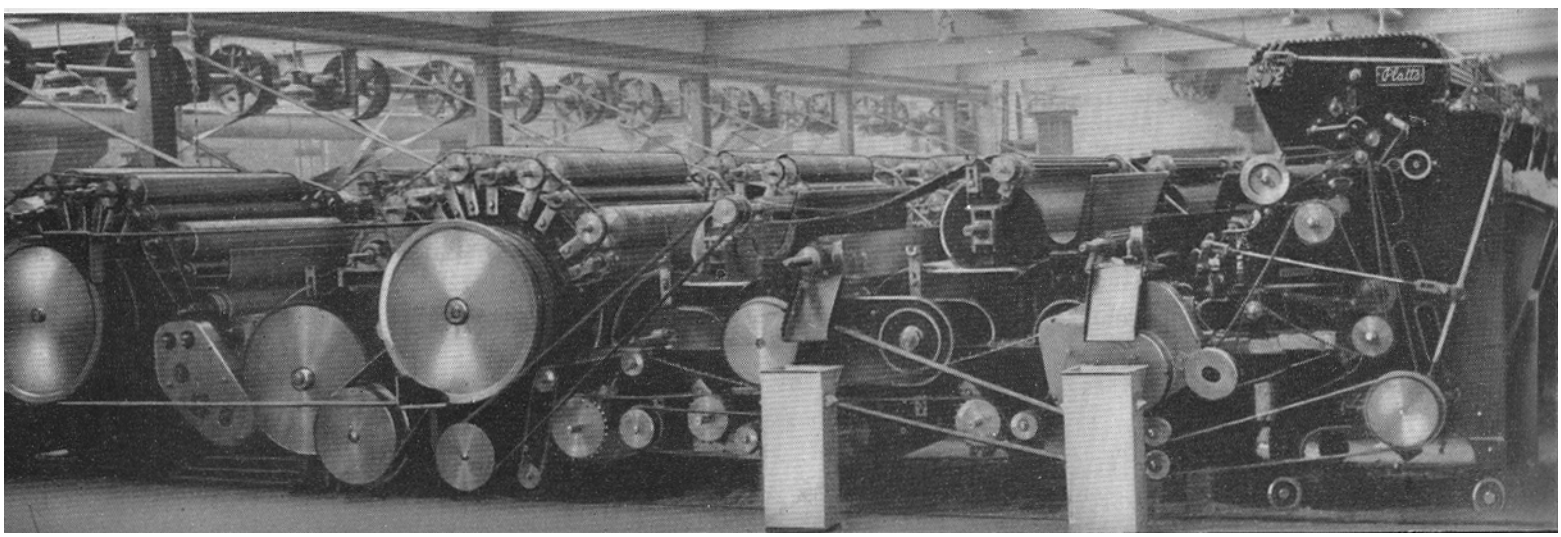
The wool is fed to the card from a hopper which passes forward a uniform stream to a moving sheet, and this in turn presents it to the feed rollers A and B.

Briefly, the carding process is a repetition of three actions. First, a "working" action is brought about by the points of the one roller moving towards the points of another, (N and O) which disentangles the fibres. Second, a "stripping" action occurs when the points of one roller strip material from another by scraping the backs of the teeth of a second roller, (T and Q). And third, a "lifting" action takes place when the backs of the fancy teeth (rollers P and c) enter into the backs of the swift teeth (N and a) and raise the fibres to the surface of the latter rollers so that they can more easily be transferred from the swift to the doffers (O and b). Enlarged photographs of these actions have been shown in a previous article.[1]

Reference to Fig. 2 will show that the rollers of the card rotate in various directions and incidentally at various speeds, as indicated by Table I. Furthermore the spacings between the rollers, which work in con-

1. *See page* 10.

FIG. 1 *Double worsted carding engine. The cans in the foreground collect the burrs after they have been removed by the burr beaters.* (*Courtesy: Platt Bros. (Sales) Ltd.*)



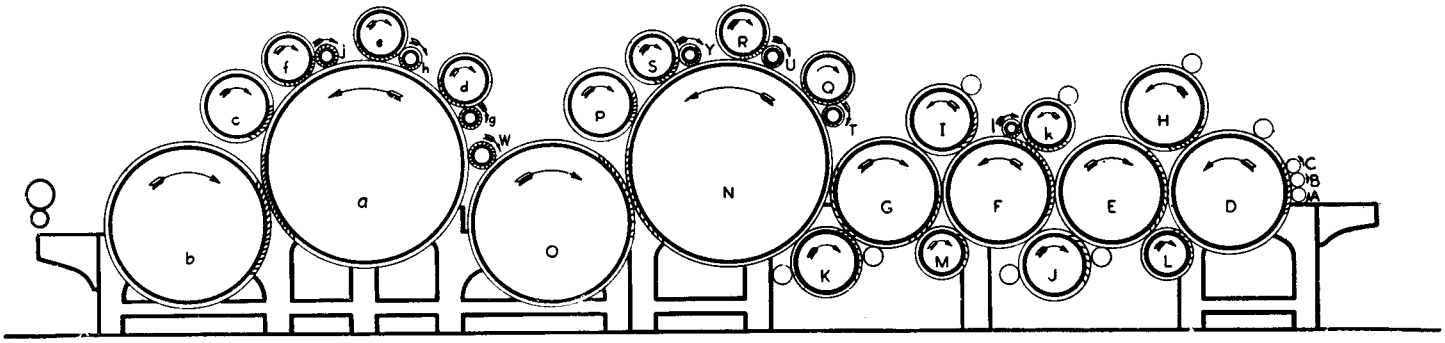


FIG. 2 *Diagram of worsted card.*
(Courtesy: Platt Bros. (Sales) Ltd.)

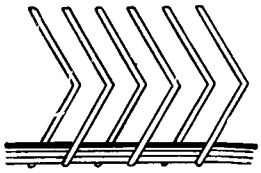


FIG. 3 *Diagram showing arrangement of wire teeth.*
(Courtesy: Longmans, Green & Co.)

junction with each other, gradually decrease from the first to the last rollers in the machine. Thus the wool is gradually disentangled as it passes through the machine, for it is first subjected to coarsely clothed rollers set at relatively open settings, and then, as the wool becomes more carded, the spacings between the rollers decrease and the pinning of the teeth increases. In this manner it is possible to reduce fibre breakage to a minimum, and yet disentangle the fibres to a fairly open state.

Finally the carded wool is removed from the last doffer, b, of the machine, by a swifty oscillating comb in a web which is gathered together, as shown in Fig. 4, to form a sliver. This is usually collected into cans, but it may be wound on to balls. The production per hour of a card varies again with the type of wool and the burr content, as the latter tends to reduce the output. Normally, merino wools can be carded at the rate of 40-50 lb. per hour, whilst the production in the case of crossbreds may be as high as 90 lb. per hour.

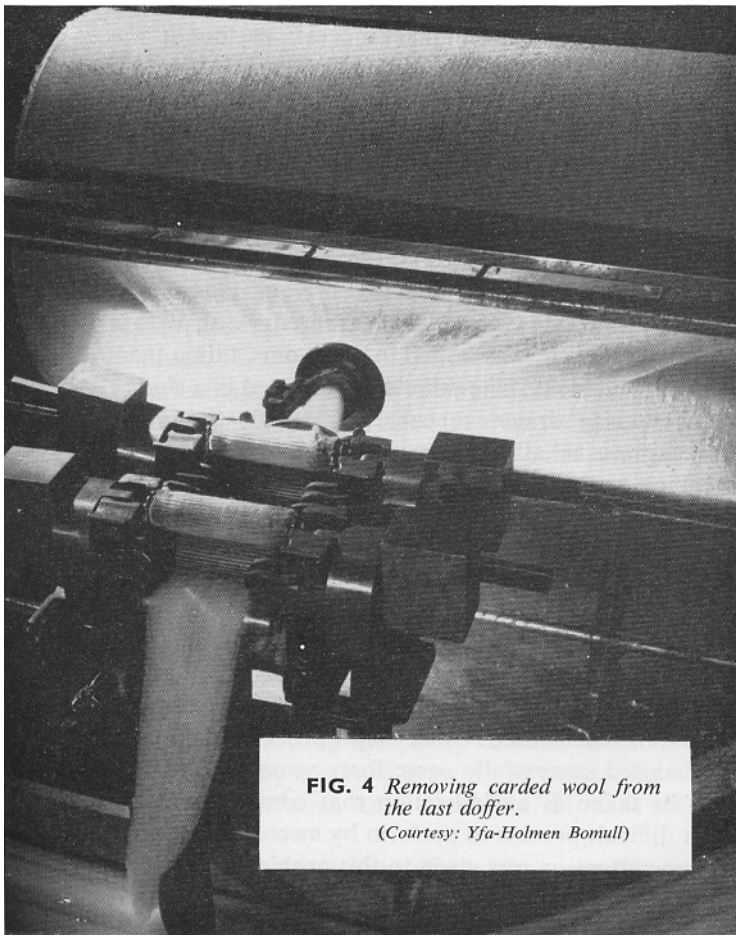


FIG. 4 *Removing carded wool from the last doffer.*
(Courtesy: Yfa-Holmen Bomull)

FIBRE BREAKAGE

The degree of fibre breakage varies considerably with the type of wool being carded and the amount of entanglement incurred in scouring and drying. The finer wool fibres are, of course, more easily broken than the crossbred varieties, and this tendency is further aggravated by the matting of the merino fibres in scouring. It is not easy to assess the degree of breakage which occurs in carding, because of sampling difficulties encountered in measuring the fibre length of the raw wool, but it is probable that, even under the best conditions, fifty per cent of the fibres entering the card are broken during their passage through the machine. This follows as a direct consequence of the entangled state of the fibres fed to the card and it is difficult to see how it can be avoided with our present technique of processing. It has a direct bearing on the relative weights of top and noil obtained from carded sliver, and since the noil content increases with the degree of breakage in carding this problem of fibre breakage is one of the carding engineer's chief worries.

TABLE I

Ref. letter	Name of Roller	Diameter (inches)	Speed r.p.m.
A, B and C ..	Feed rollers ..	3	2
D	1st licker	30	12
G	4th ,, ...	26	120
N and a	Swifts	50	120
O, R and S ..	Workers	12	5
d, e and f	,, ...	—	—
T, U and Y ..	Strippers	5	250
g, h and j	,, ...	—	—
P and c	Fancies	16	450
O and b	Doffers	40	8