COTTON WASTE

ITS PRODUCTION MANIPULATION AND USES

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BY

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PREFACE.

This treatise upon cotton waste is designed to be of service to all who are directly or indirectly concerned with the production, uses and treatment of cotton waste in any of its forms.

The master, manager, or foreman of any ordinary cotton-spinning mill will find in these pages many notes and discussions relating to the production, characteristics, regulation, and treatment of cotton waste in his own factory.

A section also is devoted to a description of the weaving and general uses of yarns spun from cotton waste.

The work, however, deals specially with a description of the machinery and processes involved in the cleaning, opening, carding, and spinning of cotton waste, and it may be reasonably claimed that the treatment of the subject is full, comprehensive, and detailed.

Particularly are the processes and machinery required for the production of condenser cotton waste yarns explained herein; and certainly no one interested in this line of work ought to be without this treatise.

It has been the aim of the author to prepare a treatise likely to prove of practical help to persons connected with almost every section of our gigantic cotton trade, so far as the waste question is concerned.

In these days of keen competition and strict attention to detail, no one can afford to neglect the question of waste, whether it be in the direction of reducing its amount, or applying it more and more to useful and profitable purposes.

The thanks of the author and publishers are due to those firms who have supplied some of the illustrations, and whose names are mentioned in the text.

THOMAS THORNLEY.

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CHAPTER I.

THE PRODUCTION, CHARACTERISTICS, AND REGULATION OF COTTON WASTE.

The Use of Cotton Waste.

It has been repeatedly impressed upon our English cotton spinners and manufacturers that certain countries abroad are far ahead of us in regard to the utilization of cotton waste. Indeed, it may be said that certain districts of Germany almost lead the world in this particular direction. Not only does Germany import a fair amount of cotton waste from this country, but also a far larger amount from the United States. It is no more convenient to blend the wastes from America with those from Egyptian and Sea Islands cotton than it is to mix these widely different cottons in ordinary cotton spinning, and the German imports of cotton waste from America can generally be relied upon for reasonable uniformity in this respect. In the German market there is a distinct preference for imported soft waste, and Germany appears to be more than able and willing to absorb practically all the soft cotton waste obtainable from France, England, and America. A good price is often paid for the best clean, soft waste, reaching sometimes up to 70 per cent or so of the price of raw cotton, which is not to be wondered at when we remember that such waste may not need opening and cleaning by the usual processes, and will lose very little in weight. The best clean, soft waste must not be confused with soft waste that is more or less dirty, and is sometimes exceedingly so. In a consular report it was stated that in 1907 Germany imported linters and cotton waste from mills to the extent of 38,000,000 lb. from the United States, 14,000,000 lb. from India, and only 1,250,000 lb. from England. Several countries ship some sorts of waste to Germany, and import other kinds therefrom. Germany purchases all kinds of cotton waste from the United States, but in particular soft wastes such as sweepings, fly, and strips. Some of this goes to make coarse towellings, scrubbing cloths, dish rags, cheap cotton blankets, and flannelettes. The counts are usually very coarse—say from 5's to 5's or 6's, although the very best sorts range up to 10's or even 12's counts. In a general way yarns spun from cotton waste are intended for the wefts of woven goods of one description or another, and the warp may be of better and finer yarn, either from cotton, linen or other well-known textile fibre.

Recently there has been very great interest centred in the subject of cotton-waste spinning, and it is very likely that in future a good deal more cotton waste will be made into yarn in this country than has hitherto been the case. Of course, it is not to be forgotten that the large increase in the number of ordinary cotton-spinning mills will have placed a larger quantity of cotton waste on the market, and this will largely compensate for the increased demand for waste caused by the recent extension in number of spindles for the spinning of cotton waste into yarn of low counts and quality. Another point to remember, however, in this connexion is that a waste-spinning machine is enormously productive —not because of the high spindle speed, because this is wonderfully low, often only about 350 revolutions per minute, and not even because of a high carriage speed, as a good speed is five draws per minute. The great production in pounds weight is, of course, due to the low counts that are spun, so that if a waste mule spinning 3's counts can produce 21 hanks per spindle per week, this will equal 7 lb. per spindle. A cotton mule on ordinary cotton yarns of about 30's can produce something like 30 hanks per spindle per week, which only equals 1 lb. per spindle, whereas it would equal 7½ lb. of 4's yarn.

The Making of Waste in Cotton Mills.—Introduction.

In the earlier days of cotton spinning on the factory system a much larger proportion of the raw cotton was rejected as waste at one stage or another in going through the mill processes. Thirty years ago a great many cotton mills were very lax in their methods of checking the waste losses, and much more good fibre found its way into the waste bags and cans than is now the case. It is an actual fact that within the present writer's own personal experience when a youth, the frame overlooker of a certain well-established and large mill regularly connived with the fireman, and every week personally put inside the boiler fires a good quantity of bobbin waste in order to deceive those in higher authority as to amount of bobbin waste that was made. This practice had been going on for years before it was finally exposed.

Formerly it was the usual thing, even for users of average American cotton, to work both the taker-ins and the cylinders of carding engines without undercasings, and to extract double or more of the percentage of fly than is now accepted as a basis.

We expect these articles will more than serve the purpose of showing the huge importance of properly regulating the amount and character of the waste that is made in our spinning mills, and also of utilizing to the best advantage the waste that is unavoidably and necessarily made. On the other hand, we show that it is easy enough to reach a foolish extreme in using up too much of the soft waste in our own mills; but it is quite as unbusiness-like to allow too much waste to be made and sold at a big loss.

The Blowing-Room.

Badly set and badly conditioned machines, careless and unskilful workpeople, and incompetent administration often cause much more waste to be made than ought to be. Speaking generally, the bale breakers, hopper feeders, openers, and scutchers should produce very little fly indeed, these machines and processes being concerned in extracting the more glaring and heavy impurities and undesirable matter, such as seeds, sands, leaf, stick, and other dirt. Every effort should be exerted to obtain and work upon the golden mean of extracting the maximum of such undesirable refuse with the minimum of good fibre. For example, it is well understood that the broad principle with regard to beater bars is that if the spaces between them are too wide, the droppings will be too rich or too full of fibre; the opposite extreme of close spaces may remedy this evil, but care should be taken to give the sand, dirt, and seeds every reasonable opportunity of escaping, and not being allowed to be drawn back again into the cotton by the air currents. In this connexion it is probably one of the most curious features in regard to openers and scutchers that the air current is usually permitted to enter mostly through the very same bars between which most of the impurities are driven. Apparently, it is glaringly anomalous that we should work under such conditions that the emission of the dirt is restricted and checked by the admission of the air required to fill the partial vacuum caused by the fan. As a matter of fact this has often been noticed, and our machine makers have often attempted to introduce fresh positions for admitting the air rather than at the beater bars. All experience, however, indicates that this is the best point for air admission in spite of this disadvantage, and it therefore becomes incumbent upon all carders and managers to be sure they have such a well-balanced fan draft or current of air in each machine that the special requirements are fulfilled to the best advantage. For example, it may easily happen in a scutcher that a fan draft is so weak that the cotton is not brought freely away from the beater to the cages, and portions of good fibre are cut by excessive treatment, or are driven out as waste. On the other hand, if the air current coming through the beater bars is too strong it will not allow the lighter impurities to pass through the bars, and the cotton is not sufficiently well cleaned. Openers and scutchers should be manipulated so that very little waste of any value is extracted at any stage, except perhaps below the leaf extractor bars, and yet nearly all the heavier impurities must be taken out before the cotton leaves the blow-room. Numerous types of grid have been more or less used between the beaters and cages, but after all these experiments thin wrought-iron bars, or thicker cast-iron ones appear to receive far and away the most adoption either as beater or cage bars, the thin wrought-iron bars costing more, but probably giving the best results.

Various Kinds of Cotton Waste Droppings.

At this stage it will be profitable to briefly describe the various kinds of waste produced in a blowing-room, taking them in proper sequence or order of occurrence in the mill. The first droppings or waste taken from the very earliest stages exhibit an extremely sandy character. This is the case for example with much of the dirt and waste matter taken from below the bars of the cleaning portion of the long exhaust feed trunk, whether this dirt be removed by hand or by the automatic and slowly moving self-cleaning lattice sometimes fitted inside these trunks. This is again the case with the dirt taken from below the feed-box of the hopper bale breaker. There is scarcely any seed taken out at this stage, very fine sand or dirt forming the bulk of the weight along with a fair proportion of bits of leaf and stick, the whole being, so to speak, held together by a very small percentage of fibre, which apparently clings to the dirt, and is taken out therewith. The writer has made close examination of such droppings or dirt, and apparently the small percentage of fibre extracted at this point is composed of some long fibres as well as short ones. Neither in the long exhaust feed trunk, nor at the feed-box of the hopper is any definite means made to drive out, beat out, or pull out any of the waste or dirt, the latter being simply allowed to fall out and pass through bars in cases where it is sufficiently loose from the body of the cotton. This explains why such a small proportion of seed, and such a large proportion of sand help to make up the bulk of the waste extracted at this point. More open bars and slower passage of the cotton may have some tendency to extract a higher percentage of impurities at this stage. It may also be pointed out that passing the cotton through a bale opener or a lattice feeder prior to its passage through the long exhaust feed-trunk, will not only enable the cotton to pass more easily along the trunk, but also open the cotton sufficiently to facilitate the falling out of the dirt in the trunk. From underneath the inclined spiked lattice of the bale breaker may be gathered a small percentage of the smallest sand and dirt containing possibly even a lower proportion of fibre than that from beneath the feed-box bars of the same machine.

Waste from Crighton Opener with Hopper Feeder.

From beneath the bars of the delivery box or stripper roller of the hopper feeder a certain amount of waste may be gathered which contains more seed and fibre than any waste made at any previous point. Naturally the amount of sand dropped at the hopper feeder is much less than from the bale breaker.

It is well known that it has long been the custom to apply a small porcupine beater to the feed part of a vertical Crighton opener in order to prepare the cotton for obtaining the full benefit of the cleaning and opening actions of the vertical beater. Beneath this small porcupine beater are placed transverse grate bars, and a fair proportion of undesirable matter is extracted at this point. It usually contains a percentage of all the impurities present in raw cotton, such as sand, leaf, seed, and short fibre, but compared with the droppings beneath a blade beater contains fewer seeds, although quite as much fibre.

From the large dirt chamber surrounding the vertical beater itself we naturally obtain a comparatively large proportion of undesirable matter of all descriptions usually present, but here again we may usually note a lower proportion of seeds, and perhaps a higher proportion of sand, as compared with the blade beater. The blade beater apparently possesses the property of driving out the heavier substances such as seeds better than the steel knives of the porcupine or Crighton. Naturally a great proportion of sand and dirt has already escaped when the cotton reaches the blade beater, and hence the droppings from beneath the grate bars of the blade beater appear whiter and more full of seed than the droppings from the larger beater.

The grate bars surrounding a large Crighton beater are made of different shapes as per requirements. As a matter of first cost, the cheapest bars are those cast in sections, which can be readily put in place or taken out again. The alternative thin wrought-iron bars take a good deal of handling, but there are people who insist on having them. The section cast-iron bars are made with smaller apertures and thicker metal facings between the apertures when it is required to restrict the amount of waste extracted at this point, the thickest metal and smallest holes being used in cases where the Crighton is used for the re-treatment of cotton waste. While referring to the different kinds of waste extracted from a Crighton opener and scutcher combined we may say that it is becoming the practice to use 24 inch diameter porcupine cylinder instead of 16 inch diameter, as was formerly the case.

Scutcher Droppings.

As before stated, the droppings from beneath the blade beater of a scutcher present a contrast to any other waste in respect of containing such a large proportion of seed, this being true either of the finisher, the intermediate scutcher, or when a blade beater forms part of an opener combination.

In the writer's opinion the blow of a blade beater is more searching than that of any other form, and certainly more than the 4-inch knife or blade, now almost universally adopted on the large cylinders of openers. At the same time there is little doubt that this blade beater is more likely to cut or injure the fibre than almost any other form used in connexion with an opener for cotton. For the latter reason some users of long staple cotton have ceased to use a blade beater at any position, and so long as the seeds can be extracted by the extra use of hoppers of porcupine beaters there is much to be said in favour of this system. For all ordinary cottons it is the opinion of the writer that at least one blade beater should be used because of its more decided and searching action on the cotton, and there being scarcely any possibility of any portion of cotton escaping repeated and powerful blows from a blade reaching the full width of the machine. It is a curious fact that in examining the waste beneath the blade beater the heaviest waste, such as seeds, will be found to be driven into the farthest corners of the dirt box, this fact being partly due to the ease with which such droppings can overcome the resistance of the entering air, and partly due to the ability of the beater to drive a comparatively solid body like a seed farther than such light substances as cotton fibres. Compared with the total weight of droppings gathered from beneath a blade beater, the proportion of fibre is distinctly small, but there is at this point a good proportion of bits of stick and broken leaf.

The Leaf Bars.

The waste immediately following the beater droppings is that from beneath the bars which extend from the beater to the cages. It is customary to apply a dead air box beneath these leaf bars for the sole purpose of preventing the admission of air at this point, which would be likely to interfere with the free passage of cotton from beater to cage, and also to give a better chance for leaf, short fibre, or any impurities to drop out between these leaf bars. As a natural result we find the waste at this point to contain a good deal more fibre and a good deal less seed in proportion to the total weight of the waste, than at the beater bars. Partly because of having a comparatively small dirt box between the leaf bars and the dead air box it is customary to drop the bottom door of this box every two or three hours, and this checks the tendency of fly to choke up the leaf bars.

All kinds of patent bars have been tried at this point, but it is doubtful whether any better cleaning bars can be used than the wrought-iron ones. If laid traversely across the machine there is perhaps a better chance for these bars to scrape out the sand, but some people prefer them to be laid at right angles to the cages, or parallel with the sides of the machine, this at any rate being the contrary method adopted for the beater bars.

Formerly, instead of these stationary leaf bars, Messrs. Crighton used a very slowly traversing lattice, and this travelling lattice is now applied often by a well-known machine firm beneath the ordinary bars, and additional thereto. The object of this travelling lattice is to dispense with the necessity for dropping the door every two hours or so, since the dirt dropped on top of the lattice, drops off and upon the floor as the lattice creeps slowly round.

Licker-in Fly.

There is a close resemblance between the droppings gathered from beneath the licker-in of a carding engine and that gathered from the various positions of an opener or scutcher. As a matter of fact, the licker-in may be described as the beater of a card, and more especially so since the metallic taker-in displaced the old leather covered taker-in. Proportionate to the total weight of waste extracted at this point, there is more fly or waste fibre than sand, leaf, or seed, as compared with the opener or scutcher waste, and probably the chief explanation of this point lies in the fact that the vast bulk of all the impurities has already been driven out in the blowing-room machinery. Beneath the licker-in is the final position in cotton-spinning machinery at which we may expect to find any quantity of sand or seed, or other heavy impurities, although the total weight or percentage of waste made at this point is almost always less than that extracted by the flats. Either flat strips or cylinder strips contain an infinitely smaller proportion of sand, leaf, or other impurities than licker-in droppings, while at the same time there is a much greater proportion of fly or fibre in the former. Licker-in droppings, when good undercasings with close bars are used, are not really of very much more value in waste spinning than are some of the wastes from the scutcher. On the contrary, the other wastes of a card, whether they be card front fly or any of the strippings, are of considerable value in waste spinning, as waste goes.

Thirty or more years ago, before the device of Joseph Bennett, of Whitfield, Glossop, began to be applied to carding engines, i.e.

the feed plate, along with the metallic taker-in, it was customary to allow all the droppings from the licker-in free scope to fall on the floor, and not to prevent this by undercasings; and in those days licker-in fly was of far more value for the purposes of waste spinning than it is at present.

If we examine a card back full of waste we shall find the upper portions reasonably fibrous, with the bottom portions full of the heavier impurities.

The Beater Bars of Openers and Scutchers.

Probably no part of an opener or scutcher for cleaning and opening cotton has been more the subject of discussion and invention than the grate bars beneath the scutcher beater and beneath the first portion of a horizontal opener beater. The number of bars to be used, the exact shape of these bars, the exact angle of the bars, their distance apart from each other, and their distance from the path of the beater have been frequent points of discussion, and many arrangements have been experimented with.

A question one may reasonably ask is, why have comparatively thick cast-iron bars been so often preferred in place of thinner bars of better material. It is a matter of fact that scores of blowing-room machines have recently been fitted with thin steel bars beneath the beater, such bars having originated abroad, and brought all the way to our Lancashire mills. The practice in such a case is to take out the existing bars beneath the beater, place a spiked comb bar next to the feed roller, and follow this by possibly fourteen or more thin steel bars on a scutcher or a greater number on an opener. The comb bar may have possibly one row of spikes for Sea Islands, two rows for Egyptian, and four rows for other cottons (see fig. 1, p. 12).

There can be no doubt that the introduction of these patent bars has frequently led to extra cleaning of the cotton when the same has been of a somewhat dirty character. Special packings are used at the ends of these bars to give them a suitable angle, and there are one or two little special details of arrangement. Apart from all this one is led to ask—Why have our English spinners not insisted on thin steel beater bars being supplied by our machine makers, instead of the comparatively clumsy thick ones we often find in use? We are inclined to think our spinners would have been willing to pay the extra cost if they had realized the extra benefit resulting from having more cleaning edges in the same space, and yet better openings for the dirt to escape.

It may be laid down in a general statement that what we want in beater bars is the provision of the maximum number of cleaning bars, the best shape and angle of bars for permitting the escape of the droppings, and for permitting the air to enter for the fan draft, without also permitting any re-drawing-in of the dirt and undesirable matter. Thick bars do not lend themselves to the best attainment of these desirable features, especially when used in the very limited space available between the feed rollers and bottom of the beater chamber in connexion with a double- or treble-bladed scutcher beater. If cotton is to be permanently at a higher level of price—then greater attention must be devoted to beater bars, leaf bars, licker-in undercasings, flat stripping plates, and any points which greatly affect the quantity and character of the waste made at the blowing-room and carding machinery.

We also want beater bars so fitted into position that it is almost impossible for the angle or adjustment of the bars to be disturbed during working, and we are afraid some of our spinners have paid rather too much attention to cutting the machine makers down in price, and too little attention to such important points as these. As a rule a machine-maker naturally likes to make machines that he can be proud of, but he may as well shut up shop if prices do not provide a reasonable profit, and spinners should remember such points as these.

An important point to remember is the effect on the air current of any alterations in the beater bars, and we are of opinion that this particular feature is often overlooked. If the beater bars of a scutcher are so altered or changed that a greater volume of air can find its way through the bars, this is bound to exercise an effect on the air exhaust problem. Cases have occurred where much trouble has arisen in this particular direction. We have never to forget that we have the apparently anomalous procedure of the chief intake of air on a scutcher occurring at the very beater bars through which the larger proportion of the heavier impurities are expelled by the force of the beater assisted by gravity. As a matter of fact the intake of air at this point is of material service in preventing the escape of too much good fibre along with the undesirable matter. Experiment has demonstrated that no better position for the intake of air has yet been found, and it is no haphazard reason that is responsible for the apparent anomaly.

It is a curious fact—attested to by persons who have watched the actual occurrence—that some of the lighter dirt expelled from the upper bars of an opener or scutcher, has often been attracted back again into the good cotton at the lower bars, and therefore the angling and adjustment of the bars should be such as to prevent this. In some cases division plates have been introduced with advantage between the upper and lower portions of the bars, and this point is perhaps worthy of more attention, although some firms have discarded the same after trial.

It need hardly be said that apart from the kind of bar that is employed it will usually be found the better practice to have a reduced angle and closer bars for the cleaner cottons than for dirtier cottons, but after all this usually only means taking out one or two bars for the dirtier cottons, leaving fewer bars to spread over the same grate-bar area.

Probably the leaf bars between the beater and the cages are of less importance than the beater bars, but even these have been the subject of much experiment in regard to shape and setting, although after all a favourite type is the thin straight bar.

The Schaelibaum Bars.

Referring to the figure, which represents the arrangement complete, it will be observed that the cotton is drawn by means of the pedal B and feed-roller A to the beater D, which latter revolves at the usual high speed. The cotton is pressed against the beater and taken away by the friction set up. It is asserted that by this means the cotton is not subjected to a sharp blow, because of the rapidity with which the beater arms follow each other. The friction thus set up electrically excites the fibres, and causes them to form into curls or coils. These latter are taken out by the comb E, which is fixed underneath the pedals B, the pressure of the beater causing the fibres to pass rapidly through the points thereof; and to ensure this work being done thoroughly, the comb is made in one piece. Connected with this comb is an angle-iron F, which steadies and strengthens the plate. The catch-edge bars follow immediately after the comb, and are laid in segmental brackets supported from the sides of the machine. At the end of the grid a dead-plate M is fixed, which is perforated so as to allow any light dirt to fall through; and to prevent any draught at this point the space below is made air-tight. Means are also provided for regulating

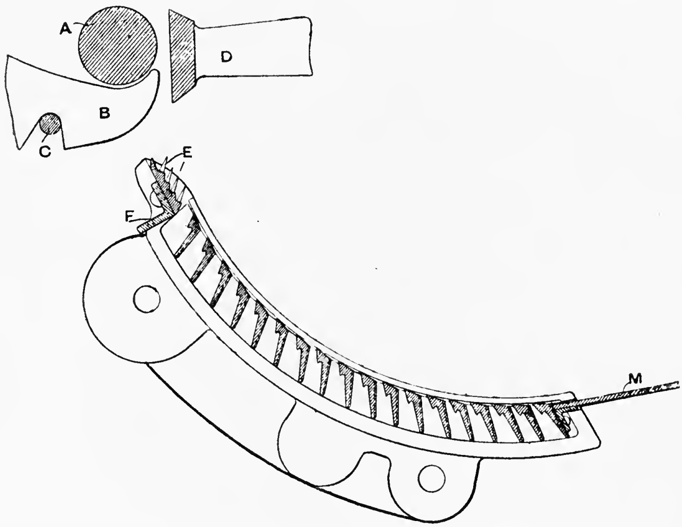


FIG. 1.—Feed-roller. Schaelibaum Bars.

the draught about the grid, so that the spaces between the bars are always free for the dirt to pass through without danger of the cotton going along with it. We may add that the fixing of the grids to ordinary machines is easily done, and need not interfere with the ordinary mill arrangements.

Testing for Waste.

It is important in a spinning mill that the exact weight of cotton passed through the various processes should be reasonably well recorded. The weighing of all finisher scutcher laps affords in a way one method of totalling up the weights, but it is not a customary thing to weigh the cotton at different stages such as cards, combers, draw-frames and fly-frames as this would be a very troublesome thing to do. Dependence rather is placed upon testing for waste in the blow-room, at the cards, and at the combers. Also upon the calculation of weights put through based upon the readings of the indicators at the various bobbin and fly-frames.

Finer the counts of yarn spun, lower the weights put through, and more highly priced the raw cotton and spun yarn become and the more likely will it be for intermediate weighings of material to be profitable. Comparisons of weight of cotton used, and weight of yarn obtained from spindle point, extended over a suitable period of time, afford a proper indication of the percentage of waste over all. The waste returned from any set of machines may afford a method of testing the waste per cent locally.

Calculations on Waste per Cent.

On numerous occasions the writer has been written to and spoken to with regard to difficulties connected with percentage problems. Two or three calculations are given below which will exemplify one section of such problems. It is in waste and wages calculations these points become of most importance. In actual practice in spinning mills it is a more or less frequent occurrence to thoroughly clean the openers, scutchers, and cards, and to pass a certain weight of new cotton through the same in order to ascertain the amount of wastage due to droppings and invisible loss.

Case I.

100 lb. weight of new cotton is passed through the opener, scutcher, and card, and there is a loss of 4 per cent in the opener, 2 per cent in the scutcher, and 6 per cent in the card. Find the loss in lb. weight at each stage, and also the total loss per cent.

1. In the first operation it is clear that 100 lb. loses 4 lb. since this equals 4 per cent.

2. In the scutcher, however, 2 per cent loss does not mean just 2 lb. since 96 lb. loses 2 per cent.

∴ If 96 lb. lose 2 per cent, what will be the loss in lb. weight?

$$\frac{96 \times 2}{100} = 1{\cdot}92 \text{ lb.}$$

3. At the carding engine we pass through 96 lb. less 1·92 = 94·08 lb., and this loses 6 per cent. What is the lb. loss?

To restate the case we say: If 100 lb. lose 6 lb., what will 94·08 lose?

$$\frac{94{\cdot}08 \times 6}{100} = 5{\cdot}6448 \text{ lb.}$$

4. We have a total loss in lb. as shown below :—

4·0 lb. at opener.
1·92 lb. at scutcher.
5·6448 lb. at card.

11·5648 lb.

We are now in a position to show where the apparent anomaly occurs that is often a little perplexing to students and mill men. By the terms of the question we lose altogether 12 per cent, and if we start with 100 lb. and lose 12 per cent we should lose 12 lb. But we have shown that only 11·5648 lb. are lost. How is this?

The answer simply is that per cent loss is not equal to lb. loss in actual figures at scutcher and card. Take the card in particular. Six per cent is lost here, but clearly this is not 6 lb. but only a little over $5\frac{1}{2}$ lb. If 50 lb. lost 10 per cent it would not be 10 lb., but only 5 lb. In this example, therefore, we have the percentage figure greater than the actual lb. loss. It is not 100 lb. which loses 12 per cent in one operation, since the 6 per cent loss at card is only lost on 94·08 lb., which is practically 6 lb. less than 100.

Case II.

The position may be stated by a second example which still more nearly approaches actual mill practice, and is probably a little more difficult to understand. Suppose 100 lb. of raw cotton be passed through the opener, scutcher, and card, and losses are determined as follows: Opener 4 lb., scutcher 2 lb., card 5 lb. What is the per cent loss in each case, and what is the total loss per cent?

1. Since at the opener 100 lb. loses 4 lb., this is clearly 4 per cent.

2. At the scutcher 96 lb. loses 2 lb., what is the per cent loss?

$$\frac{100 \times 2}{96} = 2{\cdot}08 \text{ per cent.}$$

3. By the time the cotton reaches the card it has lost 6 lb., and therefore 94 lb. are put through the card, and lose 5 lb. in waste, leaving 89 lb. of good sliver. What is the per cent loss at the card?

$$\frac{100 \times 5}{94} = 5{\cdot}32 \text{ per cent.}$$

So far everything appears very self-evident and simple. But now again we have an apparent anomaly. We have found the losses to be as below:—

			Actual weight.
100 lb. fed to opener gives .	4	per cent =	4 lb.
96 lb. fed to scutcher gives	2·08	per cent =	2 lb.
94 lb. fed to card gives .	5·32	per cent =	5 lb.
Total	11·4	per cent =	11 lb.

The question is: What is the total per cent loss? We at once say 11·4 per cent, as we have just calculated and totalled. But we started with 100 lb. of cotton, and now we have 89 lb. left, so from this point of view we would say at once 11 per cent represents its total loss. In a way it could be argued that both are correct. It must be noticed that per cent loss in both examples totals higher than lb. loss.

A third example may be taken in which the comparison is taken right through a mill spinning combed yarns.

Example III.—100 lb. of raw Egyptian cotton is passed through all the processes and made into yarn. It is found there are the following losses in waste:—

In the blowing-room .	5 per cent.
At the carding engine .	4 per cent.
At the combing machines	15 per cent.
Frames and mules . .	4 per cent.

Now ascertain the loss in lb. at each stage, the total loss in lb., and the total loss per cent.

1. In blow-room 100 lb. loses 5 per cent., which equals 5 lb.
2. At the cards 95 lb. loses 4 per cent.

$$\therefore \quad \frac{95 \times 4}{100} = 3{\cdot}8 \text{ lb. loss at cards.}$$

3. At the combers 91·2 lb. loses 15 per cent.

$$\therefore \quad \frac{91{\cdot}2 \times 15}{100} = 13{\cdot}68 \text{ lb. at combers.}$$

4. At the later processes 77·52 lb. loses 4 per cent.

$$\therefore \quad \frac{77{\cdot}52 \times 4}{100} = 3{\cdot}10 \text{ lb. loss.}$$

The total losses in lb. and per cent are shown below:—

Per Cent.	Lb.
5	5
4	3·8
15	13·68
4	3·10
28 per cent.	25·58 lb.

The question naturally asked is: We start with 100 lb. and finish with 74·42 lb., so how can we lose 28 per cent? The whole explanation of all these cases rests on the fact that the losses in all intermediate stages are not made on 100 lb. weight, but on something less.

Summary of Wastes.

In a particular case the following detailed and tabulated list of wastes from the various parts of a card was obtained from good American cotton:—

Cylinder and doffer strips	1·6	per cent.
Licker-in fly . . .	1·0	,,
Cylinder fly . . .	·3	,,
Card-box fly . . .	·2	,,
Feed-roller waste, etc. .	·6	,,
Flat strips . . .	2·3	,,
Total . .	6·0	,,

This is a rather larger percentage than is often extracted from American cotton at the carding engine. In the case of carded Egyptian, however, the percentages often range higher than the above, and the following is given as an actual example entering into the writer's own experience:—

Cylinder and doffer strips . .	1·9	per cent.
Fly from beneath taker-in . .	1·1	,,
Fly from beneath cylinder . .	·2	,,
Fly from beneath card-box . .	·3	,,
Waste from clearer at feed-roller, etc.	·7	,,
Strips from the flats . . .	3·0	,,
Total . . .	7·2	,,

In these examples no account is taken of invisible loss.

It will not be out of place at this point also to give some idea of the proportions of waste of the different sorts to be found in all departments of a mill, and again it will be done best by giving an actual example. The waste from the blowing-room may come under the general term of droppings, and all of the visible waste in the case under notice totalled 3·9, while in addition there was an invisible loss of 1·1 per cent. At the carding engine the total strips from the flats was 2·8 per cent, and all other card waste came to 3·4 per cent. Combers were not used in this particular case, so that no machine after the card made any great weight or per cent of waste. The summary will be best indicated in tabular form, as below :—

Blowing-room visible waste	3·90	per cent.
Blowing-room invisible loss	1·10	,,
Flat strips	2·80	,,
Other wastes from cards	3·40	,,
Total amount of bobbin waste . . .	0·76	,,
Total amount of clearer waste, including under clearer of mules	1·43	,,
Card-room sweepings	1·10	,,
Oily waste and spinning-room sweepings .	0·50	,,
Various other items	0·60	,,
Total	15·59	,,

It must not be taken that the foregoing classification of the various kinds of waste is adopted by all firms, as the system varies somewhat with different firms. Bad cotton, high speeds, careless or unskilful operatives, dry, frosty weather. The prevalence of dry east winds, machinery out of order, and other circumstances, always tend to increase the percentages of wastes, while the opposite conditions tend to reduce the amount of waste below what may be taken as a fair average. In cases where a spinning firm also winds or reels the yarn there is also the item of reelers' or winders' waste to be considered, and this often is no mean consideration, as the yarn having reached this stage has had all the money spent on it, and yet waste yarn will not command as good a price as the best card-room wastes.

Carding Engine Waste.

Reverting briefly to the special subject of waste produced at the carding engine, we may note that this machine is the most prolific in the making of waste of any machine in the mill, providing the comber is not used. The waste of a carding engine over all generally ranges between the limits of about 4 per cent and 8 per cent, but, of course, about 18 or 20 per cent of waste is taken as a good basis for a Heilmann comber.

Licker-in droppings are quite dirty, and often rival some of the wastes or droppings extracted at the opener or scutcher, but all other waste from this point onwards contains only a small proportion of the worst impurities, such as sand, seed, leaf, or motes.

Even the flat strippings and the cylinder and doffer strippings of the card, as well as the fly consist for the most part of fibre which is most useful for one purpose or another afterwards.

Card Strips.

Broadly speaking, the waste from a carding engine is divisible into two chief parts, fly and strips. Strips are the wastes that are positively stripped or pulled from the fine wire teeth of cylinder, doffer, and flats by the aid of special mechanism. The term "fly" comprises practically all the waste of a card that is driven off, or, so to speak, flies off any of the working parts and finds its way to the floor beneath the back, middle, or front portions of the machine. Above we may have given a much fuller division of the card wastes than just merely fly and strips. Apart from the droppings beneath the licker-in, which are full of motes, leaf, sand, and other undesirable matter, the other wastes of a card present a much similar appearance, being composed for the most part of fibre, which is by no means all of short staple.

Card strips form one of the most important items in the business of a soft cotton waste dealer—indeed, the most important item apart from comber waste. It is good usable waste, which is afterwards cleaned and applied to very important uses, being readily convertible into low counts of yarn, especially when operated by a proper waste spinning plant.

There is a very close resemblance between flat strips and cylinder or doffer strips, there being in each case a fair proportion of motes, leaf, and stick present in the waste, but not very much sand, as the latter for the most part drops to the floor, and readily leaves the cotton when the fibres are so very well separated between the feed-roller and the licker-in, or between the licker-in and the cylinder.

Long Fibre in Flat Strips.

A good proportion of the strips will be found to consist of short fibre, and really it is short fibre that we want to extract at this point. As a matter of fact, however, it is equally true that a good proportion of the strips also consists of good fibre. The present writer has for many years past contended that the carding engine was a very imperfect machine in regard to its inability to sufficiently discriminate between short and long fibre, so as to retain the latter while rejecting the former. There is doubtless considerable truth in the contention that long fibres adhere better to the teeth of the cylinder because of their greater length, while the shorter ones will more readily move from the cylinder teeth to those of the flats; but there is no doubt that much good fibre also is transferred to the flats, and is then extracted as waste. In like manner many of the short fibres penetrate between the cylinder teeth better than the long ones, and are not removed by the doffer, but remain to be cleaned off as brush strips; but it is only too true that here also the action is more or less imperfect, and many good fibres follow the same path as these shorter ones. That the card is utterly unable to extract the major proportion of the short fibre, whatever the settings and working conditions may be, is proved by the fact that any ordinary Heilmann cotton comber, with average settings and working conditions, operating on Egyptian cotton, will extract something like 18 per cent or so of waste—nearly all of it being short fibre—after the card has done its best with the cotton. The trouble with the card is that in making it take out a greater percentage of short fibre, you also almost invariably make it extract a greater amount of short fibre.

As regards the flat strips, there are two principal methods of increasing the percentage of these. In the first place the speed of the flats may be increased, this being usually followed by an immediate increase in the amount of flat strips. It is well established that the flats under average conditions will become reasonably well charged with strips, however fast they are made to traverse, and there is no such law as that faster flats bring out proportionately thinner strips. For American cotton about two inches per minute is often used as the speed for flats, and almost double that for Egyptian, so that on the average a much greater weight of flat strips is produced from Egyptian cotton than from the same weight of American cotton. The second chief method of increasing the weight of flat strips is to move the upper edge of the front or stripping plate farther away from the cylinder. As a rule this is a pretty certain and very ready method of increasing the weight of flat strips, but there is much difference of opinion as to why this particular effect should be produced. Some effect may be exercised also upon the flat strips by the adjustment of the back plate above the licker-in.

In order to get good clean work from the card, one of the first essentials is to keep all the wire sharp, smooth, and level across, and also to have the stripping and grinding operations regularly and efficiently attended to. If the various working organs of the machine, such as cylinders, flats, and doffer, are allowed to become overcharged with dirt and fly, or these parts are set too far from each other, or the wires are dull, the quality of the carding is bound to suffer proportionately.

The Stripping of Flat Cards.

The revolving flat carding engine has always succeeded in attracting a good deal of attention on the part of inventors and practical mill men, and there is generally some patented idea or other about this card which is at the current moment commanding the attention of the trade.

Patent brushes for clearing the flats and patent combs for aiding in the same work have been introduced with a great deal of success during the last fifteen years or so.

For twenty years or so special forms of mechanism for grinding flats from their working surfaces have been applied, and their relative merits and demerits have been discussed a good deal.

More recently still various forms of strap forks for carding engines have received considerable adoption, and these again have been superseded in interest by the question of locking motions for the front stripping doors of revolving flat cards. The present writer has never known of any other detail of mechanism, or any form of patented device that has so rapidly and so extensively been made the subject of letters patent in connexion with the cotton trade than in the case of locking motions for the stripping plates of carding engines. The subject has been a burning one, many mills having had as many as half a dozen different motions under trial. If a mill had forty cards they could nearly have had a different motion on every individual card if they had been so disposed, although two or three of these locking motions apparently stand out as superior to the greater proportion.

Even more recently still the attention of practical carders is being directed to the question of removing the dust created during stripping of cylinder and doffer at the very moment when such dust is being created, instead of permitting the same to settle on the machines and floors, and into the lungs and nostrils of the strippers and grinders.

Removal of Stripping Dust.

Perhaps it is not too much to say that all the above specified improvements and new devices patented and otherwise, are overshadowed in interest by the very latest novelty of them all in connexion with the revolving flat carding engine. The question of dust removal during stripping is such a very serious one that it has been the subject of discussion at meetings of the Trades Congress, and questions have been asked in assembled Parliament on this particular point. Parliamentary legislation has been made on this point to reduce the evil. There are several devices now on the market for removing the stripping dust, and a good many have been more or less adopted, although they undoubtedly add to the apparatus required in the card-room. But the latest claimant in this connexion does a good deal more than remove the dust created by stripping—it goes in for preventing any such dust being created.

A mere statement of the claims made for the new device for stripping flat cards on the vacuum system is almost staggering to a practical carder, and we will just recapitulate these without in the slightest degree committing ourselves at this point as to the advisability of adopting the same.

Claims for Vacuum System of Stripping Cylinders and Doffers of Cards.

The claims made by Cook & Co. for their new stripping method may be enumerated as follows:—

"The card cylinders and doffers stripped entirely by suction rotary brushes are dispensed with, and nothing is brought into contact with the card wire. Less time occupied in stripping cylinders, consequently more frequent strippings can be made, thus obtaining the best carding conditions. No stripping brushes. No dust removal plant necessary. No door locking motions required. No damage to card clothing. Longer life of card clothing. A great saving of time in stripping. No stoppage of cards. A gain of 8 per cent in production. Better carding. Less waste and less labour. No danger of accidents with strap forks or belts when stripping."

Taking item for item and going over the list and endeavouring to realize what each item may mean, will serve to convince anyone that in this new method of stripping the cylinders and doffers of carding engines we are face to face with a device which contains great possibilities, and whose potential development is at least full of interest. There are many interests involved in the adoption of a device such as this one—some of them mechanical, some affecting the health of the workers, some affecting the amount of labour and the work of the operatives, others affecting the quality of the waste, the quality of the work produced, and last, but not least, the ventilation of the room and the cleanliness of the machinery.

Dust Extraction and the Wire Clothing of a Card.

It is to be presumed that a certain amount of dirt and dust is certain to be always found in raw cotton, and it is scarcely to be expected that this should be extracted from the cotton in the mill without more or less entering the atmosphere at the mills. Naturally it is in the earlier cleaning and opening processes that the dust makes itself manifest, and it hardly gives any trouble at all in any process after the carding engine. Bale breakers were at first installed without fans and dust extractors, but it was soon found best to apply these. From one point of view it is remarkable that the blowing-room should be more free from the dust problem than the card-room, but of course this is readily explained by the very general adoption of the fan draft principle directly to the machines. One cannot help but admire the beautiful manner in which the suction or blowing principle is adopted in an opener or scutcher so as to help the cotton forward, and also to extract the fine dust without the latter entering the atmosphere. It is not to be wondered at that inventors at different times have considered the application of the pneumatic principle to an ordinary carding engine, but the tendency for detrimentally affecting the fine web or fleece of cotton, the difficulty of extracting the impurities from the card teeth, and the proper disposal of the dirt, have until recently proved to be great obstacles to the adoption of any such system in England, except in a more or less experimental fashion.

It is the usual practice to strip a card three or four times a day, and on each occasion quite a cloud of dust is created which is bad for the machine, the quality of the yarn, and the health of the workpeople. It has always been a very common thing for many grinders and even carders to leave their trade at a comparatively early age owing to chest and asthmatic troubles, largely due to the dust discharged into the atmosphere of the card-room during the stripping and grinding processes. Speaking in a general sort of way, it may be said that stripping occurs twenty times as often as grinding, so that stripping dust is a far greater evil than grinding dust, although with equal quantities grinding dust is probably the more injurious owing to its metallic character.

Effective ventilation of the card-room by the use of fans placed in the side walls of the building has much improved the atmosphere in many of our mills, although this system is by no means free from defects.

During the last two or three years it has become very generally acknowledged that the only correct method of removing the stripping dust is to do so at the very moment of stripping, and accordingly we now have various more or less successful apparatus for the purpose. In some cases the dust is removed by apparatus acting on the vacuum principle; in other cases by the operation of quickly revolving fans, and there is usually some form of hood or dust collector brought into close contact with the card while the stripping brush is being used. At the time of writing (November, 1911) mill inspectors are insisting on the use of these appliances.[1]

Vacuum System of Stripping.

Let it be clearly understood that it is in this feature of actually doing the stripping that this system differs from the others, and it is a very great difference indeed. It must remain for those

[1] As first test cases, about August, 1911, four Rochdale firms were summoned for not having applied any such mechanism.

directly concerned in the working of our spinning mills to judge for themselves in respect of the desirability of immediately applying any such system, having regard to all the circumstances of the case. At any rate, we cannot be wrong in calling attention to this new stripping method, and in giving some sort of explanation of its construction, objects, and operation. So far as the writer is aware a stripping brush of one sort or another has been regarded as the most essential apparatus in regard to cylinder and doffer stripping since the earliest days of cotton spinning. This new system, however, revolutionizes the stripping operation, inasmuch as the brush is practically done away with, and this carries with it several possible advantages apart from prompt removal of the dust and loose bits of fibre so often found in the neighbourhood of carding engines. In various ways during recent years we have become more or less familiar with the principle of cleaning by high-pressure vacuum, and in this connexion reference is made to the use of Booth's patents for vacuum cleaning in textile factories. Briefly described, it may be said that for the purposes of stripping the cylinder or doffer a nozzle is traversed across the face of the cylinders or doffer—as the case may be—and a sufficiently powerful inrush of air is obtained from a high-pressure air pump, so that strips, dust, dirt, leaf, portions of seed, or other usual constituent parts of the card strippings are drawn into the nozzle. The dust and strippings are drawn through iron piping to a suitable receptacle in an effective manner.

It is well known that factory inspectors have two special features in view in respect of cotton carding engines at the present moment: (1) To secure the application locking motions for the front or stripping doors. (2) To secure better atmospheric conditions by effective and prompt removal of the dust created in the operations. It is a singular fact that this apparatus attains both objects in a manner half incidental and quite in addition to the performance of the stripping operation by air current instead of by revolving brush.

Take, for example, the stripping of the cylinder which is done from the back or feed of the card by the vacuum system, so that the front stripping door is not needed, and may be screwed fast by set screws which would not be touched at all for supplying purposes. We understand that this meets all the requirements of the factory inspectors in this particular direction.

From the receiving chamber a main pipe of $1\frac{1}{2}$ in. diameter is run into the card-room and adjacent to the cards, and fixed as required on the ceiling, on the floor, or possibly on the ceiling of the room below the card-room. In positions convenient extension pipes are coupled to the main piping, to which one end of a flexible tube is connected, the other being attached to the cylinder or doffer nozzle on the card during stripping. The cylinder nozzle is a permanent feature of every carding engine, and is mounted on a suitable traversing mechanism, somewhat after the principle of the Horsfall. The point or mouth of the nozzle is made to run along a narrow slot cut in the fixed back plate of the carding engine. Special brackets are used to receive the cylinder nozzle mechanism, but for the doffer nozzle the usual grinding brackets may be utilized. The doffer nozzle is made to operate above the doffer comb on top of the doffer, and this is clearly the best position in every way, because there is little cotton at this position of the doffer.

As regards the stripping action on the cylinder, this occurs above the licker-in at the point where the cotton fibres are passing along from licker-in to doffer, and this is obviously not without its disadvantages. The writer, however, was informed that after repeated trials above and below the licker-in, the higher position was found to be distinctly the better, all points considered. The mechanism of the doffer nozzle is portable—unlike that for the cylinder—and may be carried from card to card. In both cases revolution and traverse are obtained from a rope pulley driven from a convenient pulley on the card. Each nozzle is fixed so that the mouth is about $\frac{1}{16}$ in. away from the wire of the card, or a sufficient distance to ensure that no actual contact is made with the wire. This removes the danger of possible injury to the wire by repeated contact of wire of stripping brush with wire of card.

Briefly put, the constituent parts of the mechanism consists of suitable rope pulleys and brackets, nozzles with traversing arrangements, flexible tubing, iron piping, an air-tight iron cylinder for receiving and retaining the strips, and finally an air-pump. The pump is of the high-pressure type, containing fast and loose pulleys, and can be fixed in any convenient part of the mill where there is a driving shaft making at least 100 revolutions per minute. If used for cleaning as well as stripping the pump might be working practically all day, but if for stripping only, then only intermittent use would be required.

The receiving chamber is a large iron receptacle, possibly 10 ft. high by 3 ft. 6 in. diameter, made air-tight, and with a suitable door for cleaning out the strips as required. Filtering arrangements are used to prevent the dust fibre, etc., from getting into the pump cylinders, there being a pipe connexion from the pump to the air-tight chamber. The pump and receiving chamber will probably in most cases be found near together, but this is not an essential feature, and the receiving chamber can be placed in any position suitable for the deposition of the strips.

It is possible to use as many as three cylinder nozzles or two for the doffers at the same time, the other suction pipes being well sealed up for the moment by taper rubber plugs. All of the matter constituting the strips may be drawn through the nozzles and pipes with the cards running full speed, and it is claimed that even in stripping the cylinder the amount of good cotton taken with the strips is so very small as to be practically a negligible quantity, figures being given to support this view. With doffers, of course, there is no question of taking good fibre through the pipes owing to stripping above the comb. In cases of fine spinning and high qualities of yarn, if there was any fear of good cotton going through when stripping the cylinder the side shaft could be put out of gear without putting the main driving belt on the loose pulley.

The Front Plate of the Carding Engine.

There can be no doubt that the question as to why does moving the top edge of the front or stripping plate farther from cylinder cause more flat strips can be argued from various points of view, and most people who have considered the matter will concede the point to be a somewhat puzzling one.

There are many men who may be rightly deemed shining lights in the cotton-spinning business, either from a theoretical or practical standpoint, who frankly admit they are by no means entirely satisfied as to the exact reason for the result produced. It is not because they are short of ideas on the subject, nor is it because they have not made observations and experiments touching this point, but rather because results vary, and objections can be urged against any theory or explanation yet advanced.

It is probable that factors which enter into this problem are: (1) centrifugal force, (2) air currents, (3) the adjustment and condition of such parts as the flats and back plate, (4) the bite between the front plate and the cylinder or "the nip".

One argument put forward to explain why setting front plate farther from cylinder causes more flat strips may be explained as follows: If the top edge of front plate is put closer to cylinder it breaks up the air current better that is lying close to the cylinder and taken along with it. By thus breaking up the air current the fibres of cotton have a better tendency to stand out from the cylinder and can be taken from the doffer better by the cylinder. The net result is that the cylinder is kept cleaner, the cotton penetrates and sticks to the cylinder wire better, so that less is taken off the cylinder by the flats, thus reducing the flat strips. At any rate this theory possesses the merit of greater novelty than some others, but the present writer must not be understood to commit himself to a belief in its correctness. Presumably its correctness would need to be shown up by the amount of cylinder strips also becoming less, and it is doubtful whether two or three days' testing of the same would show any appreciable difference.

Some good men consider that air currents have more to do with this problem than has centrifugal force, but there are other quite as good men who consider centrifugal force to be the leading factor in the problem, and still others who contend against both theories.

A second possible explanation has been offered as follows. There is always a tendency for a quickly revolving body to throw off anything that may be upon its surface owing to the effects of centrifugal force. This being so there must be a tendency for the cylinder to throw off the fibre that it carries from taker-in to doffer, a tendency which is more or less resisted by the back and front plates and also by the flats themselves. If the front plate is set farther away at its top edge it permits this tendency to be developed more strongly at the final point of contact surfaces, and hence the flats succeed in bringing away more fibre as waste. Against this explanation is that the flats are charged with fibre from the very commencement, and therefore do not thus take away the extra fibre as suggested. Moreover, a very closely set front plate can in some cases be made to almost prevent flat strips altogether, although by taking flats out over the cylinder it can be proved that they are charged with fibre at that point. According to this argument, therefore, it is easy to answer the statement that a wide setting permits fibres to leave the cylinder for the flats by asking, How can this be so when the flats are already charged prior to reaching this point?

Other reasoning and explanations upon this point are connected with the question of external air currents affecting the fibres at the front plate, also air that may enter at the sides of the machine. It has been argued that when air gets in at the sides of the card, it is attracted by the cylinder, and may affect the edges of the fleece of cotton more especially. Cases have occurred in which a front plate which refused to permit strips to be made on one card gave quite satisfactory results when transferred to another card. In many cases the flat strips have been appreciably affected by alterations to the back plate.

Communications on the Front Plate Question, sent to the Author.

1. *Front Plate of Carding Engine.*—I should be glad to have the question of front plate of carding engine discussed, and herewith I contribute my quota. I have been personally connected with a fair amount of experimenting on this question as to the effect of front plate on the flat strips. In a certain case there was a card which gave a great deal of trouble with the weight of strips, and although I put the plate to practically touch the cylinder, the strips came out altogether too thick, and no amount of humouring the front plate would stop this. We did not find the law to apply that setting the front plate closer reduced the strips in this case. Being determined, if possible, to get at the root of this matter, an experienced fitter was put on the job for about three days, and he altered and tested front plate in various ways, blocking up air passages, putting a strip of wood and iron across the plate to prevent air from getting in, but still no change was made in the strips, and the fitter went away. Afterwards I did my best in the matter, and, singular to say, I found in this case at least it was neither the front nor the back plate that was wrong, but the cylinder. I believe if the cylinder had been correct the front plate would have acted properly. This leads me to another version of what causes the flat strips to be altered in thickness besides what you have put in your article, and I am obliged to use the word "suction," as containing the explanation.

The flats are loaded with fibres as long as they remain on the cylinder. Immediately they leave the cylinder the fibres on the flats come under some influence which draws them more or less from the flat wire to the cylinder wire. This we can prove by putting the front plate so close as to have flats coming out bare of any strips and loading the cylinder. Does not this prove that centrifugal force of itself does not affect flat strips? My point is this: The front plate, assisted possibly by centrifugal force, acts as a suction plate. We have a current of air generated by the cylinder, we have a plate which we put closer to the current of air, and by this means obtain more suction—if I may use the word—of strips from the flats. If we get a perfectly covered cylinder, and perfectly covered flats, and a perfect plate—practically speaking I mean—the drawing power is strong enough to clean the flats of all fibres. This is only one of the points affecting the front plate and flat strips.

2. *Front Plate of Carding Engine.*—Does the setting of front plate affect the quality of the strips from the card? One of your correspondents says no, but I think 99 per cent of carders will think otherwise. All practical experience proves that the position of front plate does affect the quantity of strips. But how? This is what we want to get at. I believe that centrifugal force and air current explanations are all off. We cannot get inside a card to see it work, and in my opinion there is no need if we grasp the essential conditions that prevail. What are these conditions? 1st. A revolving cylinder covered with card wire with the business point of the card tooth leading. 2nd. Flats over the top of the cylinder, also covered with card wire, but the business points of the card teeth in the opposite direction to the wire on the cylinder. 3rd. Next we have the cotton fibres carried forward by the cylinder card teeth against the opposition of the flat card teeth. The cylinder wire is therefore the comber and the flat wire the retainer. Now, when the flat is leaving the cylinder the fibres in the flat are being combed forward by the cylinder card teeth, and the fibres come in contact with the front plate. Now if you set your plate an inch away from the cylinder there will be no bite between the plate and the cylinder wire; but set your plate close and then you get a keen bite. This bite controls the amount of flat strips. One of your correspondents says he has seen cards in which the alteration of the front plate did not affect the strips. May I point

out that in such a case the flat when leaving the cylinder is not near enough to the point of the front plate. On most cards this can be altered by dropping the brackets that carry the front flat shaft.[1]

Holland's Web-Conductor for Carding Engines.

This appears to have been applied to cotton cards since about 1870 or sooner, and is a most excellent little device now universally adopted, although it would appear the inventor did not patent the arrangement or derive material benefit from it.

It consists of a very smooth flat plate, held by one or two studs possibly $2\frac{1}{2}$ in. or so in front of the mouth of the trumpet.

It forms a guide plate for the fine web of cotton before the latter enters the trumpet. The web-conductor is grooved at the outer portions but raised in the centre, and helps greatly in collecting the loose web into a more condensed order before the cotton is formed into a sliver at the trumpet.

The conducting plate has a very excellent effect in keeping the selvedges of the web in condition, and thus restricts the amount of waste and the number of slubs formed at this particular part of a card. The conductor has a good effect in gathering in the loose fibres of the web and preventing waste in any part of the web.

Very light selvedge guides of a somewhat similar shape have been often used, or draw-frames between the rollers with good effect on the sliver.

Selvedge guides are used in several positions on the draw-frame and lap machine, or ribbon machine, in order to prevent excessive increase in the lap width, with accompanying bad selvedges and waste.

Hand-cards.

Nearly forty years ago a well-known authority on cotton spinning wrote as follows :—

"Formerly cylinders were stripped by hand with what is termed a hand-card, which is a board with a handle about half the width of the cylinder and having a piece of card sheet nailed to it.

"This is still used to some extent and has a pernicious effect

[1] The author does not commit himself either for or against the above principles.

in loosening and opening the wire on the cylinder. Another method of doing this is to turn the cylinder slowly backwards by hand and gather the strips upon a clearer, which is turned at the same time in the opposite direction. The latter method avoids damaging the cards upon the cylinder, but it does not get out the motes which are clutched in the wire of the latter."

Undercasings.

And again: "The casing of cylinders underneath has now become very general, and is absolutely necessary for short staple cottons and for present speeds. Various opinions prevail as to the kind of undercasing it is best to employ. Those made of tinned flat iron soldered to three segments are simple, cheap, and good, but this plan does not admit of any variations at the spinning mill when once applied, therefore the following is to be preferred. This is made of sheet iron plates bent to the curve of the cylinder and pierced with oblong small holes about 1 in. long by $\frac{1}{4}$ in. wide.

"Casings should be set close to the cylinder and ought not to be wider than the width of the wire on the cylinder as they work better this way than when made the width of the frame. Some spinners have their carding engines only partially cased, preferring to make a little fly to possible discoloration of the yarn."

"Any kind of casing tends somewhat to discolour the yarn, but in other respects they are economical.

"The discoloration of the yarn arises in a great measure from the particles of metal which fly off when the cards are ground up with emery and particularly when hand-strickles are used.

"If two rows of cards be worked with and without undercasings there is a great difference in the appearance of the yarn, showing up in stripiness and a bluish tinge when undercasings are used."

"Smooth well-made web-conductors placed in front of the trumpet of the calendars help to reduce waste by keeping the selvedges of the web well under control.

"It is a very common thing for a front cross rail to be placed just under the doffer or so near to it that waste tends to accumulate on the rail and after a time becomes picked up in small portions and is carried round by the doffer into the web. By the same means the fine web beneath the doffer often becomes ruffled and patchy."

Comber Waste.

It is well known that comber waste is a very important item indeed in mills which go in for the production of really good combed yarns. When it is remembered that with single combing alone as much as 20 per cent of the total cotton supplied to the combers may be rejected as waste—stuff for which possibly 15 pence per pound may have been paid in days of high prices—an idea may be formed of the cost and importance of this subject.

It is well known also that the draw and lap machine—or ribbon machine—is an optional machine for use in front of the comber instead of a special draw-frame for the purpose. Until a few years ago the amount of adoption of the ribbon machine scarcely appeared to warrant its introduction a matter of possibly thirty years ago. During the last few years, however, this machine has very rapidly increased in public acceptance, and there is little doubt that the extensive adoption of the Nasmith and Heilmann combers requiring wide heavy caps has exercised an important influence in this direction.

Granting that the use of the ribbon machine diminishes the per cent of good fibre extracted as waste at the comber, may we not also suggest that in days of high-priced cotton the argument for using the ribbon machine instead of the special draw-frame possesses additional force since the preservation amongst the good slivers of 100 lb. of extra fibre costing 15 pence per pound, means so much more than 100 lb. at 7d. or 8d. Items such as these are sufficient to turn the scale in cases of machines which are wavering in public estimation, as the ribbon machine was for a number of years.

The Disposal of the Comber Waste.

The most orthodox arrangement for disposing of the waste at the machine has been to have rectangular boxes placed on the floor behind the machine, each box serving for two heads, and the waste being simply dropped from the doffer combs into the tins. At regular intervals the waste may be pressed down into the boxes to prevent too rapid overfilling, and possible danger of some of the waste being taken back into the machine.

Mr. Sylvanus Anderton—well known in cotton-spinning circles in the Bolton district as an expert on combers—some time ago devised a neat little tin arrangement fitted near the doffer, which helps to keep the comber noil down in the proper receptacle, and greatly diminishes the risk of any of the waste touching the doffer and being carried back into the range of the principal acting organs of the comber.

The most ambitious and most revolutionary arrangement of recent years, however, in regard to the disposal of the comber waste, consists in the application of what is known as Roth's patent aspirator, upon the adaptation of which eminent machinists have expended a good deal of time, skill, and money. The well-known doffers, covered with strong wire in a leather foundation, and also the doffer combs, are entirely dispensed with. An arrangement is fitted which possesses points of resemblance to those employed on openers and scutchers for disposing of the air and fine dust. The removal of the waste is effected by a current of air. The combing cylinders and quickly revolving brushes for cleaning the cylinder needles of all the waste material remain as before, but the combing cylinder and brush for each head are partially enclosed with a special casing, and the waste thrown off from each head is deposited upon the perforated portion of a cylinder. In other words, the casings have communication with a cylindrical filtering screen which extends the whole length of the machine, from the centre of which it has communication with the forced draught apparatus. The air duct placed at the back of the machine is connected with an exhaust fan. The successful accomplishment of this particular idea should remove an eyesore from the cotton combers, should keep the combers cleaner, should quite obviate the smaller troubles such as waste picking up again into the machine, and ought to leave the work if anything cleaner. It remains to be seen how much this device will be adopted.

Below is reproduced by kind permission of the lecturer a good proportion of a lecture recently delivered at the Bolton and Manchester Technical Schools, by Mr. Norman Jones, Examiner in Cotton Spinning to the City of Guilds of London Institute.

In this lecture many points affecting the production and regulation of cotton waste are admirably treated, in so far as Sea Islands and good Egyptian cottons are concerned in the blowroom and carding engines.

Lecture.

We have now to consider the second important feature of the machine, viz. its cleansing efficiency and the factors affecting it, which are chiefly: (1) the relative areas of the cylinder and that portion of its circumference which is occupied by the grid bars and hood respectively; (2) the number, section, angular setting and spacing of the grid bars; and (3) the establishment of the correct ratio which must be maintained between the induced air currents generated by the fan and the velocity of the blow given to the cotton, together with the speed and volume of the air displaced by the rotation of the cylinder. For the first of these circumstances it may be stated that in machines of modern construction, 20 per cent of the cylinder circumference may be allotted to the hood or casing prior to the point of commencement of the grid bars, and 50 per cent of the circumference to the grid bars themselves. The shape and setting of these bars are governed by several factors, the chief of which are: (1) the nature of the material to be acted upon; (2) the amount of impurities contained in it; and (3) the relative amount of opening and cleaning to which the cotton has been subjected at different positions in its passage over the grid bars, and the difference in the character of the impurities which are ejected at these points. The object of the bars should be at first to arrest the cotton sharply, and the section of the first few bars should be such as to hold the cotton for a very brief period after its impact, thus allowing the impurities to free themselves readily, and by presenting angular faces to the detached tufts of cotton, which tend to prevent their rapid passage over the bars, causes them to be struck oftener by the blades. As the cleaning proceeds, the necessity for this sharp impact and progressional obstruction becomes less; the bar angles should be made less acute, so that, as the cotton is driven forward by the combined action of beater and fan, it is subjected to a series of gentle vibrations, which finally develop into a slight scraping action, as the now opened cotton passes over the final section of the bars. The action or effect produced on the cotton varies therefore in accordance with the changes in section of the bars, so that the angle made by the bar faces becomes of the utmost importance, and should receive a corresponding amount of attention. When these angles have been satisfactorily established, the full cleaning efficiency of a set of bars can only be realized when the air current passing through the spaces between the bars is correctly adjusted to the bar sections, and in acccordance with the effects which the angular setting of the bars is designed to produce upon the material. Theoretically, the air current passing into the machine through the grid bar apertures at any point should be just sufficient to detach the cotton from the bar edges and keep it inside the beater chamber. As the sections are changed, and with the angles made by the bar faces becoming less acute, the force and volume of the air current necessary to detach the cotton becomes less, and should be reduced in approximately the same ratio as the reduction in the holding capacity of the bars. The advantages derived from the reduction of this air current are very great, as it allows lighter impurities to be ejected from the cotton which could not possibly have made headway against the strength of the current necessary to detach the cotton from bars of more acute angles.

The realization of these effects can be attained by dividing out the beater chamber into sections, corresponding to the different sections of bars used, so that the series of bars of different sections may be isolated from each other. These divisions can be readily applied in the form of sheet-iron folding doors, easily removable for cleaning purposes, and the subdivision of the entire chamber may be arranged to form two or three chambers as may be necessary. It is not advisable to carry this farther than three subdivisions for various reasons. Each division should communicate with the external atmosphere through examination doors provided with draft control regulators. These latter should be regulated to govern the air supply in decreasing volume as the cotton becomes more open and the impurities to be extracted become finer. These subdivisions also serve a useful secondary purpose, as they break up the local circular air currents which are generated by the meeting of the fan and beater currents inside the chamber, and which in a chamber not subdivided or fitted with baffling plates, transfers a constant stream of impurities from the upper to the lower series of bars, where they re-enter the machine and pass forward. For the actual design and spacing of the grid bars themselves there is much divergence of opinion; the methods employed differ considerably even when intended for use under similar circumstances.

It is not possible in a short space to detail the many factors which influence these arrangements, but the following method of construction possesses the advantage that it has been evolved from practical experiments, and is specially adapted to the previous data supplied on this type of opener working the cottons under discussion. Let A represent the circle described by the tip of the cylinder blades and B the circle of grid bar edges. The distance between

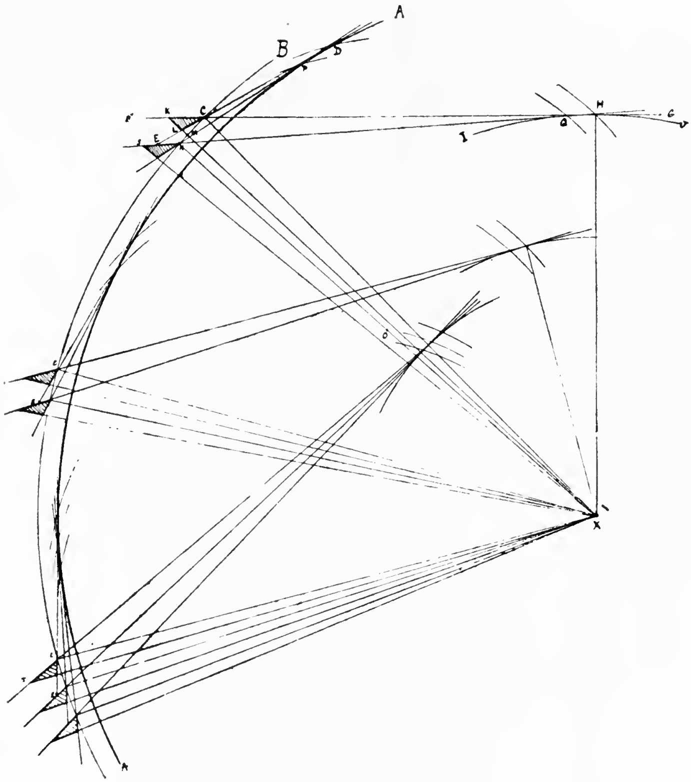


FIG. 2.—Angles of Beaten Bars.

the circles should be $\frac{9}{16}$ in. to $\frac{5}{8}$ in. Assuming the edge of the first bar to coincide with the point C, then through C draw DE tangential to beater circle A. On CE construct the angle ECF of 30° and project the line FC to G. Through X (the centre of the beater circle) draw XH at right angles to FG. With centre X and radius XH draw the circle IJ, which will be the construction circle to which all the upper bar faces must be tangential for bars of similar section. From C mark off CK $1\frac{1}{4}$ in. long, and from X draw the radial line XK, intersecting the line DE at L, this completes the bar CKL. For the second bar, mark off on the circle B a distance MN of $\frac{1}{2}$ in. N is commencing point for the second bar. Join NX and bisect the line at O. With centre O and radius NO, cut the circle A at P, and the circle IJ at Q. Project lines through N from P and Q respectively. These lines will then be tangents to their respective circles, and the bar may again be completed by a radial line from X passing through S. For the bars of the second section the construction is similar except that the angle ECF is 45°. The bars of the final section are also similarly constructed, but with angle ECF 50°. On analysing this construction it will be noted that two of the bar faces are similar in each instance, the difference being in the angle made by the face line CF with the tangential line to beater circle CE. The reasons for this are as follows: The tufts of cotton struck by the cylinder blades are projected forward in a line tangential to the blade circle, so that the bar face CE following the same course presents the least possible obstruction to the flight of the impurities, hence the reason for adopting this method of construction for the whole series of bars. For lower cottons this line would be made to fall away from the beater a few degrees more than the tangential line, which would increase its keenness, but this is not to be commended for the finer cottons. The angle ECF is highly important, as it determines the cleaning capacity of the bar to a very great extent. The more acute this angle the more tenaciously will the bar cling to the cotton driven on to it, and the efficiency will thus be determined by the effects produced by the interaction between the bars and the cylinder blades. Acute angles retain the portions of cotton for a comparatively longer period than more obtuse angles, thus allowing the impurities time to fall, preventing too rapid passage of cotton through the machine, and causing it to be re-presented to the cylinder blades oftener, all of which tend to open and clean the cotton to a finer degree. On the other hand, too great keenness in the bar angle scrapes and deteriorates the fibre, makes good waste, and if the retentivity of the bar is too great causes overcrowding, with consequent stringing and cutting of the material if the fan draft is not excessively powerful, which, of course, defeats the object of the bar entirely.

It is thus obvious that bars of very acute angles, if used, must be few in number. In the second set of bars, the change of section consequent upon the alteration of the angle ECF to 45° has a very important effect. In the first place its obstructive effect is decreased, and in the second place its capacity for retaining the material inside the machine is increased. The latter development is necessitated to a certain extent by the cotton having been opened out to a finer degree, and is directly due to the change in the bar angle ECF, causing the point E, which represents the intersection of the face line CF by the tangential line CE, to be nearer the point C in the second set of bars than in the first, and nearer still in the third set. This point represents the farthest outer position on to which the cotton can be thrown, theoretically speaking, and bringing this point nearer to the edge C of the bars makes it increasingly difficult to throw good material through the apertures.

Before leaving this phase of the subject one very important feature must be noted, viz., that all through the various changes of bar sections, the spaces between the bars remain the same, viz. $\frac{1}{2}$ in. It might on first consideration appearthat this practice would conduce to the passage of good material through the bar spaces, especially as the general practice is to reduce the apertures towards the final sections of the bar system; but for the cottons under discussion, with the conditions previously described and the bars arranged as demonstrated, no good material is wasted. On the other hand, with the different sections of bars divided to form two or more chambers, and the air currents efficiently controlled, the extraction of finer impurities during the latter stages is greatly increased by the additional area provided for their exit. Before leaving the subject of the opener, it should be stated that under the foregoing conditions the cotton should not be subjected to more than one beating, so that the single cylinder machine with lap part is amply sufficient, the double opener being much too severe for these cottons.

In the second process of preparation, viz. scutching, the cleaning is continued, and at the same time the finished result should be the foundation upon which the subsequent regularity of the product is built. The cleaning in this machine is due primarily to the action of the bladed beater and its auxiliaries, the grid bars, cages, and fan. The action of the bladed beater is more thorough than that of the cylinder beater, as it strikes its blow simultaneously across the full width of the machine, thus driving out impurities which have escaped the picking or rough combing action of the cylinder. This action of the bladed beater is also productive of much evil if its characteristics are not carefully studied and their effects noted. In the present instance, and for Sea Islands and the finest grades of Egyptian cotton, the diameter of the beater should not exceed 16 in., as the surface speed of larger diameters when striking the same number of blows is apt to become excessive. The restrictions as to surface speed, previously described in connexion with the opener, limit the speed of the 16 in. beater to 800 and 1000 revolutions per minute for Sea Islands and fine Egyptian cotton respectively. The inter-relation between the blows per inch, speed of feed, and weight delivered to the beater per unit time are also important, and certain conditions are established by practice which must not be exceeded. Thus for Sea Islands cotton the blows per inch turned through by the feed-roller must not exceed 20 to 25, and the weight of the combined laps on the creeper should not exceed 1·20 oz. per yard per inch width of lap fed. For the fine Egyptian cotton the blows may range up to 30 per inch, with an average weight fed up equal to 1·40 oz. per yard per inch in width. These conditions give a linear speed of feed equal to 64 to 68 in. per minute for Sea Islands and fine Egyptian cottons respectively.

One of the most important considerations in the treatment of fine cottons by a bladed beater is the setting of the distance from the nip of feed rollers to the path of the blade, and for these cottons, fed up at the speed and weight ratios previously given, a setting of $1\frac{5}{8}$ to $1\frac{3}{4}$ in. from centre of the feed roller to the edge of the beater blade when in the same horizontal plane gives good results. This setting cannot be fixed arbitrarily for every instance, even for the same cottons, as other local circumstances tend to modify it within certain limits. A very good practical method of checking the effects of a setting deduced from a theoretical consideration of the leading factors, is to study the fringe of the lap which projects through the feed rollers. For the cottons under discussion a lap fringe of from $2\frac{1}{2}$ to 3 in. long, measured from roller nip to extreme edge, should be in constant projection from the rollers, and the beater action should not shorten this fringe. The extra length of lap projecting through the nipping point over and above the setting distance, is due to the lap being bent round the circumference of the bottom roller by the beater action, and to avoid abrasion of the material a feed roller should never be used for fine cotton which will not allow a full $\frac{5}{16}$ in. to $\frac{3}{8}$ in. clearance between the blade edge and its nearest point when set the correct distance from the roller centres.

The manner in which the cotton is removed by the beater should be carefully studied, and in connexion with this the following details should receive attention. The beater setting having been decided, the feed roller should be weighted sufficiently to compress the material being fed to such a degree that the lap fringe develops a tendency to spring away from the surface of the bottom feed roller, and project itself into the path of the revolving blades. This weighting, however, must not be carried to excess, and, speaking generally, a weight of approximately 10 to 12 lb. per inch width of feed will be found sufficient for the densities of feed previously given.

Under these circumstances, the first point on the lap fringe to receive the impact of the beater is at a distance of about 1 in. from its extreme edge. The beater striking this point drives back the fringe, and passes along it, its resilience due to the compression between the feed rollers forcing it against the beater blade, and thus causing the fibres to be removed from its extreme edge, which is naturally thin and the resistance to extraction considerably less. Immediately the blade passes, the flexibility of the fringe causes it to again project itself forward to receive the next blow, the action of the feed motion, of course, automatically restoring the amount of material removed by the blades, thus maintaining uniformity in the length under treatment. The removal of the fibre under these conditions is effected in the most suitable manner possible, and with the minimum amount of strain and damage, as the resilience of the fringe and its ability to move away from the beater ensures almost perfect inviolability. On the other hand, if the setting distance is too close, or the diameter of the feed rollers too large to give a proper clearance, the result is a crushing or chopping of the material between the circumference of the bottom feed roller and the beater blade, which is denoted by the fringe of the lap showing a very abrupt change of section with an irregular straggling edge, in which rolled up fibre and artificial nip are readily discernible.

In all cleaning machines in which the material is fed in lap form, the exact manner of the removal of the successive units of material as deduced from a close study of the immediate section of the mass from which they have been extracted, is of paramount importance to the successful manipulation of the machine, and forms in practice a most valuable and unfailing guide to the realization of the highest efficiency. The maintenance of a uniform fringe, accompanied by uniform reduction in its section, also increases the efficiency of the beating or cleaning action, as the impurities are worked downwards by the repeated blows of the

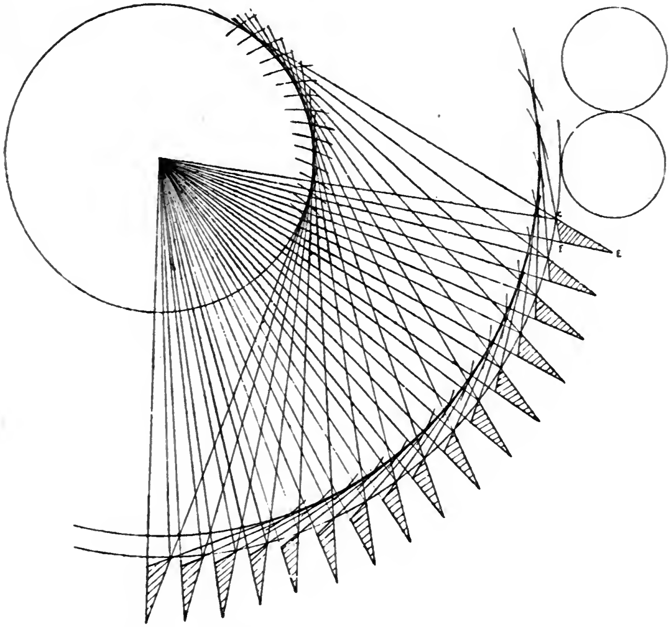


FIG. 3.—Angles of Grid Bars for Scutcher.

beater into the thinner sections of the fringe, when they are more easily driven out.

The construction of the grid bars in the scutcher must also be arranged in accordance with the more open condition of the cotton and its extraction in finer particles. The construction following upon the same principles as previously detailed for the opener is indicated in Fig. 3, where the angle ECF is made 50° as in the final sections of the opener bars. The face CF is tangential to the beater circle as in the previous instances, and the lower side of each bar is radial to the beater circle. The practical advantages derived by constructing the lower face of every bar radially to the centre of beater circle are very great, as it gives symmetry to the bar system, provides excellent facilities for the passage of impurities outwards, and greatly facilitates the setting of the bars to their correct angular positions respective to the beater circle, if for any reason they have been removed. For fine cottons the section of bar shown in Fig. 3 may be used throughout the entire set in the scutcher, and the spacing may be arranged as follows :—

Assuming 15 to 18 bars in the set, the first eight may be spaced $\frac{3}{8}$ in. apart, the next four bars $\frac{5}{16}$ in. apart, and the rest $\frac{1}{4}$ in. The first bar may be set $\frac{1}{2}$ in. from the nearest point of the bottom feed roller, and all the bar edges nearest to the beater, a distance of $\frac{7}{16}$ in. away from the beater circle. For coarser cottons these particulars and settings would differ considerably, the bar angles being much more acute and ranging up to 35°, which involves a different method of construction entirely; but for the cottons forming the subject of these remarks, the previous arrangement gives good results without injuring the fibre. It is also good practice to divide the beater chamber in this machine into two separate divisions, and admit a lesser volume of air to the one section, thereby increasing the cleaning efficiency.

The further cleaning and removal of impurities is now undertaken by the card, whose action is much more refined than that of the preceding machines, and is admirably adapted to the requirements of the material at this stage. In the practical carding of fine cottons there are several circumstances to be observed and anticipated if the fibre is to emerge from the process without injury, as the relatively higher factor of cohesiveness existent in cottons of longer fibres greatly augments the difficulties of their effective separation. Having formed the material into a suitable lap for presentation to the card, the first subject for consideration is the method of feeding to the taker-in, in order to obtain the greatest efficiency from the action of that most important organ. The results obtained from the treatment of the lap by the taker-in are dependent upon several factors, the chief of which are : (1) the pitch, shape, number, and surface speed of the teeth ; (2) the mass of the material fed per unit time and the ratio existent between these two circumstances ; (3) the profile of the feed plate, which, in conjunction with the linear speed of the feed, determines the duration of the combing action ; (4) the shape of the mote knives, and their angular disposition with the surface of the taker-in, and their respective distances from the feed plate from each other and from the undercasing of the taker-in ; and (5) the constructional features of the undercasing, the shape of the bars, the setting, and the influence of the local air currents generated in the taker-in chamber.

Taking the first of these items, viz., the clothing of the taker-in, the dual duties of the teeth must be considered, viz., the opening out of the tangled mass of fibres in the lap and the carrying forward of minute bunches of fibre to the cylinder. The teeth must, therefore, be so shaped that these functions will be satisfac-

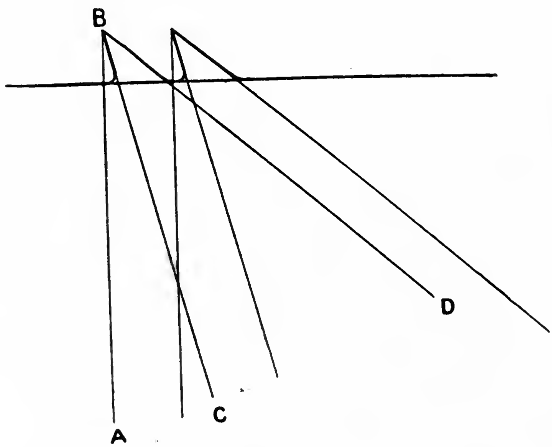


Fig. 4.

torily performed, and for the cottons under treatment a profile as indicated in Fig. 4 gives excellent all-round results. In this form of clothing the circumferential pitch of the teeth is ·25 in., the working depth ·156 in., the angle which the carrying face of the tooth makes with the vertical (angle ABC) 15°, and the angle of the tooth from the line of its front edge (angle CBD) 35°. This profile of tooth when worked at a speed suitable for the cotton, develops sufficient retaining power to allow of the use of a fairly open grid, thus providing facilities for the extraction of minor impurities. For fine cottons sufficient opening out is accomplished (provided all other conditions are normal) by spirals of 1 in. pitch, with 6 in. complete threads on the taker-in surface. This gives a pitch of ·16 between adjacent threads.

The profile of the feed plate is shown in Fig. 5, and its leading characteristics are as follows: The horizontal axis of the taker-in passes through the nose of feed plate at approximately the position at which the fibres are liberated from the nip of the feed roller, and the distance between the teeth of the taker-in and the face of feed plate at this point (A) should not be less than $\frac{1}{8}$th of an inch when the lower portion of the plate is set to a 5's gauge from the teeth. The angle made by the face of the plate AB relative to the circle of the taker-in should be such that the teeth first touch at a point D ($1\frac{1}{8}$ in. from A), and leave again at a point E ($1\frac{1}{2}$ in. from A).

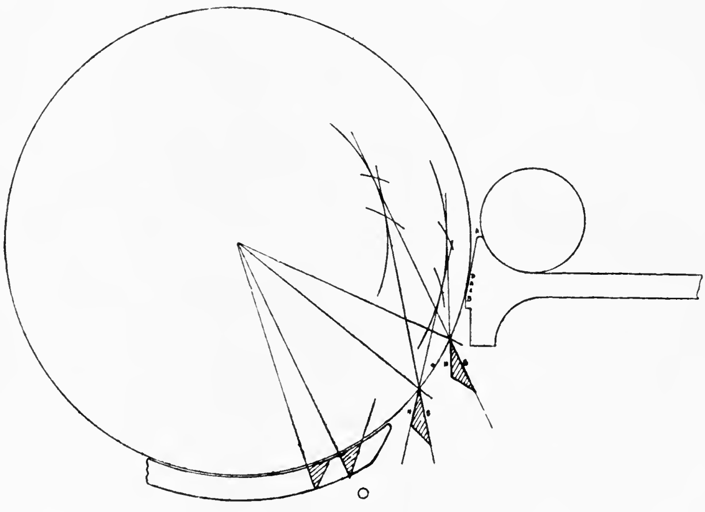


FIG. 5.—Undercasing and Mote-Knives of Carding Engine.

The bearing distance of taker-in teeth to feed plate is thus from D to E, the teeth being at their greatest depth at the point X, midway between D and E. This should be tested practically when changes have been made in the length or angular disposition of the face of the plate, by smearing the face AB with some kind of marking substance, moving the plate up to the taker-in until it touches lightly, and then turning the taker-in gently by hand, afterwards noting the effect on the face of the plate, where the marking substance should be removed for the distance specified. The face AB should be continued a full $\frac{1}{8}$ in. beyond the point E, where the marking by the taker-in teeth finishes, thus giving a length of AB equal to $1\frac{5}{8}$ in. It is highly important that the face of the plate be continued beyond the point E, as if a form of plate be used in which the point B coincides with or is higher than the point E, the percentage of good fibre ejected at this stage will be considerably higher than would be the case with a feed plate on which the face was extended well beyond this point.

The extension of this face beyond the point at which the taker-in teeth definitely commence to leave it when following their path of circular movement, greatly facilitates the retention of the fibre by the teeth, on account of the angular face of the feed plate following to a certain extent the contour of the taker-in surface, and thus lessening the distance between the points of the teeth and the face of the plate.

The angle made by the mote knives is a very important feature, and is responsible for much of the clearing out of fine impurities. It is not possible to state any definite degree of angle which will suit every instance, as circumstances vary to an extent which makes the standardization of this setting impossible. For normal feeds and speeds, and for long-fibred cottons, worked with takers-in covered with teeth as previously indicated, a good method is to arrange the two faces of the bars G and H tangential to circles of $6\frac{1}{2}$ in. and $9\frac{1}{2}$ in. diameter respectively; this setting proving the most effective out of an extended trial of several combinations of angles. The distances between the feed plate and the knives, between the knives themselves, and between the second knife and the undercasing, also have an important influence upon the result, and very good all-round results are obtained by keeping all these distances within the length of ·7 times the average length of the fibre, which in the present instance limits the distance between the first two of these settings to $1\frac{1}{4}$ in. The taker-in undercasing may be extended to within $\frac{5}{8}$ in. of the second knife. The bars in the undercasing may be fixed as indicated, with $\frac{3}{8}$ in. clear space between each bar, and constructed with the receiving face set at an angle of 45°, with a radial line from the centre of the taker-in. The edges of the bars must be rounded off and highly polished, and the undercasing, mote knives, and feed plate set as closely as possible to the taker-in.

The examination of the lap fringe after it has been subjected to the action of the taker-in, is a good practical method of ascertaining the suitability of any given combination of taker-in speed, profile of feed plate, and speed and weight of the feed per unit time. When the fibres are being removed under the best conditions, the lap should taper off uniformly from full thickness to a thin fringe of fibres, which should present a level and unbroken edge. The extent of the tapered section should not be too short, and should average for these cottons from $1\frac{1}{2}$ in. to $1\frac{5}{8}$ in. If the section of the fringe shows very abrupt reduction it may indicate that the feed plate incline is either too short or has insufficient clearance from the teeth of the taker-in at its upper edge for the weight or mass of fibres presented.

If the edge of the fringe is very irregular, with gaps at intervals, the probable causes are too great a length of incline from the nipping point to the point of release ; too quick a speed of feed relative to the surface speed of the taker-in ; insufficient weighting of the feed roller ; or the roller and the feed plate out of alignment with each other, thus failing to establish a perfect grip on the lap across its full width, which results in "plucking" and very irregular removal of the material. Under any circumstances, if a uniform fringe is not permanently maintained, a higher percentage of good fibre will be found in the droppings than would be found normally.

The arrangements of speeds, drafts, and production vary slightly according to circumstances, and in the working of superfine cotton a knowledge of the limiting factors is of great assistance when the necessity for adjustment occurs.

The first feature in this respect which demands attention is the maximum permissible speed of the constant speed organs, viz. taker-in and cylinder. These speeds are, of course, limited by the nature of the material, and in the present instance should not exceed 900 and 1900 ft. per minute for the taker-in and the cylinder respectively. The speeds of the variable speed organs, viz. the feed parts and the doffer and its connexions, are governed by various factors, amongst which are (1) The ultimate counts of sliver required relative to the count of the lap fed ; (2) the production required from cards, and the number of cards available relative to this total production ; (3) the maximum density of the feed per unit time which the nature of the material will allow without deterioration ; and (4) the minimum surface speed of the doffer which will clear the cylinder efficiently.

Taking this from the point of view of the best practice for fine cottons, the considerations affecting the quality of the product should be the first to receive attention, and in this respect the feeding of the material becomes of paramount importance. The density of feed per unit time is in turn dependent upon the charging or distribution of material upon the surface of the cylinder, and for fine cottons this factor is readily found by experiment. For fine Sea Islands cotton the weight fed should not exceed 15 to 16 grains per minute per inch width of lap, with a linear of feed spread of from 5 to $5\frac{1}{2}$ in. per minute. For fine Egyptian cotton the weight fed may range up to 18 grains per minute per inch width of lap, at approximately the same rate of speed. These factors should not be exceeded, as with the speeds and particulars previously given the charging of the cylinder under these conditions reaches the maximum safe density at which the fibres may be transferred from cylinder to flat and flat to cylinder without straining and rolling up into nep. The resistance which is offered to the transference of the fibres thus alluded to, should be as far as possible the resistance of the wire itself, and should not be increased by the extra resistance imposed by a mass of contiguous fibres.

In respect to the doffer speed, it is usually conceded that this is subservient to the weight per yard of the sliver required, and whilst this theory under certain circumstances might be correct, it may also in other instances be equally incorrect. The speed of the doffer should as far as possible be governed by the weight fed per unit time. It may be assumed that for a certain distribution of fibre on the surface of the cylinder, a certain speed of doffer surface containing a given number of points will be found to effectively clear the cylinder. It is, of course, not possible for any speed of doffer to absolutely clear the surface of a cylinder as it passes, on account of the very limited area of the surfaces in contact, the great contrast between the speeds of these surfaces and the natural cohesiveness existent between the fibres buried in the cylinder wire and those on the surface. These circumstances, along with others of a more or less variable character, make the entire stripping of the cylinder every revolution an absolute impossibility, and this is clearly demonstrated by the time taken by the cylinder to discharge its superfluity when the feed is stopped. It is therefore self-evident that the slower the speed of the doffer for a given weight of feed, the greater will be the number of fibres carried past it, and as a natural consequence the greater will be the working density of the fibre on the cylinder surface; thus tending to overcard and strain it.

For the conditions and feed weights as previously indicated, the surface speeds of the doffer for Sea Islands and fine Egyptian cottons should not fall below 55 to 58 ft. per minute. It is not an uncommon occurrence when the output of a card is adjusted to give the same total production of a lighter sliver, to find that the increased doffer speed for the same weight of feed results in a diminution in the percentage of flat strips. This is on account of the increased efficiency of the doffing action, as if fibres are constantly passing the doffer, the inevitable result is the retention of good fibre by the flats. This same defect may also be the result of wide setting between the doffer and the cylinder, by neglect of stripping at consistent intervals, and by dull wire. The speed of the flats is also a very important consideration, as it affects not only the quality of the carding but the percentage of waste extracted. No definite rule can be stated, the speed being purely dependent upon local circumstances and the condition of the cotton under treatment in respect to cleanliness. The average speed for superfine cottons usually ranges from two to three inches per minute. The action of the flats is one of great interest, and should be carefully studied in conjunction with the cotton under treatment. The rate of presentation of clean flats to the cylinder at that point at which the cotton contains practically the whole of the impurities which the flats are expected to extract, governs to a very appreciable extent the cleanliness of the resultant sliver. If a card be run bare and the cylinder and doffer stripped so that no charged surfaces exist upon any of the carding organs, the card started in this condition, and again stopped when the sliver has attained its average weight per yard, much valuable information may be gathered by turning the flats back and analysing the flat strips in their various positions. It will be found that, providing the flats have been properly set down in the first instance, very few (if any) of the larger impurities have passed the first four or five flats. The charging of the flats is heavier at the feed than at the delivery end, as might naturally be expected and the percentage of good fibre is considerably greater in the initial than the terminal sections of the flats, the strips on the initial section of the flats being much more loosely held than those in the latter sections. The most striking feature is the absence of any of the heavier impurities in the flat strips after the first few flats, which throws a very interesting light upon the action of the flats on the cotton.

In connexion with the above experiment, it must be remembered that all the flats were uncharged or bare to commence with. The inferences which may be drawn from this experiment are: (1) That the cotton as received by the cylinder from the taker-in is brought forward in the form of minute tufts of fibres clinging together, rather than in individual fibres as is often supposed. These small tufts are arrested by the first flats, and retained until they are straightened out and removed by the cylinder. The heavier impurities having been arrested by the flats are retained by them, being firmly embedded in the flat wire as a result of the extraction of the fibres to which they are attached, these being drawn away from them through the wire of the flat, that is, through the heel. (2) That the presentation of good fibre to the cylinder by the flats continues for a certain period after the flats have become fully charged at the feed end, and this period is dependent upon the speed of the flats, the weight of the feed, and the quality of the cotton. Simultaneously with this removal of good fibre, the flats are intercepting other fibres on the cylinder surface, so that as a result of this mutual interaction the composition of the flat strips changes as the flats follow their normal course. The longer fibres having greater affinity for the quickly moving points on the cylinder than for those on the slowly moving flats are carried forward, whilst the shorter fibres and impurities tend to take their place and remain. (3) The efficiency of the flats gradually diminishes as they approach the termination of their course over the cylinder, and this loss of efficiency may be allotted to two distinct circumstances, which, however, influence each other in a very decided manner. In the first place, the "loading" or accumulation of material on the wire surface of the flat, naturally reduces its available number of intercepting points, thus lessening its effectiveness in dealing with the fibres on the cylinder. In the second place, the character of the strip itself as the flat nears the completion of its path over the cylinder further reduces its efficiency in the following manner: It was previously stated that, in a card actually at work, the flat strips are equally as heavy at the feed as at the delivery end. There is, however, this difference, that the flat strips at the feed end are almost wholly composed of good material which is readily transferred to the cylinder, thus freeing the flat and enabling it to intercept other fibres to replace them. The flat strips at the delivery end are composed of fibres which have been intercepted, and on account of their shortness the cylinder has been unable to transfer them. The interaction between flat and cylinder thus becomes less, owing to the decrease in the quantity of transferable material held by the flat, and which at the same time prevents the flats in the latter sections from exercising more than a nominal intercepting action on the material held by the cylinder. This further emphasizes the necessity for close observation and regulation of the supply of clean flats to the cylinder in accordance with the waste to be extracted from the material under treatment, and the best practical method is to adopt a speed which gives a strip of sufficient density to strip cleanly, without clinging to the flat wire.

In the carding of fine cottons very heavy flat strips should always be viewed with a certain amount of suspicion, as they are usually one of the first signs of grave deterioration in the action of the machine, and this indication should never be neglected. Excessively heavy flat strips, if not due to the causes previously enumerated, may be due to too slow speed of the flats, or to wide setting of the front fly plate. The latter procedure is sometimes resorted to by the uninitiated to produce a heavier strip, and is very much to be depreciated. It may invariably be detected in the appearance of the flat strips as they fall away from the stripping comb, by the "bridging" or connexion of flat strips to each other by a network of good fibre. If this setting be carried to excess the strips may be pulled bodily away from the film of good fibre, thus proving it to have been extracted subsequent to the formation of the flat strips, and its position relative to the flat strips shows that it has been taken from the cylinder entirely. Finally, for the very best Sea Islands cotton, flats not less than 2 in. wide, $1\frac{3}{8}$ in. on the wire, should be used; whilst for the lower qualities of Sea Islands and best Egyptian cotton, the $1\frac{5}{8}$ in. flat, 1 in. wide on the wire may be used. The "heel" in both instances should not be less than ·038 in. per each inch of width.

Passing to the final cleaning process in the preparation of cotton for fine spinning, viz. combing, it may be stated that this is the only process which exercises a discriminatory or selective action upon the material. It is this propensity which makes this process invaluable, and makes it by far the most important of the entire series of preparatory processes. It differs also from the preceding cleaning processes in the fact that, during combing, the fibres are held at each end in alternate sequence, and subjected to a sufficient strain to check their natural curling tendency. This governing action is not relaxed until the fibres are incorporated in the sliver, thus resulting in absolute parallelism of its component fibres. The efficacy of the combing operation is not wholly dependent upon the action of the machine itself, but is greatly influenced by the method of presentation of the material. This latter factor is one which varies considerably, according to the character of the material and the results required; but for the finest cottons the most suitable method is to present it in the form of as light a lap as the production required from the machines will allow.

This system favours the extraction of nep, which generally exists to a very great extent in the finest cottons, where its absence is most desired. It is also found that in these cottons the neps adhere very tenaciously to the fibre, and this disadvantage is accentuated by the fact that the long, fine fibres are more easily strained than shorter, and consequently thicker, fibres would be. The balance of advantages are thus easily on the side of lap feeding in the form of light laps, and for the best results the weights should not exceed 18 to 20 and 24 to 28 grs. per yard per inch width of lap for fine Sea Islands and Egyptian cottons respectively. For these cottons, also, machines wider than $8\frac{1}{2}$ in. in the lap are not to be commended, as the production of an even fleece or web from a lap wider than this at the weights per yard specified, becomes a matter of great difficulty on account of its extremely delicate nature.

Defects in Rovings—Their Causes and Remedies.

Summary of Defects.—(1) Uneven rovings; (2) soft rovings; (3) hard rovings, or rovings having too much twist; (4) dirty rovings or rovings containing nep and small portions of leaf; (5) stretched rovings; (6) cut rovings; (7) rovings containing slubs; (8) stained rovings; (9) single rovings; (10) thickened rovings.

1. *Causes of Uneven Rovings.*—These may be caused through the circuit or passage from rollers to bobbin not being free enough, or through faulty action of differential motion, or slippage of cone belt, or binding of the racks and rack pinions. Uneven rovings may, however, be caused by uneven slivers; also when short fibre

is present to a great extent in the raw cotton, or through deliberate mixing of long- and short-fibred cottons.

Remedies.—Examine flyer and see that it is thoroughly clean. Pass a strand of some material covered with French chalk through flyer leg and thus clean it. Examine differential motion, see that all parts are well lubricated. Examine all wheels of which it is composed for broken teeth, etc. See that they are properly in gear with each other. Make cone belt sufficiently tight to avoid excessive slippage. Examine racks and rack pinions as to their efficient working. See that the slivers put up at slubbing frames are uniform. We could not avoid the presence of short fibres in the raw cotton as these are present more or less according to the circumstances under which the cotton is grown. We could abstain from mixing long and short cottons and this would certainly give better results.

2. *Causes of Soft Rovings.*—Insufficient twist in the rovings; weights falling and not being seen, or weight being disconnected from weight hook; defects in roller coverings.

Remedies.—We should of course put on a less twist wheel, i.e. one having a less number of teeth, thus affecting all parts of the frame with the exception of the twisting spindles, which would remain the same, thus giving the desired effect.

See that the rollers are properly weighted, all weights being connected to the rollers by the weight hooks.

Channelling of the front top rollers, due mostly to faulty traverse motions may allow the rovings to come through too freely. Put in fresh rollers with good coverings. Make traverse motion so to work that we shall obtain best results.

3. *Causes of Hard Rovings.*—These may be caused by having too much twist, we should therefore put on a twist wheel having a greater number of teeth and obtain the reverse of what we got with the change in second case. Top rollers binding is a common cause.

4. *Causes of Neppy, Dirty and Leafy Rovings.*—Nep is present to a greater or lesser extent in all cottons. It consists of very small portions of fibre which curl up into very small specks and afterwards mix with the rest of the fibres, making it difficult to extract.

Dirt and leaf ought not to be present in the roving to any great extent, unless something is very wrong; however, we often find small portions of both.

Remedies.—We might see to it that flat, cylinder, and doffer clothing on the card were in good condition, so as to take out the maximum amount of nep, the settings being kept good.

There is, of course, a less tendency for the nep to find its way into the roving when combers are used, because the fibres are treated more positively. If these conditions are fulfilled it will undoubtedly minimize the amount of dirt and leaf.

We may, however, pay heed to air current and dust flues in openers and scutchers, and the mote knives and licker-in on the card. See also that there is every facility for the dirt falling out at each process.

5. *Causes of Stretched Rovings.*—Rovings are stretched through the rolling effect produced by the wheels of the swing motion when the lift travels one way, by a wrong size of ratchet wheel or cone belt in wrong position.

6. *Causes of Cut Rovings.*—Rovings may be cut or thin places made (1) through rollers becoming dirty and clogged; (2) also through neglect of oiling, flutes or uneven surfaces on leather-covered rollers.

Remedies.—Clean through the rollers top and bottom and see to proper lubrication thereof. Take out all defective rollers and replace with rollers recovered and varnished.

7. *Causes of Rovings Containing Slubs.*—These are often caused by fibres clinging together with moist matter of one kind or another, being more present in carded than combed rovings. They are also caused through neglect of cleaning top and bottom clearers at regular intervals.

N.B.—In "Draw-frames and Fly-frames," 6s. net., by the present author, this subject is very fully discussed.

The Work on Self-Acting Mules.

Excessive breakage of threads from any cause inevitably leads to excessive loss in waste. Some of the leading causes of bad spinning are referred to below, and the remedy in each case is fairly obvious. Naturally, the primary requisite is the use of cotton sufficiently good for the counts and kind of yarn that has to be spun. If the cotton is much below the standard required there will be bad spinning and inferior yarn, although these detrimental effects may be often diminished by running the carriages out more slowly or putting more twist in the yarn.

It is a very bad sign, and it is an awkward feature to deal with when some of the threads are so tight as to be breaking while other threads at the same time are running into snarls. Putting too much gain of carriage in or too much "ratch" often cause excessive waste and bad spinning, these extremes being resorted to in order to keep snarls out.

It is possible to cause extra thread breakages by excessive twist and not accompanying this with suitable regulations of carriage tension. Unlevel rovings, many bad ends in the rovings, rovings too weak through over-stretching, or else short of twist, or other defects in the bobbins, or in the creels, may cause excessive breakage of bobbins, and this makes it difficult for the operatives to keep up with their other work. It is absolutely essential for the production of good work that a minder and his piecers shall be able to keep up with the work, and not have to keep stopping up in order to get straight again. When a good average minder cannot do so it is time things were improved somewhere. Every good spinner knows that it is a first law with him that he must not get behind with his work, as it may easily multiply against him in the way of cops wanting pushing up after the threads have run down for a time, roller laps wanting pulling off, and roller laps causing other threads to break. Even in the case of bad spinning it is easier for the operatives to keep up with it than to keep getting behind, and then attempting to get straight again.

In order to produce the minimum of waste the bobbins in the creel must be run off as near as possible, and not taken off and cut or pulled to waste when quite a lot of roving remains on the bobbins.

It is necessary that minders and piecers should work on a good system in regard to re-creeling, doffing, cleaning, and other duties, and in particular care should be taken not to have too much of this kind of work coming on at one time. Method in creeling, doffing, cleaning, and in particular in regard to piecing up will enable a slower man to beat a quick one who has no good method. It is surprising how far piecing up one or two ends every draw will go towards keeping up the ends if done systematically and all the time. After ends have been run down for a time, the cops must be pushed up exactly level with the others, as pushing the cop up the spindles too far will lead to the threads breaking in the winding on, while if not pushed up sufficiently there will be nicked cops. It is rather better to push up such cops before piecing the threads as the opposite practice slakens the end a trifle. Many operatives pick the first thread from the spindle points as the carriage moves up, but this pulls good yarn from the cops, and increases the waste; but operatives should always be ready to piece up as soon as the fallers unlock.

Frosty weather is very bad for cotton spinning, and will often cause excessive thread breakage, or so affect the threads that the latter will break either in spinning, backing-off, or winding-on. The judicious use of special humidifying apparatus, combined with sufficient heating, often show up to the greatest possible advantage in dry, frosty weather, or when dry east winds prevail, in preventing excessive breakage of threads. Cotton is very susceptible to variations in heat and humidity, and absence of a reasonable amount of these always plays sad havoc with the spinning.

In backing-off it is advisable to have a uniformity and balance between the unwinding of the threads from the spindles, and the descent of the winding faller wire, or otherwise there may be excessive thread breakages and waste due to this point. Both in backing-off and in winding-on there is often excessive thread breakage due to very heavily weighted salmon head levers, or due to the excessive application of the nosing motion, or to excessive inward speed of carriage, or to the nut of the governing motion not moving sufficiently high up the arm. Also during the backing-off and running-in badly set faller wires may lead to thread breakage and waste, and during winding-on it is quite possible for defective cop shaping to effect all this.

A fruitful cause of cut yarn, broken threads, and consequent waste is very late faller unlocking, or having the carriage out of the square or straight line, so that it comes against the back-stops in an irregular manner. Anti-snarling motions or hastening, or "fine rim motions" applied too keenly may all lead to extra waste and work due to excessive breakage of the threads.

In following the routine of piecing up an operative should follow each mule up each time there are broken threads, and for this purpose reasonable pains should be taken to have one mule keep up with the other. Bobbins taken out too soon make waste, and equally bobbins allowed to run bare involve extra waste. Motions are available for stopping one mule of a pair from gaining on the other, but these do not appear to be very much adopted. Even when no threads are broken a good spinner will often follow a mule up in order to pick a bit at a roller or a clearer, and this helps when a hurrying time comes along. Breaking bits or pieces of bobbins out either means excessive waste in pulling or cutting these off, or else it means creeling and making piecings twice over in putting the piecings in again. The management should help the spinners to the utmost in this respect, so as to keep the roving bobbins of one size and prevent creels from coming out together. Piecers should be trained to make short piecings, and as soft as possible, so they don't break again, since bad bobbin piecing alone may be responsible for many thread breakages and increased waste. Waste is often made by operatives breaking ends of long roving piecings off. Often also by roving being pulled off the bobbins and thrown on the floor, and roving tenters should not doff with the lifter at the end of traverse so as to leave roving ends near the ends of the bobbins, and thus falling off.

After piecing up a broken thread the finger should be run along the spindle to lay the slack end closer to the bobbin, and prevent lashing of other ends or re-breaking in backing-off. Running the finger down the spindle in such a case appears to lay the end closer to spindle than running the finger up, and practice will show which answers best in any particular case, but either will do if properly attended to.

Nicked cops and odd soft cops are serious defects in mule yarn, and are very often the spinner's fault and should be checked in every reasonable way. Usually nicked cops are the result of threads being allowed to remain broken for some time, and then pieced up without the cops being pushed up, this often showing a double carelessness. Slack strings are chiefly responsible for odd cops being thicker and softer than the bulk of the cops, and the yarn from such cops will be naturally weaker and much softer twisted than the bulk. Usually nicked cops and those made from slack strings have to be put into the rejects, and sold as waste cops, or else made up into spindle banding.

Slack spindle bands, greasy spindle bands, slack rim bands, dirty spindle footsteps and bolsters are frequent causes of bad spinning, broken threads, and waste. What are termed "thick" and "single" portions of roving inevitably lead to extra work, and waste at the spinning machines, such defective rovings originating at the intermediate or roving frames by three back bobbins running together, or two front ones in the case of "thick" rovings, or one only going forward instead of two at these machines in the case of "single". The cardroom people should protect the spinner in these respects in order to keep the waste down to a minimum.

In order to reduce the amount of work and waste during doffing to a minimum the operatives should see that all the ends are pieced up before doffing, because each broken end will require winding-on as well as piecing up after doffing. The counter faller should be put down to the best position for allowing sufficient slack yarn for pushing the cops up, but not enough to entangle the threads with each other, the latter being a very likely thing in the case of pin cops and narrow spindles gauges. Also when winding-on the doffing thread, and when finally running the mule up after doffing, care is needed to keep the threads at best tension without being either too slack or too tight. Upon re-starting take particular care to have the quadrant nut of correct height in order to avoid snarled yarn on the one hand or threads breaking through over-tension on the other hand. All these points affect both the number of thread breakages and the amount of waste that is produced.

Pasting, whipping, and tubing are the three recognized methods of obtaining good cop bottoms, and the first two especially need skilful and careful attention in order to limit the waste made in winding, reeling, or weaving when the cops have to be skewered. A great amount of waste has been caused by soft, crushed up cop bottoms, with imperfect apertures in them. Cops should be laid straight in the skips, and the noses should not be bent too much in the doffing process.

Bad cop noses often lead to excessive waste in the subsequent processes, and are often due to such circumstances as cop noses being built up too thickly, or nosing motions not applied keenly enough.

Cracked empty bobbins at the roving frame often lead to the first layer of roving on a bobbin coming up dirty and oily, and also sometimes bobbins are damaged in transit from roving frame to mule creel. Cops getting on the floor, too much thin oil being put on the rollers, are other causes of stained and oily yarn and extra waste.

Every effort should be made to have the top and bottom clearers lapping nicely at the spinning machines, remembering that loose fibre and accumulations of fibre frequently make bad ends and increase the waste.

Spinning Waste, Middle Iron Roller Laps, Fluker Rods, and Crows for Mule Bottom Rollers.

One of the differences in detail in regard to mules designed for fine spinning from Egyptian cotton and those designed to spin lower numbers from American cotton may be found in connexion with the method of keeping the front bottom rollers clean and of licking up the waste made by broken threads. A mule differs from a bobbin and fly frame in the important respect that the mule need not be stopped to piece up the threads which more or less break in the ordinary way—apart from the question of a "sawney". The soft, untwisted cotton coming from the rollers when individual threads are broken must not, however, be permitted to make iron roller laps.

There are chiefly two rival methods of doing the work under discussion, viz. the fluker rods and the short "crows" or "sticks". For the most part it is accepted that the short crows are the best for all mules in which there is lever weighting of the rollers with saddle wires passing down between the front and second rollers. Formerly these crows were used simply in the bare wood, and in that state were particularly easy to clean. Possibly about thirty years ago the practice of covering these wood under clearers with flannel began to be extensively adopted, with the result that their work is done much better, although they may be somewhat harder to clean.

The fluker rod consists of a long polished iron rod, revolving a short distance below the front and middle top rollers, driven by a pair of small pinions from the front roller. Each fluker roller reaches the length of half a mule. Now here is a point worthy of attention on the part of practical men in regard to fluker rods. By using just two pinions for driving, the fluker rod is made to turn inwardly or with its top surface moving always towards the middle iron roller, and this is the usual method. It is quite possible, however, to effect a vast improvement in regard to middle iron roller laps by introducing a carrier between the two pinions, and thus making the fluker rod revolve in the opposite direction, or have its top surface coming away from the middle iron roller. It is only fair to point out, however, that all is not for the best in making such a change, and it is perhaps not to be recommended except in extreme cases of trouble with middle iron roller laps—a by no means uncommon occurrence in fine spinning with comparatively large roller drafts.

Perhaps the greatest defect of the suggested method of driving the fluker rod consists in the tendency for the rod to help loose fly and bad ends through the rollers, whereas in the more established method the tendency is to hold such defective work back, and to take the same round the fluker rod.

A little reflection will make it clear that an outward rotation of fluker rod will tend to lift up from the iron roller any broken ends, whereas the rotation inwardly tends always to hold such broken ends nicely down. The best known remedy for excessive licking of middle iron laps in cases of fine spinning is to take all the weight off the middle top roller, and then set the centres of front and middle rollers well inside the length of the staple. In this way the shorter fibres are helped better forward from middle to front roller without much injury to the long fibres. It goes without saying that keeping the drafts down to a moderate limit is a good remedy for middle iron roller laps, and this is sufficient to prevent this trouble from development to any great extent in using American cotton with single roving. With double rovings, however, it is often an awkward matter to keep the drafts down at the mule, while the cotton is reduced to a fine grist, and the fibres are so much separated they will easily follow the bottom iron roller.

In many cases the use of iron pickers is prevented by the management for middle iron roller laps, whereas the use of the softer brass pickers may possibly be encouraged.

Referring again for a moment to the question of fluker rods, it may be pointed out that a most important reason for their adoption is to be found in the fact that it is usual to weight the short front top rollers of a fine mule by hooks reaching down the front, and these hooks are greatly in the way of wood "crows" or sticks when the latter are required to be cleaned. In some districts where operatives used to American cotton have gone on Egyptian fine spinning it has been deemed best to use the crows, and also use inside weight hooks.

Banding.

Due to slack strings, nicked cops, pulled out bottoms, spoiled noses, and similar defects, there is often an appreciable weight of spoiled cops, unfit for the usual market for good yarn, but still suitable for use in the yarn form instead of being broken up into cotton waste. As stated, a very large proportion of such cops is used up in making ropes and spindle banding, in some cases being sold for this purpose to banding manufacturers, but in other cases the banding, not the ropes, is made at the spinning firm.

There are specially convenient machines available for making banding of either the solid or the tubular kinds.

Obviously the ordinary solid banding may be made on well-known doubling lines by winding, doubling, and twisting a sufficient number of threads together. Both tubular and solid banding are extensively used in the spinning trade and the tubular is considered to be the more durable, especially if the knots are tied in a sufficiently careful and skilful manner.

Tubular banding may be said to have a hollow core and the braid is made on a different principle from the solid banding, having more a plaited character, obtained by crossing and re-crossing several yarns together on a special machine. The development of technical education has brought into power intelligent foremen who can superintend such accessory processes.

A Manager's Letter on Waste in Cotton Mills.

Approached on the subject a manager friend of the writer's wrote as follows :—

"The waste that is produced in a cotton-spinning mill is a very important item indeed. Unless the utmost attention is given to this matter by the management on the one hand, or the workpeople on the other hand, there will be a very serious loss, some of which could have been avoided. It is absolutely necessary that every precaution be exercised in this respect and reasonable strictness is essential. At the openers and scutchers nothing should be allowed to be driven out except such undesirable matter as seeds, sand, heavy dirt, leaf, or other similar stuff, with a very limited amount of fly. Any excess of fly should be at once checked by closing the bars or other means.

"There has always been a tendency for the carding engine to take out good fibre, and both the fly and the strips should be checked to every reasonable extent. In cases where the quality required in yarn is not particularly good the flats should be run very slowly and the stripping plate kept pretty closely set. In other cases the flat strips should be either combed or a good price obtained for them from waste dealers. There are very few cases indeed in which it is worth while to run modern carding engines without undercasings to licker-in and cylinder. The can tenters or lap tenters should always guard against lap end waste and front sliver waste, and neither at cards, combers, nor draw-frames should extra soft waste be made by cans choking up and running over, although this danger is not great, except at the card, owing to the use of stop motions on the other machines. Usually it is advisable to keep the rollers of the draw-frame nicely varnished in order to reduce waste in roller laps and on the clearers. The creel bobbins in all the fly-frames, mules, and ring-frames should be run off as bare as possible, and careful supervision is always needed on this point, since many operatives have a bad habit of making excessive roving waste. Whenever waste is made—and there is no means of quite eliminating it—it should be kept off the floor as far as may be convenient, or at least very quickly picked or swept up again. Top clearer waste, roller lap waste, crow waste, and roving waste, especially, come under this last remark. The different kinds of waste produced at the various machines, such as lap ends, sliver waste, fly from undercasings, strippings, clearer waste, and sweepings should be kept separate, and careful picking should follow any mixing which may have occurred from any cause. Dirt boxes, waste tins, or other receptacles for waste, should be provided wherever required."

"The waste of the various spinning mill processes constitutes an important item in mill statistics.

"Between the weight of cotton used and the dry yarn spun there is in spinning an average loss of something like 10 per cent. with good carded American. This is variable according to the grade of cotton used and heavier also when Indian or Egyptian are used, as compared with Sea Islands, and Boweds cottons. When double carding or combing are done there is the extra percentage of waste due to these extra processes.

"In the blow-room the largest item of waste—and almost the only item—is formed by what are termed droppings.

"Should a line drawn at a tangent to the path of the beater pass directly through the space between the bars, the maximum of droppings is obtained so long as the bars are unaltered otherwise.

"The fly taken through the air tubes from the blow-room machinery to the fan chamber or dust cellar is very worthless and yet is sometimes sold as 'Fan fly'.

"The bag pickings from the tares of the cotton bales are frequently used among other cottons but are sometimes sold. When they are used every care must be taken to avoid picking bits of jute bagging.

"In regard to card-room sweepings this is a somewhat elastic item, and sometimes an appreciable gain may be obtained by more stringent discipline in this connexion.

"Spinning-room sweepings should be kept free from the top clearer, under clearer, bobbin waste, and banding waste, all of which are of higher value.

"Increase of crow or under clearer waste is an indication of worse spinning and reduced quality of yarn.

"About 1901 prices of some sorts of cotton waste were so low that it was scarcely worth while to bag the commoner sorts. While in 1909, 1910 and 1911 high prices ruled for waste."

The Waste Question.

Formerly it was considered a sufficient achievement if yarn and cloth could be produced from the raw material even at great expense and loss in waste of raw material or in expenditure of almost unlimited human energy.

To-day it is necessary to economize both as far as can be made practicable.

The days of no undercasings to the taker-in and cylinder of a card are over for all ordinary work, and labour is economized by the use of machinery. We require to produce a particular kind of yarn or of cloth from a particular kind of cotton, with a minimum waste loss in order to make a profit.

At the time of writing—June, 1911—we have been for some time troubled with a shortness of raw cotton, and this has made the cotton-waste question of greater importance than ever before.

In a certain test made in Georgia it was found that about 10 cotton bolls out of every 100 were more or less diseased, while it was estimated that it took about one hundred thousand bolls to make a bale of short staple uplands cotton.

Undeveloped seeds are responsible for a good deal of waste, as inferior fibre is attached to immature seeds, and portions of such seeds often find their way into our cotton supplies in considerable bulk.

One American writer says: " With these 10,000 coloured and defective spots and 400,000 motes to the bale, a sample always grades from one to two grades lower than the same sample without them ".

It has been estimated also that rapidly running and defectively adjusted saw-gins are responsible for the cutting and breaking of about 3 per cent of the American cotton crop.

In the case of cotton made into yarn and cloth in the Southern States of the American Union, it has been found in some cases more profitable to use cotton that has not been pressed into heavy compact bales, such bales being in some cases available when the spinning and growing localities have not been so far apart as to make the cost of transit for unpressed cotton too great.

Waste and Stop-Motions for Doubling Frames.

All doublers more or less experience the need of an automatic stop-motion for doublers and twisters and particularly those who are engaged in the fine two-fold business. Considerable waste is caused by the broken end wrapping round one of the two expression rollers before being detected by the attendant. Even if a broken end does not make a roller lap it may become entangled with an adjacent thread and produce the still worse evil of four-fold which is so much expensive waste. A great deal of these fine two-folds yarns is used in the lace trade and again in the weaving trade in the production of such goods as dress-pieces, velveteens, good linings and such like, and if short lengths of four-fold are allowed to pass into such goods, their value may be seriously depreciated. For the most part reliance is placed upon the care and skill of the operatives, and upon the use of the doubling winding frame for keeping these evils down to the lowest limits, and without doubt a good deal can be done in this direction. For all that, there is still room for the adoption of an automatic stop-motion on twisting frames to stop delivery of any individual thread when such is broken.

In one example a drop-wire or cradle, made of steel, hardened and tempered, and enamelled or copper plated, is carried by, and swings loosely upon, the pivots of each short top expression roller. The front portion of this drop-wire or cradle is of such a shape that the yarn—after passing under the bottom roller and over the top one—is hooked under the needle and holds the same up. Upon the thread breaking, the front portion of the drop-wire, hitherto held up by the yarn, falls down or turns round on the pivots of the top roller, so that a wedge-shaped portion enters between the top and bottom rollers.

As a result the top roller is tilted backwards out of connexion with the bottom one and delivery of thread is arrested. This arrestation is rendered more certain owing to the top roller falling against the cap-bar—recessed for the purpose—and trapping the thread between roller and cap-bar, the trapping action being increased by any pull there may be on the thread.

Moreover the tilting backwards of the short top roller also tends to draw the loose leading end of the broken thread out of the way of entanglement with the adjacent bobbins and threads.

Even if the broken thread does become entangled with the real one, it will probably either break itself free or it may prevent the unbroken end from being drawn forward on its bobbin, thus causing the same to become slack and allowing the second cradle to come into stopping position, in which case the ends may twist together for a moment until the second is broken off, and four-fold is prevented.

An additional merit claimed for this device is that, when an end breaks and the roller tips over, a sufficient length of thread is left hanging from the top roller for tying-up purposes, and as the thread does not run off the top roller end all that is necessary for re-tying is to lift the roller back into position. Waste is diminished by the prevention of roller-laps. There is also a benefit gained by the surface of the rollers being damaged by cutting roller laps off; such injury is bad for working afterwards.

Extra Waste from Inferior Cotton.

The profits to be obtained from using a cheaper cotton, and yet maintaining the quality of yarn, and good working of the cotton, are so very obvious that unfortunately it is a frequent occurrence, among those not fully realizing the bad effects, for such to purchase inferior and more wasty cottons.

Using unripe cotton and unequal mixtures of cotton—whether done at the gins, presses, stack mixing in the cotton room, or at the lattice of the bale-breaker—will always result in more fibres flying off the bulk and lodging on the roller-beams, even in the case of mules and ring-frames, apart from losses in the earlier stages.

In the use of Indian cotton, either in India or elsewhere, there is often a tendency to use almost any kind of dilapidated opening machinery, which gives unsatisfactory opening and cleaning and yet permits too much good average fibre to escape. For such cottons also there is sometimes not sufficient testing and supervision exercised to check inferior deliveries—or cotton not up to sample.

Beater bars and leaf bars in the blow-room, and undercasings on the cards, particularly require skilful and careful attention and adjustment in order to keep the waste in proper bounds.

Referring to this matter an excellent writer on practice in Indian mills says :—

"In a mill producing medium quality of 20's from a mixing of fully good Khandeish and Guzerat cottons the dead loss (by which is meant the unusable stuff that is sold in cartloads produced mostly from the blow-room machines, or the willow and hard and oily yarn waste that is not used over again for lower counts) should not exceed at the most 14 per cent in well-managed concerns. It should be about 8 per cent in the blow-room, 3 per cent in the card-room, 2 per cent in the spinning-room and 1 per cent in the reeling-room.

"The dead loss includes cotton required for the working of lower counts of yarns, such as 10's and 12's from such waste only as is produced in the mill. These figures may be slightly varied in accordance with the cottons and the climatic changes that occur so frequently in the Bombay mills, the invisible loss being more when the dry easterly winds are blowing, as they have the effect of taking away the natural moisture from the fibres, which are set flying and nothing useful can be gathered from them.

"In the case of mixings prepared specially for warps in weaving mills this dead-loss percentage is generally higher by about 2 per cent, owing to the seedy nature of the cotton that has to be used for these mixings. In the case of a mill wholly equipped with ring-spinning this total should be less by ½ or ¾ per cent owing to the saving in reeling waste. . . .

"The quantity of usable wastes in Indian mills ranges from

10 to 14 per cent in accordance with the class of cotton and climatic conditions, in all well-managed concerns, and should economically be used over again with an admixture of about 50 to 60 per cent of shorter stapled cottons for about 10's and 12's. The good wastes of cards and draw-frames could well be used over again in the same class of mixings from which they were produced. Good supervision and careful hands will give reduced waste percentage. Sometimes in Indian mills it is found with slovenly managers and workers, that bits of clean cotton are spread on the floor, trodden about and finally consigned to the oily sweepings and almost given away."

Fuller Details of Waste in Indian Mills.

One division of cotton-spinning mill waste might be as follows:—

1. Blowing-room and card-room waste.
2. Spinning-room waste.
3. Waste from the reeling and bundling departments.

Subdivision of the wastes might be as follows:—

(1) Mixable waste, (2) half mixable, (3) non-mixable. Mixable waste includes such as can be used over again in the mixings if treated to a certain amount of opening.

The second requires a good deal of opening and cleaning and loses a good deal of its weight before it can be re-used.

The non-mixable waste must be sold for what it will fetch.

Droppings of Indian cotton in the blow-room are of somewhat different grades, those from the exhaust opener being of a very dirty nature, and very little usable stuff can be got from this waste even if treated in the willow.

The waste that comes from beneath the small porcupine beaters often used in front of a Crighton beater contains good fibre stuck fast to the seeds which are often driven out at this position.

Following this the largest quantity of droppings from the beater chamber of the vertical Crighton and this is often rather good for droppings. Various kinds of grids have been used for the vertical opener, and the kind of grid is of considerable importance. Minimum loss of good fibre and maximum extraction of seed and dirt is the desideratum to be aimed at.

The droppings from the scutcher, even with Indian cotton, may usually be opened and cleaned in the willow and used over again, but the percentage should only be low if satisfactory grate bars are used, and sometimes it pays to clean such waste before selling.

"The total dead loss of blow-room waste in Indian mills depends chiefly upon the class of cotton used and may vary from 12 to 18 per cent, but when cleaned over again the clean droppings fit for being used over again might be from 4 to 8 per cent, leaving the dead loss to be from 8 to 12 per cent. The principal cause of the heavy loss lies in the amount of seed in the cotton used."

Lap waste is usually returned behind the openers with the good cotton. It is scarcely wise to put in a large quantity of these lap ends at one time as this detrimentally affects the working of the cotton afterwards. Systematic re-use of all good waste is required rather than quite omitting the waste for a time and using a lot altogether.

Having all such waste weighed and then spread in layers over a stack mixing is one of the best methods in regard to such re-usable waste.

Imperfect operation of full-lap knocking-off motions at the finisher scutchers, the use of bad lap rods, careless piecing of the laps behind the cards, large stocks of laps accumulating, and conical building of laps, due to irregular fan draughts and lap-licking, are causes of lap waste.

It should not be permissible in these days of hollow lap rollers to leave the skewering of the laps until after the lap roller has been withdrawn, as this inevitably leads to more or less stabbing of the laps and pushing away portions of the cotton from the cores of the laps. Better tail ends and subsequent piecings of the laps result from the proper practice of inserting the lap rods before removing the hollow rollers. A check should be placed upon putting in a fresh lap when there yet remains a yard or two of the old one on the lap rod. Lap waste, even in Indian mills, should not exceed $\frac{1}{5}$ per cent of the good cotton.

Fly is the next semi-usable waste found underneath the cards. It consists largely of neps and short fibres. Its quantity depends upon the class of cotton in process, the state of the card fillets and that of the undergrids. The chief aim in this connexion is to allow just sufficient to fall out as may be required for the quality of the yarn. Wire out of condition, bad design and improper setting of undergrids, will allow good fibre to escape. In some Indian mills licker-in undercasings are dispensed with, but this makes too much waste.

Licker-in droppings make the worst waste from a card, that from beneath the cylinder and doffer being of a better character. Strips always contain good fibre.

Waste from the various bobbin and fly-frames is of the re-usable kind even in the same mill, but should be slightly opened in the machines specially designed for the purpose. It is not the best practice to open this kind of waste on the Willow or even on the ordinary scutcher, although some do it on the ordinary opener with reasonable success. The scutcher blade-beaters tend to string the cotton and unduly weaken the fibre. Unless very judiciously and carefully mixed, it is probably the case that re-use of bobbin waste, even after special treatment, tends to weaken the yarn, because the excessive treatment of the cotton fibres has tended to weaken them. In regard to the fly-frames in Indian mills it has been found that causes of excessive waste are the use of inferior cotton, insufficient twist in the rovings or slubbings, carelessness in regard to the change wheels and wrappings, ratching of the ends in winding-on, bad distribution of the roller drafts, unskilful fitting and adjustment of the parts, excessive speeds of spindle, use of bad oil, or inattention to oiling and cleaning. Again quoting the writer above referred to :—

"A prolific cause of extra waste in many Indian mills is due to the carelessness of frame attendants in allowing pieces of good waste to lie on the floor until it is trodden on and made dirty. The floors are often so greasy that the waste becomes quite spoiled which would otherwise be suitable for the same or lower counts of yarn in the same mill. In many cases tenters of bobbin and fly-frames are made to wear large canvas pockets for holding the clean waste and these should be used for the proper purpose. It is quite common for the top and bottom clearer waste on fly-frames to average from $\frac{1}{2}$ to $\frac{3}{4}$ per cent, or even more in bad cases, and this waste is quite unusable in the mill and must be sold. Other non-mixable waste from the frame-room consists of sweepings which may be divided into better and worse sorts.

"In the spinning-room it is probable that the chief item consists of underclearer waste or 'crow' waste as it is often termed in Lancashire or ' Bondas ' in India. Naturally this waste represents very considerable loss to the concern, owing to its having gone through all the mill processes. An excessive amount of this waste may indicate the use of a very poor quality of cotton, or careless and unskilful work in making the rovings or creel bobbins, or gross carelessness of the spinners in allowing broken threads to remain broken to an inordinate extent. This is inevitably accompanied by great loss in production from the spinning machines, since the waste really should have gone into yarn, as it is practically free from impurities. Reduced wages and extra work also lead to the spinners and piecers absenting themselves.

"There are very many varieties of Indian cotton and reckless changing and mixing of these often leads to the evils just referred to, while another prolific cause is the frequent changing of the atmospheric conditions. The proper use of artificial humidifiers, and proper care and use of the hygrometrical instruments will do a good deal towards minimising the variations in climate. Coarse rovings which require large roller drafts, inattention to cleaning, oiling, and repairing the rollers, unskilfulness in the adjustment of the rollers, and excessive spindle speeds are other causes of excessive clearer waste. Clearer waste from 20's yarn is very often used over again for 10's or 12's yarn, and is generally very clean and soft. There may be trouble with hard ends, but machines are available even for extracting these if it be considered advisable. It is probable that these hard threads are much more prevalent in underclearer waste from mules than from ring-frames because of the great length from spindle point to rollers in a mule with the carriage partially or entirely run out when the threads break. This feature is accentuated by the fact that a mule spinner removes his waste in lumps over the end of the clearer—taken out for the purpose, whereas a ring-spinner may pull the waste off in bits without removing the clearer. Calculated on the weight of yarn spun, clearer waste from ring-frames may reach 3 to 3½ per cent, and on mules 2 to 2½ per cent in Indian mills for about 20's."

"Roving waste is an appreciable item from spinning machines, being due to ' single ' and ' thick ' rovings pulled off the bobbins, loose ends of roving made in creeling and in piecing broken bobbins, remnants of roving cut off the bobbins when the latter are nearly run empty, nearly empty bobbins knocking about the floor.

Roving waste may reach $\frac{1}{2}$ per cent or more on the weight of yarn produced.

"A third distinct item of waste from mules and ring-frames consists of hard waste, under which heading may be included spoiled cops, small portions of cops or cop bottoms, piecing-up waste and waste due to having breakdowns in which all the threads have been broken. Careless doffing, and threads remaining broken for a time and then making nicked cops or run under cop bottoms are causes of such waste, as also may be the use of bad starch for the cop bottoms or careless application of the same. Hard waste may be used over again in those mills provided with machinery specially adapted for the purpose and is frequently sold at a fair rate for this purpose. Reeler's waste belongs to the same category as spinner's hard waste."

Double Yarn on Ring-frames.

The restriction and prevention of this has often troubled foremen over ring-frames everywhere, and is much more troublesome when rollers have two threads per boss than with single thread bosses. Even with good spinning it is necessary to use good, well-rounded and well-covered clearers to reduce double yarns to a minimum. If clearers are worn or rough at the ends they may cause double yarn, because if a thread breaks the clearer does not take it properly and there is a tendency for broken threads to run on adjoining spindles. A slight amount of cotton on the traveller clearer will break a thread and the latter may then catch in the next thread and cause double. If the steel rollers are very forward in relation to the spindles there is an increased tendency for broken threads to run into the next threads and make double. High-speed rollers throw broken threads on next threads more than low speeds.

CHAPTER II.

TREATMENT OF BEST COTTON WASTES IN COTTON SPINNING MILLS, WITH OTHER NOTES.

Treatment of Roving Waste.

THE best bobbin waste may fairly rank as an example of cotton waste, being nearly as valuable as some raw cotton, for the reason that whatever deterioration the fibre may sustain from more or less double treatment in order to extract the twist and sufficiently re-open the cotton, it will be largely counteracted by the fact that almost all the dirt, impurities, moisture, and other weight-reducing parts, will have been practically eliminated before the cotton has been converted into roving. This has always been more or less recognized, and a great many spinning firms have always followed the practice of using up their own bobbin waste for the same counts of yarn as originally intended. Until recent years, however, the means commonly put into practice for re-opening the roving waste and for mixing it with the fresh cotton were very crude, and not at all calculated to produce the best results in the mill processes and in the finished yarn. For example, it has been an occasional practice to devote a certain amount of time on a specified day to the purpose of passing the roving waste through one of the ordinary blowing-room machines, and then to mix the waste with the new cotton. In other cases the roving waste has been more or less carefully—or it may be carelessly—spread upon the cotton mixings, and treated in exactly the same way as the ordinary fresh cotton in all the blowing-room machines and the cards in succession. As a matter of fact, some such practice is even now occasionally adopted, although to an infinitely less extent than formerly. The present writer has frequently spent time in picking small pieces of bobbin waste from the flats at the carding engine, after the same had gone through the opener and scutcher, and had passed beyond the action of the licker-in of the card.

Roving Waste Opening.

One of the strongest developments of recent years in connexion with the re-using of cotton waste in the same mills has been the adoption of specially-designed machines for the first treatment of bobbin waste, either combined with special means for properly blending the reopened roving gradually and continuously with the new cotton, or leaving the waste to be spread on the mixings by hand. In regard to the actual opening of the bobbin waste some spinners have just been content with rigging up a rough machine with any kind of beater which they happened to have on the premises, or could get for next to nothing. In other cases either an ordinary carding engine has been kept on the treatment of roving waste continually, or else certain alterations have been made to the card to suit the waste. Passing the waste about three times through an ordinary opener has been found satisfactory with some firms and is considered to preserve the strength of the fibres very well.

Modern Roving Waste Openers.

After any amount of experimenting and testing, it has been generally agreed that the best treatment for bobbin waste consists in putting it through a machine which has for its central feature a cylinder covered with a multitude of fine-pointed spikes, very much after the style we have described for the treatment of cop bottom or hard waste. Indeed, this kind of beater or cylinder appears to be rapidly becoming pre-eminent for the re-linking of almost any of the finer textile wastes into which either twist at the roving frame or final spinning twist has been imparted. Certain machine-makers have obtained quite a reputation for this kind of machine, and others of the leading textile machinists are recognizing that a permanent and extended position for modern roving waste openers is assured, and have begun to make the machines.

In a manner of speaking, the accepted form of roving waste opener may be said to consist essentially of a beater of the kind above referred to, combined with apparatus and mechanism for properly feeding and delivering the waste. Almost invariably the feed and delivery appear to proceed at a very slow rate, which admirably suits the required condition of only very gradually mixing the waste with the fresh cotton, while it also permits of extended treatment of the cotton by the cylinder.

Referring now to a specific example which the present writer examined at work, this machine was fitted with a licker-in, a feature not found in all of these roving waste openers. There can be no doubt that the application of the licker-in will very considerably increase the ability of the machine to thoroughly reopen the waste, and especially if a good quantity of waste is passed through in one week, thus limiting the capacity of the main cylinder. The licker-in aids in attaining the definite object of opening the waste to such an extent that it can be blended with the raw cotton, and passed therewith through the openers and scutchers without fear of having much, if any, trouble with the waste at the carding engine, and without damaging the card wire. As to whether the waste will in any way make the finished yarn worse will depend upon the amount used in proportion to the raw cotton weight, the kind of yarn that is the accepted standard, and general attention to details. The feed-lattice of the machine is 3 feet long by 22½ inches wide. The waste is fed to the licker-in by a single feed-roller and pedals, the latter being carried on an eccentric shaft, which helps in maintaining a strictly parallel arrangement of all the pedals with the face of the taker-in. It is considered that this system of pedals is an improvement on the system of using two coarsely fluted feed-rollers, as it prevents the cotton from being pulled from the feed-roller in tufts when there is a thin place in the feed. This is practically an imitation of the practice that some people found beneficial in regard to the feeding of the cotton to some bale-breakers of the roller type, before such machines were displaced by Hopper bale-openers. Absolute rigidity of the principal working organs is essential in a machine of this kind, and all the facings, joints, pedestals, and brackets are steady-pinned in position where it is deemed advisable. The taker-in—as well as the cylinder—is fitted with self-lubricating bearings. This taker-in is 9¼ inches diameter, and is built up on the metallic principle, with sufficiently hard and tempered teeth. Its average speed is much greater than that of the taker-in of a carding engine, reaching, as a matter of fact, up to about 1300 revolutions per minute, as compared with more like 400 revolutions per minute on a card. In this particular example the cylinder is two feet diameter, and is covered with beech lags, fitted with tempered, polished teeth. The lags are firmly bolted to the cylinder, and have their ends secured by two wrought-iron rings. It may be explained that the opened waste is stripped from the taker-in by the cylinder, and this transference of fibres exercises a beneficial influence in opening the cotton. After leaving the cylinder, the cotton waste passes on to a strong wire cage, and thence upon a delivery lattice, and in a great many cases loosely upon the floor, or into skips, ready for mixing with the raw cotton. Such a machine is made by Messrs. Brooks and Doxey and is shown in Figs. 6 and 7.

Delivery of Waste.

Regarding the delivery of the opened waste, however, it will be worth while to give a little space to a special consideration

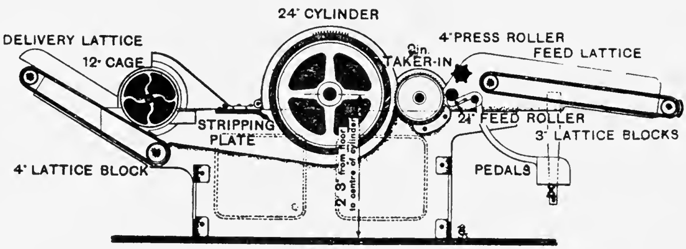


FIG. 6.—Roving Waste Opener.

of this point. As a matter of fact, practice varies considerably in regard to this detail. The original method, as above mentioned, of delivering the cotton loosely upon the floor, and afterwards mixing it with fresh cotton, has been seriously objected to by some people, and recently it has become a very common practice to have the opened roving waste delivered directly to the exhaust opener, or else to the mixing lattices or the hoppers.

Blending of the Waste from Roving Opener.

It must be understood that under the general term of "roving waste opener" we have a machine which serves equally for the bobbin waste from slubbers, intermediates, rovers, or mules, although the thinner and harder twisted roving waste requires more treatment than slubbing waste, so that while 50 lb. per hour of slubbing waste could be opened effectively, only about half that weight of roving waste could be opened. In any case, there has always been more or less annoyance and trouble connected with the blending of considerable quantities of opened bobbin waste with the raw cotton when the waste has been delivered on the floor or in skips from the roving opener, and afterwards mixed with the cotton. Difficulty has arisen in obtaining a thorough and equal blending and incorporation of the waste with the raw cotton, and the introduction of Hopper bale-openers and feeders increased rather than diminished this evil, particularly in cases in which the stack mixing of cotton had been abandoned.

Method 1.—Assuming the Hopper bale-breaker to be used, but no stack mixings to be made, the usual way is for the attendant to pass a certain amount of the opened waste along with the raw cotton into the bale-breaker. Experience has demonstrated that average results are not reliable from this practice as many attendants do not take pains to feed the waste in always equal proportion. Perhaps to a somewhat less extent the same objection applies if stack mixings are made and the waste is passed into stack mixings along with the raw cotton. The objection applies much the same if the waste is first made into separate laps upon the scutcher, and then these laps unrolled and spread across the mixings. It is self-evident to anyone possessing any knowledge of cotton spinning that unequal blending of the waste, which causes some card laps and slivers to contain a good proportion of the waste, while other laps and slivers contain scarcely any waste, can only lead to irregular work at the machines, and an irregular finished yarn. Whatever the standard of quality aimed at in spinning cotton yarns, it is a cardinal principle that all reasonable pains should be taken to maintain that standard as uniformly as possible. All this is now well understood by our cotton spinners and machinery makers, and during recent years two or three systems have been more or less extensively adopted by which uniform and continuous blending of the waste and raw cotton is obtained by mechanical means.

Method 2.—In the case of this second and more improved method of mixing the waste with the raw cotton, a delivery pipe is connected with the roving waste opener, and is also connected with the main cotton conducting pipe or long exhaust feed trunk of the exhaust opener. The waste enters into this trunk slowly and continuously, and in this way a very intimate blending of waste and new cotton is obtained. In a specific example the roving waste is passed through a waste opener fitted with a regulator to aid in uniform feeding, but which is optionally applied. Preferably this machine is also fitted with a suitable stopping and starting arrangement, and is connected by means of long rods, levers, and wires to the feed parts of the exhaust opener and the long exhaust feed-trunk, so that there shall be simultaneous stopping and starting of all these parts. The waste opener delivers the waste to a tin pipe 4 in. or so in diameter, which is pieced up directly to the 9 in. diameter principal exhaust feed-trunk. A stop valve is applied to the 4 in. waste pipe, so that waste and air can easily be shut off from entering at this point. It may be as well to point out that the combination of a waste opener with an ordinary cotton opener does not compel the coupling up of the 4 in. pipe to the exhaust 9 in. pipe, since the 4 in. pipe may deliver its waste contents directly to the beater chamber of almost any kind of large beater or cylinder.

Method 3.—It may be claimed that an advantage of No. 2 method is that the opened waste does not need to be passed through the hopper feeder or be placed on the mixing. There are many people, however, who prefer to have the opened waste incorporated in with the stack mixing if such be used, and even if it be not used prefer mixing of the waste at an earlier stage than in Method 2. As a consequence a third method has been somewhat extensively adopted during recent years. In this case a very slow delivery lattice arrangement is provided for receiving the opened waste from the waste opener, and is itself made to deliver the waste to some part of mechanism or lattice work which conveys the new cotton from bale opener to stack mixing. For example, a double elevating lattice may lift the waste and deposit the same slowly and uniformly upon the distributing mixing lattices at any convenient point. Yet, again, in a particular case recently examined by the writer, the opened waste was delivered upon the bottom delivery lattice of the hopper bale-breaker, and was then taken up by the elevating lattices along with the raw cotton. As a slight deviation from this particular practice, it is possible to arrange a delivery to the waste opener, and have this pipe leading to a condenser on the hopper bale-breaker, or the hopper feeder, when the roving waste opener can be placed conveniently in position near the particular hopper machine used for the combination. In reference to the cylinder, it is more or less the practice to have the cylinder cover fitted with a self-locking motion, which prevents the cylinder cover from being opened when the machine is working, and on the other hand prevents the cylinder from being started again while the cover is up.

Excessive Use of Waste.

A short time ago the writer had submitted to him a sample of American cotton in order to give an opinion as to the suitability of this cotton for spinning a certain count of yarn, because very bad spinning was being obtained from the cotton. Incidentally it transpired that all the crow laps from the spinning machines were being extensively used up in the mixings of raw cotton. This appears to be a typical case of the misguided re-use of waste in the spinning mill. A firm using raw cotton not good enough for the yarns to be spun, and then depreciating it by inter-mixing up all the underclearer waste from the spinning machines with the raw cotton. There is a vast difference between crow-lap waste and roving waste, the latter being quite free from hard threads, while the crow-laps are full of the same. This is so true that a separate and special machine is used for separating the hard ends from the underclearer waste of mules and ring frames, and we will briefly describe this machine later on.

The Cylinder Lags of Roving Waste Opener.

We have stated that a typical modern roving waste opener consisted of a feed lattice, press rollers, feed roller, pedals below the feed roller, a 9 in. or 9½ in. taker-in, a 24 in. cylinder, a stripping plate, a 12 in. cage, and a delivery lattice. A well-known machine is made by Messrs. Brooks and Doxey, and these makers are prepared to supply any one of three grades of spiked lags for the principal cylinder :—

1. Lags with round polished steel teeth of coarse pitch.
2. Lags with flat polished steel teeth of coarse pitch. It is claimed these lags have greater opening power on the cotton waste than lags with round teeth.
3. Lags with flat polished steel teeth of fine pitch. It is claimed that these lags have the greatest opening power of any kind, and their adoption is strongly advised for treating rovings from Egyptian cotton, and especially if these are as high in counts as 12 hank, or finer.

It may be noted that the cage above referred to and the delivery lattice are dispensed with if the roving waste opener is linked by a delivery pipe to a condenser fixed on the hopper bale-breaker or hopper feeder. (See Figs. 6 and 7.)

The Gearing.

The receiving pulley on the cylinder shaft is usually 12 in. diameter by $4\frac{1}{4}$ in. wide for 4 in. belt, and a high working cylinder speed is 800 revolutions per minute. It is recommended to be driven from a separate counter-shaft with fast and loose pulleys. The feed and delivery ends are driven from the taker-in on which

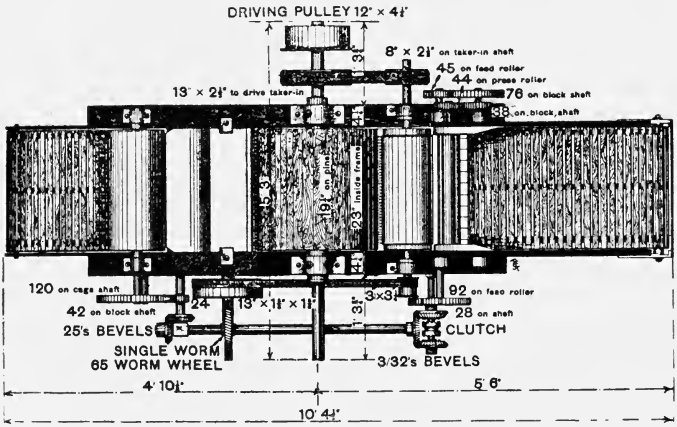


Fig. 7.—Plan of Roving Waste Opener.

is a 3 in. diameter pulley driving to 13 in. fast and loose pulleys to convey the driving to the feed and delivery gearing.

A stripping plate may be extended across the face of the cylinder to aid in cleaning the waste from the steel spikes. The cylinder cover may be fitted with a self-locking arrangement, which prevents the cover from being opened while the waste opener is at work, and which prevents the machine from being started again until the cover is put down.

As regards the kind of lags and spikes, it may be added that for roving up to 5 hank not highly twisted the round polished and coarsely pitched spikes may be recommended, but not for any finer hank. It is usually found best to deposit the opened roving waste on the short horizontal bottom lattice which transfers the cotton from the bale-breaker to the elevator lattice, but there are two or three alternative systems to suit special circumstances.

Another Make of Roving Waste Opener.

Another make of roving waste opener may be thus described : "This machine is very strong and accurately constructed, and is in general use. The waste is placed on a lattice 24 in. wide, which can be suited in length to any requirements. The waste passes under an iron collecting roller to the fluted chased feed roller, which rests on sixteen weighted levers or pedals, these latter being turned up at the ends in order to firmly grip the cotton waste quite close to the cylinder. The cylinder is very strong,

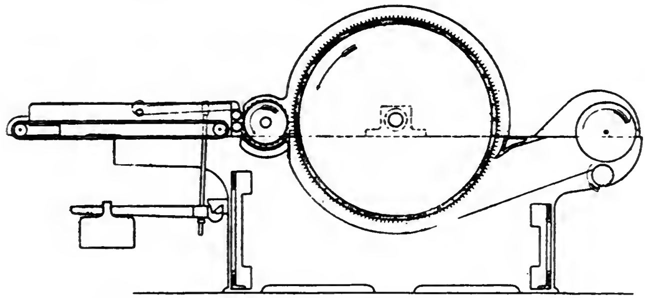


FIG. 8.—Machine for Opening Roving Waste.

and is formed of an iron body, to which wooden lags containing hardened and pointed steel pins are firmly attached. The cylinder is 24 in. diameter, and its bearings are of the Mohler self-oiling type. The cotton waste is beaten from the feed roller and levers by the taker-in, and is then passed out of the machine by means of a lattice and revolving cage, or, if desired, a mouth-piece and pipe can be fitted to the machine in place of the lattice, through which the cotton can be blown to the opener. Production, 120 lb. to 180 lb. per hour. Driving power required, about 2½ h.p. Main driving strap, 4 in. wide."

An outline sketch of this successful machine is given in fig. 8.

Thread Extractor.

Referring to the practice of re-using up the waste from under-clearers or "crows" of mules, we condemn the excessive use of such waste for twist yarns when the raw cotton is really not good enough for the twist yarns. It must not be understood that we condemn the re-mixture of crow waste in all cases. On the contrary, weft yarns of rather low or medium counts will often stand very well with such a mixing, and it must always be remembered that pin cop weft yarns have comparatively little strain placed upon them in the weaving processes. Such yarns may go directly from spinning machine to loom, whereas warp yarns must undergo the strains of winding, warping, possibly sizing, and afterwards must resist the wear and tear incidental to opening and closing

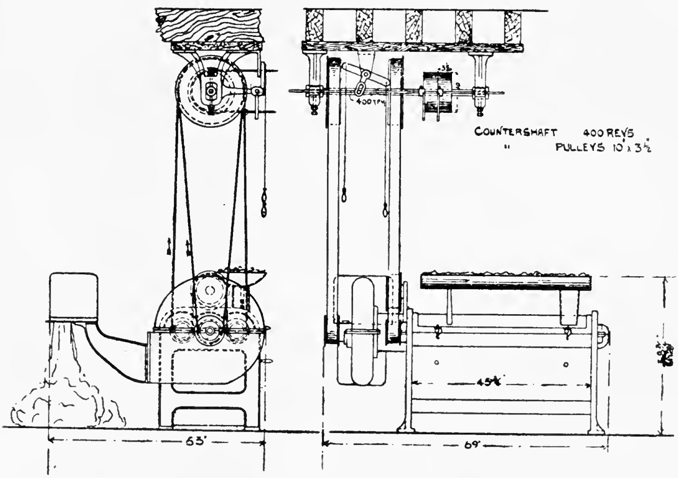


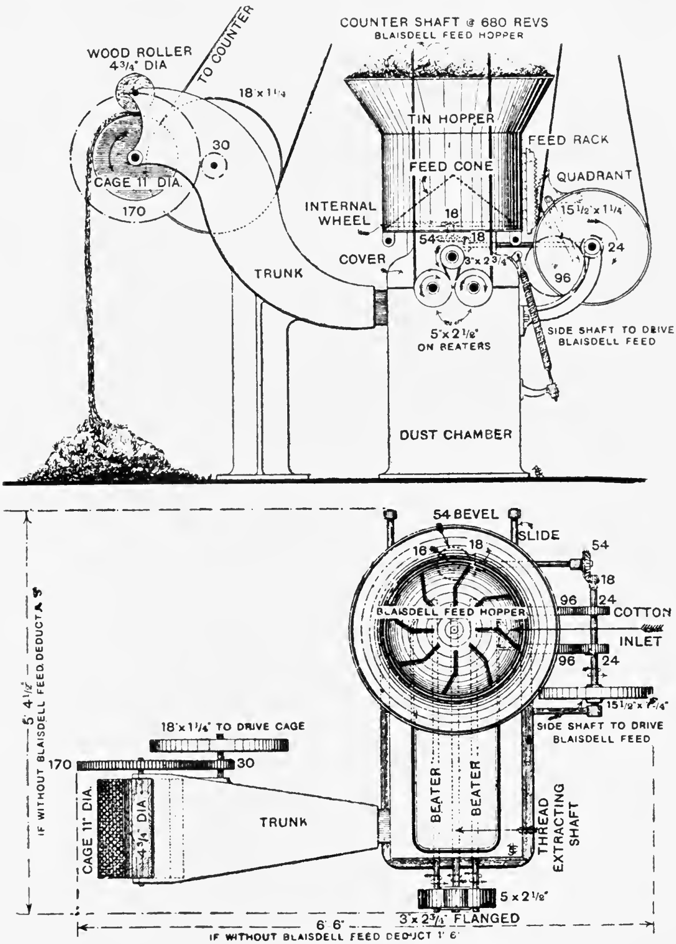
Fig. 9.—Outline View of Thread Extractor.

the shed and beating up the weft at the loom. Just as in the case of roving waste, so also have special machines been introduced to aid in the preparation of underclearer waste from mules and ring frames, so that this waste may be used over again. These machines are very simple and ingenious, and have received a fair amount of adoption, but are not near so largely adopted as roving waste openers, nor are they quite as successful in attaining the desired end. The object of an automatic thread extractor is to mechanically pick the hard ends or threads from the clearer or crow waste made upon ring frames or mules, especially in regard to American and short-fibred cottons. In a well-attended recent meeting of an important body of practical mill men at which the writer was present, it was generally agreed that the thread extractor was not an absolute success in connexion with Egyptian long-stapled cotton. Granted that the hard ends can be effectively separated and extracted from the crow laps without injury to the waste generally, there appears no reason to think such waste would be very detrimental to the yarn in re-working. Underclearer or crow waste is largely composed of the best of the cotton which has successively passed through all stages of cotton spinning, excepting the last one of all, and were it not for the broken twisted threads which often run in with this waste, the latter would be very good stuff, in spite of the presence of bad ends rubbed off the iron rollers. Every one knows that twisted threads often break off at the mule during winding-on, and then either wind round the cops or else wind round the underclearers. Neither is ring crow waste by any means free from this particular defect. Hence the invention of the particular machine under discussion. It certainly does its work quicker and more efficiently than the average hand labour; and crow laps from American cotton will work very well after treatment by this machine, and especially if weft yarns are being used.

It is quite possible to feed the thread extractor by hand, but the makers recommend automatic feeding. The waste is delivered from the machine in a fleecy condition, and it is possible either to feed it directly to the opener or deposit it upon the mixing of raw cotton in a properly graduated and proportionate manner. Apart from the automatic feeding, the central feature and acting principle of the machine consists of a waste shaft and specially formed small beaters near this shaft. The hard ends are left wrapped round the steel waste shaft which is placed in the centre of the machine, and is provided with grooves, which facilitate the ready cutting off of the hard ends. The waste shaft and the beaters run in wide bearings provided with ample lubricating facility. The beaters are made of the best cast-steel, and are perfectly smooth and well polished. As may be expected nowadays, a safety cover is applied to the beaters to prevent lifting while the beaters are working. The thread extracting shaft is chased from end to end, and has four longitudinal grooves to facilitate the stripping of the hard ends. Illustrations of Messrs. Brooks and Doxey's well-known machine are given in figs. 10 and 11.

Automatic Feed.

The addition of the automatic feeder to the thread extracting machine adds somewhat to the first cost, and makes the machine a little more complicated, but the following advantages may be claimed for its use :—



Figs. 10 and 11.—Thread Extractor.

1. It prevents over-feeding, and diminishes or quite prevents the beaters from choking.

2. It saves the time of the operative, and allows the operative

to attend better to other duties, such as removing the picked waste and bringing up fresh waste for picking.

3. It is very important that the crow waste be fed slowly and uniformly in order to get uniform and efficient extraction of the hard ends, and the automatic feeder attains this end much better than the average hand-feeding.

Process of Recovering Good Cotton from Carding Engine Strips.

The following note is reproduced without alteration from a circular issued by Messrs. Hetherington, makers of the Nasmith Comber:—

"The whole of the strips produced are put through the blowing-room or such machines in the blowing-room as may be necessary to make fairly regular laps. These laps are then put through the card in the ordinary way and made into sliver, which, after passing through one head of drawing-frame, is put through the sliver lap machine and made into comber laps 10½ in. wide; or, in cases where a ribbon lap machine is installed, the passage through the drawing-frame is eliminated and the sliver carried direct to the sliver lap machine and made into a lap of which six are doubled in the ribbon lap machine. These laps are then put through the Nasmith Comber and made into sliver, which is put up at the first or second head of drawing along with the ordinary carded sliver in the proportion of one end of combed strips to five ends of ordinary carded sliver. The yarn produced from sliver containing this mixture will, if the process has been properly carried out, be found to be slightly stronger than the ordinary yarn.

"In various tests we have made, both on machines at our works and in actual working in the mill, we find that we are always able to recover upwards of 60 per cent of good stock out of the original weight of strips dealt with.

"The following are figures based on an actual result in a mill spinning average 40's ring twist, American cotton, viz.:—

"Cotton costs 7d. per lb.

"Strips sold at 3½d. per lb.

"Value of ordinary carded sliver made from 7d. cotton, 8d. per lb.

"Production of strips per week, 3000 lb.

"3000 lb. put through blowing-room and card loses 17 per cent in waste, leaving 2490 lb. sliver.

"2490 lb. sliver put through Nasmith Comber loses 23 per cent in waste, leaving 1917 lb. of combed strips.

"The original 3000 lb. of strips have thus produced 1917 lb. of sliver, at least equal in value to ordinary carded sliver, and 1083 lb. waste of various sorts, probably worth at least 1d. per lb. all round. Thus we have:—

1917 lb. of sliver at 8d. per lb. . .	15,336d.
1083 lb. of waste at 1d. per lb. . .	1,083d.
	16,419d.
Cost of 3000 lb. of strips at 3½d. per lb.	10,500d.
Leaving a gross profit of . . .	5,919d. i.e. £24 13s. 3d.

"Additional plant required for this process for a mill of this size would be one Sliver Lap Machine, three Nasmith Patent Combers. And the additional maximum amount for wages would be £1 per week.

"No additional blowing or carding machinery is required, as, assuming that the card-room is producing sufficient to keep all spindles at work, whatever additional weight is put through in the form of combed strips may be deducted from the raw cotton formerly put through the blowing-room, so that the total weight going through remains approximately the same, and the only additional wages and power required are for the four machines mentioned above.

"The charges for interest and depreciation on the capital expenditure involved, power, wages, and margin for contingencies, would be, say, £3 per week, which deducted from the above gross profit leaves a net profit of per week £21 13s. 3d."

Letter on Cotton Mill Waste.

In answer to a query a former student of the author's wrote as follows:—

"First of all, let it be understood that I make no attempt to say what a certain waste may be used for, any further than what I have seen for myself. I intend to deal with the following waste, and first of all to say what machines it passes through and also what it is used for, and then, last of all, to describe the machines

I have mentioned. Cop bottoms, card fly, card strips, comber waste, sliver waste, bobbin waste, clearer waste from mule, washed waste (hard), washed waste (soft).

"*Card Fly.*—I have seen this willowed and mixed with card strips and spun the same as under the heading of card strips and also I have seen it used through the same machines as clearer waste. This is used for blankets which are treated to a raising process.

"*Card Strips.*—I have seen American strips mixed with bobbin waste and this mixing has spun 16's, having passed through the following machines (the bobbin waste having previously passed through a two cylinder machine for breaking up). (1) Hopper bale breaker delivering to mixings. From the mixings the cotton is put through an exhaust opener with hopper feeder and 24 in. cylinder through a trunk to a Crighton beater. The Crighton opener feeds automatically three openers with hopper feeders. These openers make laps, four of which are fed to each finisher scutcher. The lap from the scutcher being fed to a revolving flat card, through two heads of draw-frames, one slubber, one rove, and then to a coarse mule. This was used as weft for sailcloth.

"*Comber Waste.*—This will spin up to about 20's or so. I have seen this kind of waste used as ordinary cotton, having passed through the following machines. Waste scutcher with hopper feeder, and one cylinder and one beater; four laps from this were fed to the finisher scutcher. Other machines as for card strips. Also I have seen it passed through waste machinery as follows: Waste scutcher as above, finisher scutcher, breaker card with side drawing, through a Derby doubler making half width laps, two of which are placed side by side at the feed of the finisher card, this fitted with single condenser. The condenser bobbins being placed at the back of the mule. The comber waste is used for quiltings and sometimes used for the imitation of wool when mixed with cop bottoms.

"*Sliver Waste.*—This is the waste made at the card, comber, and draw-frames, and is generally used up again at the same mill.

"*Bobbin Waste.*—This is the waste made at the fly-frames and the mule. This is generally used at the same mill, but some is sold as stated above.

"*Clearer Waste.*—This is got from the mule and the ring frame, and is passed through a two cylinder breaking-up machine, through a waste scutcher with a hopper feed and two beaters. Two laps from scutcher being fed to the breaker card, which is fitted with the side drawing for Scotch feed which feeds the finisher card. The condenser bobbin from finisher card being placed in the creel of the waste mule or the cup-frame. This kind of waste is used for heavy raised blankets.

"*Cop Bottoms.*—This is the waste made by cop winders and weavers and is put through the following machines. Eight cylinder breaking-up machine with soaper attached. Through waste scutcher, two laps of which are fed to breaker card fitted with Scotch feed. Through the finisher card to the waste spinning mule. This waste is generally used to imitate woollen goods, such as blankets, and when raised giving the best imitation possible. Sometimes it is used for plain work.

"*Washed Waste (Hard).*—This is the dirty waste made, for example, in wet doubling mills, and is generally bought by the waste dealers, who have it washed, or bleached, or dyed. This is passed through the same machines as cop bottoms, excepting the waste mule being sometimes substituted by the Chapon frame. This waste is sometimes used for dyeing, which is done after leaving the mule or cup-frame, if it has only been washed. The cops from these machines being reeled, then dyed, then wound into cheeses either double or single thread. If two or three threads are doubled together they are of different colours, thus making a Granderelle yarn. The cheeses are then put on a cup-frame and twisted. The cops from the cup-frame being put in the shuttle of the loom and are often used for headings of blankets. Sometimes blankets are made entirely from Granderelle yarn of all shades and colours, giving a grand effect when raised.

"*Washed Waste (Soft).*—This is the sweepings up which are put through a picker and then possibly washed. Sometimes, however, they are not washed at all, being put through the machines as received, first through the willow and other machines as for clearer waste. If washed it is put through the same machines but omitting the willow. This also was used for blankets.

"Having now put down the kinds of waste I have seen worked, I will now describe the machinery I have mentioned.

"*The Willow.*—This consists of a cylinder fitted with spikes which dash the cotton against spikes in the cover, thus knocking the dirt or foreign substance out. It has an automatic arrangement for varying the time it may be desirable to retain the various classes of material in the machine in order to obtain the required cleanliness.

"*Cop Bottom Breaking-up Machine.*—This machine is fitted with from 1 to 8 cylinders according to the amount of opening required. The cylinder is formed of an iron body to which wooden lags containing hardened steel-pointed pins are firmly attached. The lags being held to the iron body by a hoop, so that if any pins get damaged they can be easily removed and renewed. The cylinder is about 36 in. diameter and run up to 700 or 800 revolutions per minute. The machine is capable of dealing with about 80 lb. per hour according to circumstances. It is generally fitted with a soaping apparatus."

Another friend wrote as follows :—

"Old strapping is cut up and sold for mending shoes, etc., the worst pieces of leather and piecings are sold and made into brakes for wagons.

"Roller leather scraps are sold and used for various purposes, the worst being used for polishing.

"Card fillet is sometimes sold to clothe cards for carding an inferior cotton, and sometimes cut up for cleaning straps and scouring steel rollers. Scrap-iron goes to the foundry and waste paper to the paper mill. One firm sell their old banding from spindles to a firewood dealer for bundling purposes.

"Cinders have not often a commercial value and it costs about 9d. per load for their removal if there is not an adjacent tip.

"Flue dirt sometimes or rather under some circumstances costs about 2s. a load for removal, in one case, however, that has come under my notice the remover of this flue dirt extracts a small amount of cotton from it and sells it for packing, and carts the stuff away without charge.

"Three kinds of waste are made at fly-frames : (1) Roving waste ; (2) fly on creels and flyers, along with which is put flat waste from clearers ; (3) sweepings. Card-room sweepings are usually bagged together.

"The sweepings in the spinning-room are generally divided into two classes and labelled spinners' sweeps and spinners' clean waste. The latter is composed of roller-laps and the fly which accumulates on the carriage creels, etc., and the amount varies considerably.

'Occasionally cop bottoms have to be doffed in varying sizes and these are bagged separately. If on tubes and only a small amount on they are put in the waste paper.

"In the spinning-room there are many bands and it is common for as much as 80 lb. per week in a medium mill to go as waste. They suffer the same fate as cop bottoms.

"At one time it was better to wash, steam and mangle the oily waste, but now its value is not decreased through oil.

"Waste is usually bought by a dealer. The price does not vary like cotton and contracts are made for months ahead. When the dealer gets it he sorts it and tests and marks it and some dealers have plant for willowing and cleaning.

"Some kinds of waste are spread over the floor and then left for a time to the tender mercies of a sulphur stove. This is the cause of many fires. Sometimes the stove is in a room underneath and the cotton is spread over a floor perforated with holes. This is to get the impurities out and to bleach the cotton."

CHAPTER III.

THE OPENING AND CLEANING OF COTTON WASTE.

Summary of Machines More or Less Used in the Treatment of Cotton Waste.

1. Oldham Willow.
2. Hard-waste or cop-bottom machines containing from one to eight picker cylinders.
3. The Crighton opener.
4. Single scutchers for wide laps.
5. Various machines constructed from old cotton opening and cleaning machines.
6. Soaping apparatus applied to cop-bottom machine.
7. Hopper feed to breaker carding engine.
8. Breaker carding engine with rollers and clearers.
9. Scotch feed.
10. Lattice feeders.
11. Derby doubler.
12. Finisher carding engine.
13. Condensers of various descriptions applied to finisher card.
14. Finisher cards with manifold coiler system.
15. Roller and clearer carding engines discarded from cotton-spinning mills, equipped with condensers and waste card feeding and delivery arrangements and used in the waste trade.
16. Occasional use of one fly-frame in the preparation system.
17. Self-acting mules with woollen mule headstocks.
18. Self-acting mules with cotton headstocks.
19. Self-acting mules without drawing rollers.
20. Self-acting mules with drawing rollers.
21. Chapon spinning frames.
22. Can spinning frames.
23. Ring spinning frames with draught rollers.

24. Roving waste openers.
25. Combers for card strips.

Possible Systems of Machinery, in using Cotton Waste.

System 1. *Hard-waste, Cop-Bottoms, etc.*—The author has prepared the following summary of systems that may be used :—

1. Hard-waste breaking machine, made with any number of cylinders up to about eight, the six-cylinder machine being a very good one and more economical in use than, say, putting the same waste through a three-cylinder machine twice over.

When the waste is clean as in the case of ordinary cop bottoms, this cylinder machine is sufficient without the Willow or the Crighton. This cylinder machine may be fitted with a soaping arrangement and deliver the cotton loosely.

2. Single scutcher with hopper feeder taking the cotton from the waste mixture after passing the cylinder machine. The scutcher usually makes a wide lap, say 48 in., and should be fitted with a regulating motion of the link type (without bowl-box) in order to obtain laps as regular as possible for the breaker carding engine.

The draught should be a down-draught and it will probably be found advantageous to arrange the lap end framing to hold a creel to contain several bobbins, slivers or threads of some sort which may run in with the lap during formation and thus prevent subsequent lap-licking. A less troublesome method of preventing lap-licking than this would be to swing a drag-board from the framing and allow this drag-board to rub on the lap during the formation of the latter. It is possible to arrange a device of this kind so that the winding up of the weighted vertical lap racks also pushes the hinged door out of the way. In some cases scutchers with picker beaters are used at this stage instead of the ordinary scutchers.

3. Breaker carding engine fitted with extended feed lattice capable of holding two of the laps from the scutcher—one behind the other, in order to help in giving sufficient uniformity to the condensed slivers produced from the finisher card. This system of lap-doubling also aids in securing a good admixture of the waste.

Card 48 in. on the wire, special arrangements of feed-rollers give a good grip to the short waste—possibly covered with inserted wire or leather fillet—cylinder 50 in. diameter, seven rollers and seven clearers, one wood fancy, doffer of possibly 30 in. diameter, draw-box and coiler delivery.

4. Derby doubler with **V** table used in order to convert about sixty slivers from the breaker card into laps for the finisher card. (For hard waste the Derby doubler is more often recommended than the Scotch feeder.) A full lap stop-motion applied to the Derby doubler helps to keep the laps of uniform size for the finisher card.

5. Finisher carding engine arranged to hold two laps, end to end, from the Derby doubler, or if need be even a second pair of laps arranged behind the first pair. Or two full width laps may be used as at the breaker feed. Feed-rollers, clearers, rollers, and fancy machines the same as on the breaker.

Condenser arrangement as elsewhere described. The ring doffer condenser is much used in England and may be 24 in. diameter fitted with single rubber divider, fly-comb condenser to take off from 18 to 36 ends on the one bobbin according to counts of yarn required. Sometimes a tape condenser is used as elsewhere described.

6. The long bobbins of condensed sliver are taken directly to the creel of the self-acting waste spinning mule which can be adapted to the spinning of all kinds of cotton waste, and made either with rim parallel to carriage or headstock as desired.

System 2.—In a particular example a plant for spinning 10,000 lb. per week of 8's yarn from cotton waste, consisted of the following machines :—

1. One six-cylinder machine for hard waste.
2. One single beater scutcher.
3. Eight breaker carding engines.
4. Two Derby doublers arranged for forty-eight cans each.
5. Ten finisher carding engines each arranged to make sixty ends divided between two condenser bobbins with thirty ends each.
6. Six self-acting mules each containing 570 spindles $1\frac{3}{8}$ in. gauge, and making a 64 in. carriage travel, set out to spin on an average 7's or 8's yarn.

System 3.—For any dirty soft waste such as scutcher droppings, fly, sweepings, worst strippings such as bump yarn strippings.

1. Oldham Willow the distinctive feature of which is a large diameter cylinder, possibly 56 in. width, fitted with strong blunt spikes or teeth, capable of great cleaning and shaking effect, but not small and sharp enough for hard waste. The dirty cotton remains longer under the action of this large beater than is customary in other openers, and hence the cleaning capacity.

2. Sometimes the waste is then put through a single Crighton opener arranged probably to deliver the cotton loosely on the floor, but often this Crighton is omitted when the Willow is used.

3. Single scutcher with or without hopper feed arrangement and as previously described.

4. Single breaker carding engine which is sometimes fitted up with an automatic hopper feeder, thus permitting the cotton to be fed in a loose state and obviating the necessity of ever making the waste into laps.

5. A side-drawing and Scotch feeding arrangement which automatically conveys the cotton from the breaker card and feeds the material to the breaker card without the use of the Derby doubler. By using the hopper feeder to the card the cotton need never be made into laps and by using the Scotch feed the cotton need never be made into the form of slivers, and card cans need not be used.

The Scotch or cross feed is very largely used, but the hopper feed on the carding engine is at present only moderately used, in England at any rate.

6. Single roller and clearer finisher carding engine much as elsewhere described and fitted with any suitable form of condenser.

7. For these low classes of waste either the self-acting mule, the can-spinning-frame, or the Chapon spinning-frame may be used to spin counts from $\frac{1}{2}$'s up to about 4's for coarse wefts in cop form.

System 4.—For the finer counts of cotton waste yarns spun up to possibly 12's or finer.

For many years there has been a certain amount of waste spinning conducted on the manifold coiler system as distinct from the condenser systems. This manifold coiler system—often termed the preparation system—is a cross between the condenser system of spinning and the ordinary system of cotton spinning in which the cotton is passed through various machines containing draft rollers. In the condenser system draft rollers are more usually omitted from every machine. In the manifold coiler system generally two machines are used in which there are draft rollers.

Starting with waste of fair quality, the amount of preliminary treatment before reaching the card will depend upon the particular character of the waste and might, for example, consist of the single Crighton, and the single scutcher. A moderate amount of comber waste or even of poor raw cotton might be introduced into the ordinary waste, admixtures depending upon the special markets and uses found for the spun yarn, breaker card and Derby doubler, as before described.

Compared with the condenser system of waste spinning the leading differences begin with the delivery of the cotton waste from the finisher carding engine.

Instead of using the condenser the web of cotton waste is divided into four or six portions in its width by thin polished steel blades—or other means—placed between the cylinder and doffer. Each sliver may equal about $\frac{1}{2}$ hank in counts, a little more or less as required. These arranged along the front of the card resemble those at the delivery of a drawing-frame and may be operated on the draw-frame principle. Often the cans are a little smaller than the orthodox 9 in. diameter by 36 in. length so common to cotton spinning.

The draw-frame may be omitted and the sliver cans from the breaker card taken directly to the slubber, the rovings being drafted into counts suitable for the final spinning process, say any counts from about $1\frac{1}{8}$ up to $2\frac{1}{4}$ or so, six cans at the card suiting the production of the finer counts rather better than the quadruple system of cans.

Bobbins are made at the slubber as large as the mule creel will conveniently take—say about 9 in. lift by about $4\frac{1}{4}$ in. diameter.

It is necessary for the draft rollers at this slubber to be of comparatively small diameter on account of the short fibres under treatment, so that front and back bottom rollers may be each 1 in. diameter and middle rollers $\frac{7}{8}$ in. diameter.

In the preparation system or manifold system of cotton waste spinning the slubbing bobbins may be taken directly from the delivery of the slubber to the creel of the waste-spinning mule.

Here, again, we have radical differences from the condenser system, since this mule may contain three lines of drawing rollers of small diameter which draft out the cotton into comparatively fine counts of yarn. Such yarn differs considerably from the condenser yarn and each must find its own particular market. The yarn spun on the condenser system for the same counts will be of fuller appearance, more hairy and woolly, and will give a fuller feel and appearance to goods it is woven into, but will probably not be as strong as that spun on the preparation system.

In place of the mule for this class of work, a ring spinning-frame with small diameters of rollers may be used, and in order to give gentle drafting action such frames have been tried with four or five pairs of rollers.

In the condenser mule the draft is usually all put in by the carriage, but in the mule on the preparation or coiler system the draft is more in the rollers and there need not be the same variation in spindle speed.

System 5.—The systems previously given deal with the treatment of cotton waste when it is intended to be made into yarn, and explain the treatment for hard, clean waste, soft, dirty waste, and soft, clean waste.

A good deal of cotton waste, however, is never made into yarn at all, but simply receives preliminary treatment, somewhat after the manner of the other waste, and is then utilized for such purposes as cotton wadding, packing for delicate articles such as jewellery, for surgical purposes, for the stuffing of bed-ticks and many similar purposes. Take the treatment for cotton wadding which is the principal example of the use of cotton waste not spun into yarn.

Wadding is often made from any such waste as broken-up cop bottoms, sweepings, card strippings and clearer waste.

The hard waste might be first treated in a spiked cylinder machine and the soft waste in a Willow or Crighton, in any case the scutcher would finally make a lap for the card.

Cards for wadding are built upon the roller and clearer principle, and a good many roller and clearer cards have been bought from ordinary cotton-spinning mills and altered to suit waste carding.

If laps are fed to the card the feed lattice may be extended to take two laps, one behind the other. Sometimes the cotton is brought loosely to a wadding card and an automatic feeder is used behind the card.

A wadding card differs from the others chiefly in the delivery arrangements. The cards at the delivery may be made with lap drums, single or double spooling-frames, and equipped with stop-motions which regulate the thickness of wadding required. It is quite possible to apply these delivery devices to existing roller and clearer cards. There are what are termed the "short" and the "long" systems of manufacturing cotton waste into wadding. In the "short" system a sheet of wadding may be made on any single carding engine and this system is convenient for smaller installations and for making varying quantities of wadding.

The "long" system may be adapted to a full set of carding engines—say twelve or thirteen, and is said to facilitate the making of wadding with better exterior surfaces than the interior is composed of.

In preparing the wadding for final use, although the final spinning processes are dispensed with, certain other treatment is required for the material after leaving the wadding card and requiring the use of the following: Gumming machine with gumming roller and supply cistern for the gum, with boiling pan for the gum, these parts being suitably proportioned in size to each other and the work required. Creeper to carry the treated wadding through the drying chest. Lap forming apparatus for suitably lapping the wadding after it has been gummed and dried.

Mixings.

It may be taken that experience and judgment are necessary in mixing cotton waste in order to obtain best results at least as much as in the case of raw cotton; there is very great variety in colour, staple, comparative cleanliness and other characteristics of cotton waste.

Occasionally this waste is bought directly from the spinning mill, but the usual custom is for cotton waste to be bought from waste dealers who do business with many mills. American cotton waste does not mix very well with Egyptian waste, especially for some sorts. Even in ordinary cotton spinning such mixings are best done at the draw-frame, which is not used in the spinning of cotton waste.

In spite of the very rapid consumption of a mixing of cotton waste it is better to have mixings that will last as long as can be made convenient in order to maintain uniformity, and a fortnight is by no means too long a period.

Good cop bottoms mixed with a smaller proportion of weavers' or winders' waste and possibly an amount of comber waste may spin 6's to 9's, and an increase in the proportion of comber waste will extend to higher counts, the finest counts of all taking nearly all comber waste.

The fact that a breaker card is more often supplied with two laps feeding together, lends itself naturally to using one lap of different quality from the other.

Mixing of 8000 lb. of Cotton Waste to Spin Counts about 6's or 7's.

Strips from card flats	200 lb.
Strips from cylinder and doffer	2500 ,,
Good droppings from beneath taker-in	2500 ,,
Fly of moderate quality	450 ,,
Dirty fly	2250 ,,
Waste from draw-frames	100 ,,
Total	8000 lb.

This mixing is simply given as being representative of the kind of procedure frequently adopted in condenser spinning from soft waste.

Soaping Apparatus.

Similar counts might be spun from cop-bottom and other hard waste, but the mixing might have some other stuff put into it to solidify it and give it, so to speak, a little back-bone.

Owing to the use of the soaping apparatus a mixing chiefly composed of broken-up hard waste may need to stand about two full days or forty-eight hours before using, to allow the soap spray to dry in. This soaping of the very fluffy hard waste stops it from flying about too much.

The soaping apparatus may consist of a small tank supplied with a mixture of boiled soft soap and water. A slowly revolving drum is more or less immersed in the soapy water and over the top of the drum a quickly revolving brush is always operating so as to distribute a fine spray of the mixture upon the opened waste as it is leaving the cop-bottom machine.

Messrs. Tatham of Rochdale give the following summary of three typical arrangements for cotton waste :—

"Cotton waste suitable for making into yarn is divided into two classes, one known as 'hard' and the other as 'soft'. The former includes cop-bottoms, ring-frame, reelers, and waste of a thready nature; the latter includes scutcher droppings, card fly, cylinder and flat strips, clearer laps, sweepings, comber waste, etc.

"In treating cotton waste to the best advantage it is essential to separate the better from the lower qualities, using the 'hard' and comber waste for the fine counts and the other kinds of 'soft' waste and sweepings for the lower counts.

"It will be as well to explain that one of two systems of machinery is generally adopted, either the 'condenser,' which is a modification of the woollen system, or the 'coiler' or 'preparation,' which is somewhat like the cotton system. The system adopted gives a distinct character to the yarn.

"The 'condenser' system is found to give best results where a full, level, and soft spun yarn is required; it is generally used as weft and is woven into sheetings, flannelettes, quilts, bed-covers, cotton blankets, sponge cloths, etc. It has the advantage that both 'hard' and 'soft' waste can be spun on this system, either separately or mixed together.

"The 'coiler' or 'preparation' system is most suitable where strength is of most importance, and where counts above 10's are wanted, 'hard' waste, comber and 'soft' waste, free from shell and leaf, are best suited. It is used as a weft in weaving into cloths to be printed or dyed, such as cretonnes, towels, etc.; it is also bundled into hanks and used by makers of ropes and twines. The cost of production is less than on the 'condenser' system, and the range of counts from the same plant is greater than on the 'condenser' system."

In order to guide intending purchasers, we draw attention below to three complete plants which have been found, from a long experience, to give good results, and which are working in many of the mills in this and other countries :—

No. 1 Plant.

"For spinning counts say 5's to 10's from 'hard' waste, including cop-bottoms, etc., or comber waste, on the 'condenser' system, to give a soft, full, and level yarn.

"Opening and cleaning or willowing machine or preparing machine when production is large.

"Breaking-up machine with self-acting soaping machine.

"(The above machines are wanted for hard waste only and not for comber waste.)

"Single-beater lap-forming scutching machine with hopper feeder.

"Single-breaking carding engine.

"Derby doubler.

"Single-finishing carding engine with condenser.

"Self-acting mule for condenser bobbins."

No. 2 Plant.

"For spinning counts say 3's to 16's from 'hard' waste, including cop-bottoms, etc., or comber waste, on the 'coiler' or 'preparation' system, to give a strong yarn.

"Opening and cleaning or willowing machine or preparing machine for large production.

"Breaking-up machine with self-acting soaping machine.

"(The above three machines are required only for hard waste and not for comber waste.)

"Single-beater lap-forming scutching machine with hopper feeder.

"Single-breaking carding engines.

"Derby doubler.

"Single-finishing carding engine with quadruple coiling and can motion.

"Slubbing frame.

"Self-acting mule for slubbing bobbins or ring frame."

No. 3 Plant.

"For spinning counts say 1's to 5's from 'soft' waste, including scutcher droppings, card fly, cylinder and flat strips, clearer laps, sweepings, etc., on the 'condenser' system, to give a level and full yarn.

"Improved willowing machine with patent lattice feeder and overhead delivery.

"Pickering machine.

"Single-beater lap-forming scutching machine with hopper feeder.

"(In small plants, or where coloured or lowest quality of waste is used, the scutcher may be dispensed with, and the breaking engines are then fitted with patent automatic feeders.)

"Single-breaking carding engine fed by scutcher laps and connected by patent Scotch feeder to single-finishing carding engine with ring doffer condenser or ditto, with leather tape condenser.

"Self-acting mule for condenser bobbins or cup-spinning machine suitable for counts up to 3's.

"'Crighton' opener for cleaning Indian, Chinese, or other short-stapled cotton."

Opening and Cleaning of Cotton Waste—General Remarks.

There is a very considerable choice and much variety in the blowing-room machinery for the treatment of cotton waste, brought about in the first instance by the many descriptions of cotton waste that are more or less pressed into service. Also by the fact that some users of cotton waste appear to think that any kind of machine with a beater and a fan in it will do for opening and cleaning cotton waste. The last thing some of these folks would think of doing would be to buy a new machine for the purpose, and pay full value, these being the words of a wadding manufacturer to the present writer. In like manner any kind of old building, not actually condemned as unsafe, has been deemed good enough for doing the work in. There are signs that both better machinery and better buildings will be used in the near future for the English cotton-waste trade, and the whole business placed on more up-to-date lines, and a greater proportion of the business kept in England, although it may not be as clean and nice as the ordinary processes of cotton spinning in many respects. It is the writer's opinion, however, that the allied processes of bleaching and dyeing of cotton waste in the first stage, or in one of the later stages will need to be more studied in this country in order to reap the full benefit of the home utilization of cotton waste to the greatest commercial advantage. It is found that cotton waste will bleach and dye well, even if these operations are left until the yarn is finally spun and twisted, since the twist is almost invariably kept down to a low amount, the thickness of the yarn providing sufficient strength for requirements with only a small proportion of twist.

In regard to the different types of machinery used in the earlier treatment of cotton waste it is important to remember that in making any inquiries from machine makers as regards new machines for cotton waste, it is very necessary that full particulars should be supplied by the inquirer. Especially should samples of materials to be treated be sent along with the inquiries, with full details as to the quantity of each kind or quality which would be used in making a mixing. A statement should also be made as to the range of counts expected to be spun, stating highest and lowest counts.

Productions.

Not long ago the writer heard a well-known mill manager—in charge of one of the largest cotton mills in England using Egyptian cotton—express astonishment at hearing a friend in the waste trade grumbling because his mules had only done $3\frac{1}{2}$ lb. of yarn per spindle during the current week. In this connexion it may be as well to state that 6 lb. or 7 lb. per spindle is quite feasible when spinning 3's to 4's counts upon a good waste mule, and running a good full week. About two pairs of such cotton-waste mules will turn out as much weight of yarn in one week as a mill of 40,000 or more spindles spinning from 80's to 100's counts of yarn from Egyptian cotton.

An eminent firm of cotton-waste machinery makers quote 22 lb. per spindle per week for counts $1\frac{3}{4}$'s, allowing sixty hours per week, and using a continuous spinning machine which only inserts a very small amount of twist per inch. If we were to assume 1000 of such spindles to produce 20 lb. each, this would give a weekly production of $1000 \times 20 = 20{,}000$ lb. If we compare this with a mule spinning from 80's to 100's, and assume the same to be producing $\frac{1}{4}$ lb. of yarn per spindle per week, we should require a mill of $20{,}000 \times 4 = 80{,}000$ spindles to give off the same weight of yarn per week.

Coming now to the earlier machines, we do not find any such extreme variations in production. It is a matter of fact that an opener or scutcher operating upon cotton waste may be taken as only giving about the same productions as would be given in treating raw cotton. As a matter of fact there are some kinds of waste which require more initial treatment than raw cotton, and productions are actually less. An eminent firm quotes the following productions: Cop bottom breaking-up machine once through only may be taken at 80 lb. per hour. Improved self-acting willow, 25,000 lb. per week. Crighton opener, with lattice feeder, but not making a lap, 42,000 lb. per week. Improved scutcher to make laps 49 in. wide, 12,000 lb. per week. Derby doubler, 6000 lb. per week. Each set of carding engines anything from 30 lb. per hour for about 1's to 2's down to 11 lb. per hour for about 10's counts.

The Willow.

One of the best-known machines in connexion with the initial treatment of cotton waste is the "willow," but in considering the special vogue of this machine we are at once confronted with the truth previously stated in the present article, that blow-room machinery must be adapted to the special class of waste to be treated. For example, the willow is by no means the best machine for the treatment of cop bottoms, and it is not necessary for treating clean soft waste. It is, however, of great service in cleaning dirty soft waste, such as scutcher droppings, the dirtiest fly, and sweepings. Many of our readers will remember that the Oldham willow formerly had a considerable use in regard to the preliminary opening of Indian and American cotton, being extensively used for a great many years in the Oldham district. In this particular connexion, however, it has practically become obsolete, or it has become altered and improved almost entirely out of recognition. The nearest approach to it that we have in the modern treatment of ordinary raw cotton is to be found in the "Buckley" opener, either as made by the original people, Taylor, Lang and Co., of Stalybridge, or as now also made by certain other machine makers. In the Oldham willow the beater or main cylinder utilized an upstroke, and the strong top cover was fitted with spikes or ribs, which helped to loosen the masses of cotton; it is well known that these are distinctive features of the "Buckley" opener, but in other respects the differences are great.

It will perhaps be best to give a brief description of the Oldham willow as used for ordinary cotton opening thirty to forty years ago. It consisted of a central cylinder, possibly 40 in. wide by 40 in. diameter, mounted on the main pulley shaft, and receiving motion directly from the line or counter-shaft. Extending across the periphery of this cylinder were several rows of strong, blunt spikes or teeth, and similar teeth or spikes were cast in the strong top cover. The lower portion of the cylinder was encased with a suitable grid, which was constructed to permit the escape of dirt, seeds, leaf, and stalk, or other objectionable material, while only permitting the escape of a small proportion of good fibre. The grid was constructed in two parts, the front part being hinged like a door and balanced by weighted cords or straps to permit ready opening and shutting. An exhaust fan was fitted to the machine to carry away the fine dust. The operation with hand-fed willows was somewhat as follows: The hinged grid was lowered, a sufficient quantity of cotton placed inside the beater chamber and upon the grid, and the grid was then closed again. The shutting of the hinged front grid brought the cotton within the range of action of the spikes of the beater, and these spikes dashed the cotton against the spiked and ribbed top cover, loosening the matted fibres, and liberating a good proportion of sand, dust and undesirable matter, which fell or was driven through the grating for the most part. Each portion of cotton was allowed to remain under this action for a short space of time—only a few seconds—and then the grid lowered, the opened mass of cotton released, and a fresh portion presented to the action of the cylinder. This was the simplest form of willow, and a great many years ago improved willows came out, in which the intermittent feed and delivery of cotton were controlled automatically. When it was improved upon, so as to become a cotton opener proper, the feed and delivery of cotton became continuous.

As previously stated the Oldham willow for opening ordinary raw cotton was equipped with automatic feeding and delivery of the cotton, prior to its relegation to the ranks of obsolete machines for raw cotton. We may here point out that the roller and clearer carding engine, which has almost become obsolete for ordinary cotton carding, is yet almost the only machine used for carding cotton waste. We have an absolute parallel in the case of the willow as a first machine for treating cotton waste. This willow is retained for the first treatment of dirty soft waste, such as scutcher droppings and sweepings, very much as it was left by the ordinary cotton trade.

Central Feature: Strong Spikes.

As made, for example, by either of the two well-known Oldham firms, for cotton-waste purposes, the central feature of the willow consists of a cylinder about 56 in. wide with the diameter of possibly 48 in. or 50 in. As examined by the present writer in a particular case this cylinder was fitted with very strong round teeth about 4 in. long, each tooth having an oval-shaped blunt top possibly $1\frac{1}{4}$ in. by 1 in. There might be possibly ten or so of these rows of spikes round the periphery of the cylinder, and the oval or egg-shaped blunt tops of the teeth were presented at different angles to the cotton in the different rows, so as to slightly vary the treatment. These teeth are entirely different from the ordinary flat, sharp teeth, now in general use upon the main cylinder of a cotton opener, whether such an opener be of the Crighton, Buckley, or downstroke type. There are two very distinct advantages in retaining these round blunt teeth in the willow as used for cotton waste; in the first place the teeth are the least likely of any in use to injure the fibres of cotton; in the second instance the soft waste will not cling and string to such teeth as much as it will to other well-known shapes of teeth. Yet, again, this kind of tooth is produced in a comparatively cheap manner.

For the initial treatment of hard waste such as cop-bottoms, the Oldham willow would be of very little service, as the teeth are too coarse and blunt, and there are altogether too few of them. A very large number of comparatively fine spikes or teeth are found best for the treatment of cop-bottoms, as we shall afterwards describe. There are also three or four rows of similar spikes or strong ribs forming part of the top cover, but set to come opposite the spaces between the teeth of the main cylinder to avoid contact of teeth, while permitting sufficiently close setting. Each portion of cotton is subjected to the action of these strong teeth for a number of cylinder revolutions before being released.

One Make of Willow.

The power required to drive such a machine, with about 350 revolutions per minute of main cylinder may reach something like 3 I.H.P., the driving pulleys on cylinder equalling 12 in. diameter by 4 in. by 4 in. wide for fast and loose pulleys respectively. No particular advance in construction will be noticed in connexion with the central cylinder, spiked top cover and upstroke of beater, but there are some special features in regard to the apparatus for automatically feeding and delivering the cotton.

In the case of Messrs. Platt Bros.' machine, it is equipped with a feed and delivery regulator, which distinctly tends to increase productions while retaining the intermittent feed and delivery, which latter permits a sufficiently prolonged operation of the cylinder teeth upon the cotton waste, a prolonged treatment not obtainable by any continuous feed and delivery, however slow. This willow is also fitted with an automatic arrangement for varying the time it may be deemed requisite to permit the different classes of cotton waste to remain under treatment by the main cylinder in order to obtain the required degree of cleanliness. It will be well understood that far more extreme variations in degree of cleanliness will be found in soft cotton waste than would ever be likely to occur in the case of any growth of absolutely raw cotton. The feed and delivery lattices travel at one uniform speed, and it must be understood that a modern willow for the treatment of cotton waste practically consists of the main cylinder, the requisite top covers and under-grips, a feed-lattice and a delivery lattice, and the requisite belts, wheels, pulleys, and levers for operating these parts. The feeding and discharging of the cotton occupy the same regulated and fixed time under all conditions in working while the intermittent motion applied to the rollers can be instantly adjusted, and thus allow the cotton waste to remain under treatment by the cylinder for such a time as may be deemed necessary. This willow is usually made with fan for down-draft, just as in the case of openers and scutchers for the treatment of ordinary raw cotton, but the willow can be arranged to work with an up-draft for the fan if required.

Another Make of Willow.

A special feature of Messrs. Asa Lees and Co.'s self-acting waste cleaner or willow consists in the lattice feed. The waste is placed upon an endless cloth belt, the full width of the machine, and this cloth belt travels slowly along, and deposits the waste into the feeding box. At required intervals, as regulated by the rack motion, the feeding box delivers the cotton waste into the cylinder chamber for the required opening and cleaning treatment. The duration of the intervals of feeding the cotton into the machine can be readily altered according to the class of waste under treatment, so that more or less opening and cleaning can be given as required. This particular arrangement ensures that the material shall be given to the cylinder over the whole width of the latter, and in this way the work and strain imposed upon the grids is more or less equalized. In some cases it has been found that undue pressure has been put on the centre due to more of the feed of cotton to the cylinder taking place at this position. The patent movable roller narrows the space between the cylinder and the face of the roller when the machine is delivering, and widens it when the machine is cleaning. With the ordinary roller there is always $\frac{5}{8}$ in. space, but the patent movable roller varies this from $1\frac{1}{2}$ in. down to $\frac{1}{4}$ in. The rack motion also is capable of very fine adjustment. If required, and specially ordered, this firm also supply a patent dirt remover, which moves the dirt, by means of a wrought-iron scroll, to the outside of the machine where it falls into a cast-iron box. Over this box is a revolving elevator, to which buckets are attached, and as the buckets pass round they take the dirt up and deliver it to the back of the machine into a bag or box. With this arrangement the machine is clear from dirt underneath, and no cleaning out by hand is required. There is also no accumulation of dirt to become mixed up with the cleaned cotton waste. As a general rule this machine is built for right-hand driving and with right-hand delivery. The rack motion and elevator are on the left hand, and the fan is usually arranged for a down-draft.

General Appearance of Willow.

Speaking generally about the Oldham willow principle of cleaning cotton waste, the machine at a glance appears to be all cylinder box, with a lattice to feed the waste, and another to deliver the same; the speed of fan may keep much the same as used for an ordinary cotton opener, say 1300 or 1400 revolutions per minute. In watching the machine work it is noted that possibly about 12 in. or 14 in. of the cotton waste from the feed lattice is presented to the cylinder. Then the feed is arrested while this portion of cotton is treated. Then the delivery door opens to permit exit of the cleaned cotton from cylinder chamber, and almost at the same moment a further length of dirty waste is fed to the cylinder. The opening and shutting of the delivery door may be marked with a certain amount of noise indicative of the event.

The willow, as made by Messrs. Tatham of Rochdale, is shown in figs. 12, 13 and 14. This machine (56 in. wide on cylinder), by loosening the cop-bottoms, shaking out the dust

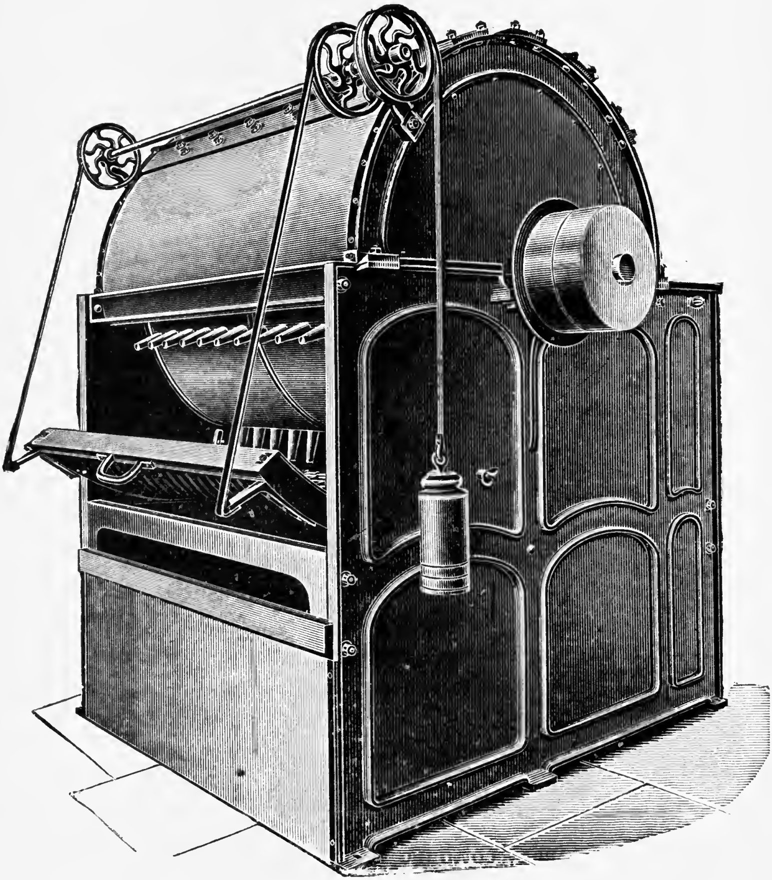


FIG. 12.—Willow, without Lattice Feed.

and taking out any foreign substance which may be in the waste, prepares same for the breaking-u p machine, and is advised where a production up to 20,000 lb. per week of fifty-six hours is required. Where a larger production is required the waste-preparing machine may be recommended in place of the above. The machine is constructed with a fan and back and front dust

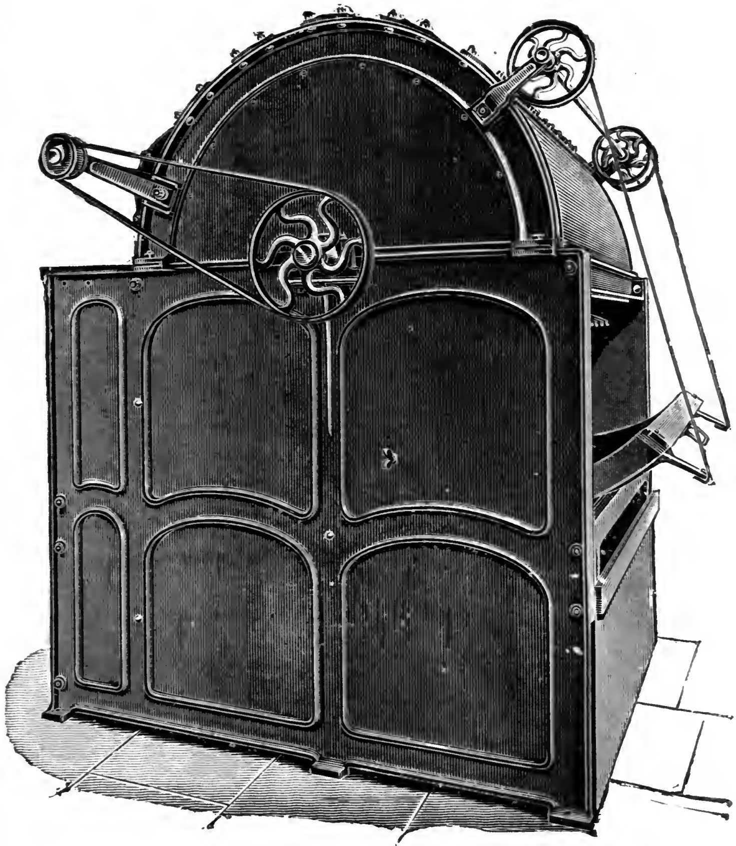


Fig. 13.—Willow, without Lattice Feed.

grids. Cylinder fitted with three wrought-iron hoops and with patent shields on cover.

Method of Working.—The waste is put into the machine by hand, the movable grid is closed, and then the revolving cylinder, fitted with six rows of strong teeth, throws the waste against the three rows of teeth attached to the bars in the cover. After a short interval the grid is opened and the waste is ready to be taken out.

Production.—About 20,000 lb. per week of fifty-six hours.

Dimensions, Weights, Speeds, etc.

Space Occupied.			Driving Pulleys.			Power Required.	Approximate Weights and Outside Measurement.		
Length.	Height.	Width.	Diam.	Width.	Speed per min.		Gross.	Net.	When Packed.
6 ft. 6 in.	7 ft. 6 in.	6 ft. 6 in.	14 in.	4 in.	320 revs.	about 2 I.H.P.	34 cwts.	27 cwts.	166 cub. ft.

The Willowing Machine, with Patent Lattice Feeder. (Fig. 14.)

(56 in. wide on cylinder.)

For opening and cleaning various kinds of soft cotton waste, including scutcher droppings, card fly, strips, etc.

Specification.—Patent lattice feeder, dust grids, fan for down-draft, patent movable roller, overhead delivery creeper, patent rack motion.

Special Features.—Patent lattice feeder ensures the waste being fed the full width of cylinder, thus equalizing the strain put on the grids.

Patent rack motion enables the attendant to regulate the length of time the waste is operated upon by the machine.

Extras.—Patent dirt remover. By means of a wrought-iron scroll revolving under the machine the dirt is removed into a cast-iron receptacle outside the machine. Over this is an elevator having an endless chain of buckets which lifts the dirt, carries same to the back of the machine, and deposits it into a box or bag, preventing an accumulation of dirt under the machine.

Production.—About 9000 lb. per week of fifty-six hours, varying according to the class of waste to be cleaned.

Note.—Whilst working, see that the projection on taking-in wheel comes one or two inches past the stop. After the wheel has gone out of gear the projection must fall against the stop.

Dimensions, Weights, Speeds, etc. (Fig. 14.)

Space Occupied.			Driving Pulleys.			Approximate Weights and Outside Measurement.		
Length.	Height.	Width.	Diam.	Revs. per min.	Power Required.	Gross.	Net.	When Packed.
10 ft. 6 in.	7 ft. 6 in.	7 ft.	14 in.	350.	about 3 I.H.P.	56 cwts.	47 cwts.	230 cub. ft.

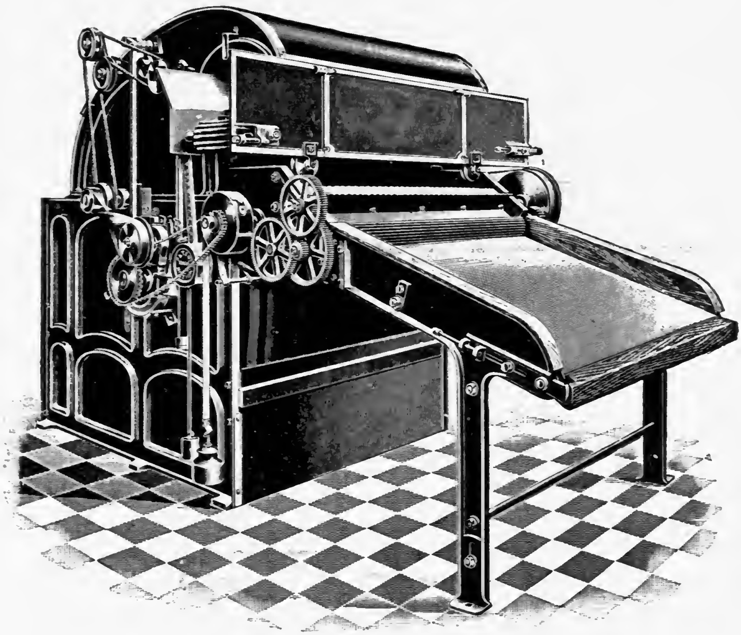


FIG. 14.—Willow, with Lattice Feed.

The Preparing Machine for Hard Waste. (Fig. 15.)

(40 in. or 48 in. wide.)

The waste is passed through this machine preparatory to being treated by the breaking-up machine.

The effect is to loosen or comb same so as to be more readily broken up and at the same time take out any foreign substance which may be in the waste. This machine may be preferable to the opening and cleaning or willowing machine where a large production is required. The machine is strongly designed and simple in construction It consists of hand feeder with hardwood lattice. One pair feed rollers covered with toothed disks. Iron cylinder covered with hard-wood lags fitted with strong steel teeth. Iron doffer covered with metal plates fitted with hardened and tempered steel teeth. Two iron calender rollers. Chain to drive the feeder. Strap-moving apparatus. Starting and stopping motion for doffer and feeder. Iron cover over cylinder and iron casing underneath fitted with door.

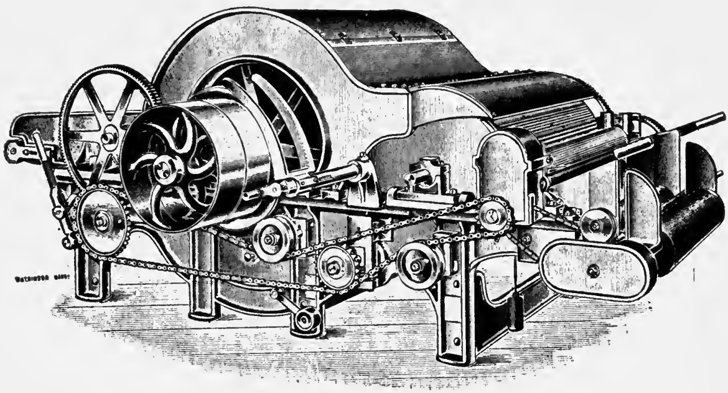


FIG. 15.—Preparing Machine for Hard Waste.

Illustration.—This shows at the delivery end a lap-forming apparatus which is not required for the purpose above described. Instead, the waste, after being stripped from the doffer by the calender rollers, falls on to the floor and is then ready to be taken to the breaking-up machines.

Production.—The approximate production per week of 56 hours for a machine 40 in. wide is 60,000 lb., and for a machine 48 in. wide 80,000 lb. This machine is made by Messrs. Tatham.

Breaking-up Machine. (See Fig. 16.)

This machine is used for opening into fibre cop-bottoms, reelers or other kinds of hard waste, and is constructed with various numbers of cylinders from one to eight to suit the quantity and class of waste to be dealt with, and floor space available.

Specification.— Machine with patent welded wrought-iron cylinders 21¼ in. wide over all, mounted with hard wood lags,

Dimensions, Weights, Speeds, etc.

Width of Machine.	Space Occupied.	Driving Pulleys.			Approx. Power Required.	Approximate Weights and Outside Measurement.		
		Diam.	Width.	Speed per min.		Gross.	Net.	When Packed.
40 in.	12 ft. 6 in. × 7 ft. 8 in. × 5 ft. 3 in.	24 in.	$6\frac{1}{2}$ in.	250 revs.	10 I.H.P.	94 cwts.	75 cwts.	450 cub. ft.
48 in.	12 ft. 6 in. × 8 ft. 4 in. × 5 ft. 3 in.	24 in.	7 in.	250 revs.	13 I.H.P.	101 cwts.	80 cwts.	500 cub. ft.

fitted with hand-forged steel teeth 19 in. wide on teeth. Steel cylinder shaft with hardened necks. Lattice feeding creeper 18 in. wide with patent treble-feed rollers to the first machine. Reversing motion to the feed rollers and lattice creeper. Patent bearings to all the feed rollers. Cages and cage gearing. Guards for the side and cross-shaft wheels, and for the wheels which drive the bottom cages. Improved self-oiling cylinder pedestals.

Special Features.—The patent welded wrought-iron cylinder is made with the shell, arms, and bosses, all of wrought-iron and welded. It is the only cylinder made with the shell in a continuous sheet welded together, and is the strongest, easiest to turn and safest and best for quick speeds and high production.

The self-oiling cylinder pedestals are of improved type, and are fitted with best brass steps. The collars of the cylinder shaft run inside the pedestals, and project into the oil reservoir at the bottom. The oil, after lubricating the shaft, runs back into the reservoir, thus preventing waste.

The patent bearings to the feed rollers have been recently introduced in order to increase the rigidity of the feed rollers in the middle; this prevents the material from being plucked through, holding same firmly whilst being opened by the cylinder.

Extras.—Self-acting soaping machine for adding to the broken-up waste a mixture of soap and water as it leaves the last or finishing cylinder. To card and spin successfully the addition of soap and water in correct proportions is essential. A breaking-up machine is shown in fig. 16.

Lap-forming machines attached to the delivery end of one, two, or three cylinder machines are frequently supplied to make laps, five of which can then be placed on to the feeding lattice of the succeeding breaking-up machine. This is a good system to adopt where length of room is limited.

Fan with cast-iron dust pipe for down-draft behind each cylinder, and with delivery lattice apparatus, for opening very dirty or dyed cotton waste.

Belt-shifting apparatus with loose driving pulley.

Wheel guards to the large wheels on feed rollers and to the wheels on delivery cage.

Lag covering for the cylinders can be supplied fitted with

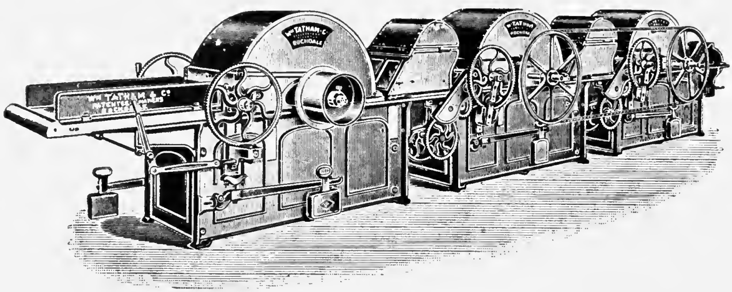


Fig. 16.—Cop-bottom Machine.

flat and headed steel teeth or round polished needle-pointed steel teeth.

Production.—Where a quantity of 5000 lb. and upwards of thread waste, say up to 40's counts, is to be treated per week of fifty-six hours, it is advisable to have the machine of six cylinders, and one passage of the waste through the machine is generally sufficient. The production averages from 5000 to 6000 lb. per week of fifty-six hours. If machines of less number of cylinders are installed the production will be correspondingly less.

Driving Pulleys.—Driving pulleys 12 in. diameter by 6 in. wide for one cylinder, or 12 in. diameter by 8 in. wide when one belt is made to drive two cylinders; in this case the second is driven by a side rope from belt-driven cylinder. It is not advised to have fast and loose pulleys on cylinder shaft.

Speed of driving pulleys, 800 revolutions per minute.

Power required.—About five indicated horse per cylinder.

Floor Space Occupied, Approximate Weights and Measurements are as follows :—

Cylinders.	Machines without Fans.					Machines with Fans, Dust Pipes, and Delivery Apparatus.				
	Gross.	Net.	Outside Cubic Measurement when Packed.	Extreme Length.	Extreme Width.	Gross.	Net.	Outside Cubic Measurement when Packed.	Extreme Length.	Extreme Width.
	Cwts.	Cwts.	Cub. Ft.	Ft. In.	Ft. In.	Cwts.	Cwts.	Cub. Ft.	Ft. In.	Ft. In.
1 cylinder	29	23	230	9 3	4 9	41	34	297	13 3	4 9
2 ,,	56	45	410	15 10	4 9	73	60	510	19 10	4 9
3 ,,	82	67	610	22 5	4 9	105	86	720	26 5	4 9
4 ,,	110	90	810	29 0	4 9	137	112	930	33 0	4 9
5 ,,	138	112	1010	35 7	4 9	169	138	1140	39 7	4 9
6 ,,	164	133	1210	42 2	4 9	201	164	1350	46 2	4 9
7 ,,	191	155	1410	48 9	4 9	233	190	1560	52 9	4 9
8 ,,	220	177	1610	55 4	4 9	265	216	1770	59 4	4 9

A soaping machine weighs $4\frac{3}{4}$ cwts. gross, $2\frac{3}{4}$ cwts. net. Outside cubic measurement, when packed, 39 ft. 10 in., and adds 3 ft. 8 in. to the breaking-up machine.

A lap-forming machine weighs 25 cwts. gross, 21 cwts. net. Outside cubic measurement, when packed, 54 ft., and adds 3 ft. 10 in. to the breaking-up machine.

Pickering Machine of One Cylinder (Tatham's). (See Fig. 17.)

Soft waste, including card fly, strips, scutcher droppings, sweepings, stocking laps, etc., after being made into a mixing are combed out. Better mixed and prepared for the scutcher, one passage through this machine is generally sufficient.

Specification.—Patent welded wrought-iron cylinder mounted with hardwood lags fitted with hand-forged steel teeth. Steel cylinder shaft with hardened necks. Lattice feeding creeper. Feeder specially adapted for soft waste. Reversing motion to the feed rollers and lattice creeper. Cage and cage gearing. Guards to side and cross-shaft wheels. Improved self-oiling cylinder pedestals.

The makers advise two cylinders where there is a good proportion of threads in the waste.

Special Features.—The patent welded wrought-iron cylinder is made with the shell, arms and bosses all of wrought-iron and welded. It is the only cylinder made with the shell in a continuous sheet welded together, and is the strongest, easiest to turn, and safest and best for quick speeds and high production.

The self-oiling cylinder pedestals are of an improved type and are fitted with best brass steps. The collars of the cylinder shaft run inside the pedestals and project into the oil reservoir at the bottom. The oil, after lubricating the shaft, runs back into the reservoir, thus preventing waste.

Extras.—Self-acting soaping machine for adding to the broken-up waste a mixture of soap and water as it leaves the last or finishing cylinder. To card and spin successfully the addition of soap and water in correct proportions is essential.

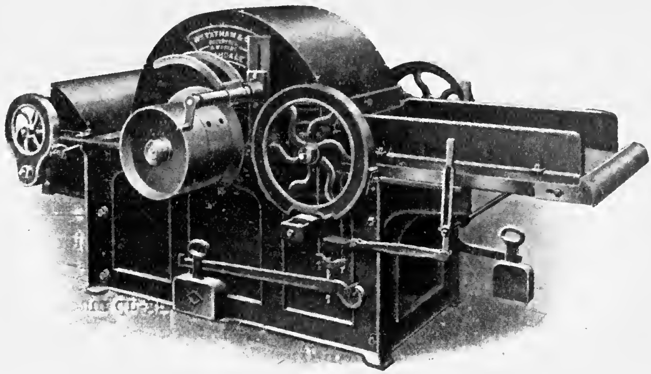


FIG. 17.—Pickering Machine of One Cylinder.

Fan with cast-iron dust pipe for down-draft behind each cylinder and with delivery lattice apparatus for opening very dirty or dyed cotton-waste.

Belt-shifting apparatus with loose driving pulley.

Wheel guards to large wheels on feed rollers and on cage.

Illustration.—The wheel guards over the large wheels on feed rollers and over wheels on delivery cage are only supplied if specially ordered.

Production.—The waste is passed once through the machine, and the production of a single machine 21¼ in. wide on cylinder is about 6000 lb. per week of fifty-six hours, the production of the wider machines being in proportion.

Driving Pulleys.—12 in. by 6 in. for one cylinder, or 12 in.

by 8 in. for two cylinders, the second cylinder being driven by side rope from belt-driven cylinder.

Speed of driving pulleys about 800 revolutions per minute.

Power Required.—About four indicated horse per cylinder.

One-Cylinder Machine.						Two-Cylinder Machine.				
Width on Cylinder.	Space Occupied.		Approximate Weights and Outside Measurement.			Space Occupied.		Approximate Weights and Outside Measurement.		
In.	Length. Ft. In.	Width. Ft. In.	Gross. Cwts.	Net. Cwts.	When Packed. Cub. Ft.	Length. Ft. In.	Width. Ft. In.	Gross. Cwts.	Net. Cwts.	When Packed. Cub. Ft.
21¼	9 3	4 9	29	23	230	15 10	4 9	56	45	410
28	9 3	5 4	32	25	262	15 10	5 4	62	49	470
34	9 3	5 10	35	27	295	15 10	5 10	68	53	530

A soaping machine weighs 4¾ cwts. gross, 2¾ cwts. net, outside cubic measurement when packed 39 ft. 10 in., and adds 3 ft. 8 in. to the Pickering machine.

Spiked Cylinders. (See Fig. 17*a.*)

Perhaps the most distinguishing feature of any machine specially designed for breaking up any cotton waste into which the final spinning twist has been imparted, consists in using from one to eight cylinders built up of comparatively fine spikes or

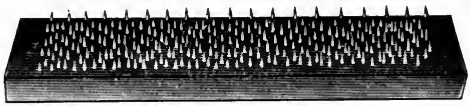


FIG. 17*a.*—Spiked Cylinders.

teeth. Harder the waste may be, and more it requires opening, the more cylinders the cotton is treated by. For example, a good machine for cop bottoms contains six cylinders all in one machine, and the cotton is treated by all these cylinders with only once feeding and one delivery. In some cases the same waste may be passed twice through a machine containing only three cylinders. These spiked cylinders, with but slight modification, appear equally suitable for treating woollen and worsted card waste, flax, hemp, and jute waste, etc. It is not considered to damage the fibre much, or at any rate to but a slight extent, the main objects being to lose the dirt and to thoroughly open out the fibrous material. Cop bottoms and hard cotton waste generally speaking are very clean, and need little attention in the way of losing dirt, but require the maximum amount of treatment for opening and re-fibring. A description of these cylinders as made by Messrs. Hetherington will convey the best idea of the special features desired in this type of machine. "The cylinders are of wrought iron, combining strength with lightness. They are turned all over the surface, and covered with beech lags, containing in the aggregate 10,000 to 11,000 teeth. These may be either black hand-forged cast-steel teeth, polished round steel teeth, or Hardings' patent flat pins. The cylinder shafts are of steel, and revolve in automatically self-lubricating pedestals, fitted with gun-metal steps, the cages are of cross-woven wire, jointed without solder, therefore not affected by heat, and with iron bound on the edges. The feed rollers are provided with a reversing motion, so that in case an accident should occur, or be apprehended, they can be instantly reversed, preventing the entry of additional material, and arresting the further passage of that already in the machine; and a motion is provided for stopping all the parts other than the cylinders."

Weighting of Feed Rollers.

A special detail of some importance in connexion with the foregoing machine consists in the method of weighting the feed rollers. The method in use for many years past on waste openers and on ordinary cotton openers and scutchers also, has been to apply the weight to the ends of the rollers outside the framing. In the above case the weighting is applied to the feed rollers inside the framing, and this brings the pressure as near as possible to the point where the rollers bite the cotton waste. This feature is of importance, inasmuch as it tends to prevent "plucking" of the cotton through the rollers, an evil which has often been a serious defect on openers, scutchers, and cards, either in ordinary cotton treatment, or in the treatment of cotton waste. In this connexion makers and users of the machines have to choose between the lesser of two or three evils. Sufficient rigidity of the rollers to prevent plucking could be obtained by making the rollers of larger diameter, but in the case of the actual striking point of last roller, large diameters place the settings too wide apart. Yet again, narrow machines will give shorter rollers, which are more rigid than the longer ones, but the narrow machines are of limited production. Long, thin, feed rollers are in a sense necessary, and yet they frequently give or permit plucking of the cotton, and hence the probable value of bringing the weights inside the frame ends. We are of opinion that this is a sound principle, and worthy of extended adoption either in openers, scutchers, or cards, or in ordinary cotton treatment as well as with cotton waste.

Preparation System.

The preparation system being a kind of cross between ordinary cotton spinning and condenser spinning, lends itself naturally to making a harder twisted yarn, spun either on a mule with draft rollers or else on a ring-frame, the yarn being more suitable for warps than for weft. The ring-frame is not much used in the spinning of cotton waste yarns.

The Willow.

The distinctive features of the Willow are: (1) the use of a limited number of strong, blunt, nearly round teeth or spikes, 3 in. to 4 in. long and from $\frac{5}{8}$ in. to 1 in. or so diameter at the top; (2) continued treatment by the beater before delivery, the feed and delivery being intermittent for the purpose, whereas in other opening machines the feed, the treatment, and the delivery are continuous.

Cop-bottom Machine.

By contrast, the treatment of the cotton in the picking or cop-bottom machine is by a very large number of very fine teeth infinitely more searching among the fibrous material. By a clutch and bevel arrangement attached to the feeding end of the machine, the latter may be stopped or reversed as required. Each steel tooth or spike about $\frac{1}{2}$ in. long and $\frac{3}{16}$ in. diameter.

Blow-room Fires.

It is of even more importance to isolate the room wherein the opening is done in cotton-waste mills than in the case of ordinary cotton spinning, and numberless fires have occurred through hard substances getting to some of the beaters or cylinders and striking fire, many fires also occurring through friction, or through waste lapping round the feed-rollers. It is inadvisable to have the mixings of cotton waste stored in the room where the picking and opening are done. Hand fire extinguishers of the kind that start off when turned upside down should be ready for fires at the start. Water buckets and hose pipes should be always handy in the breaking-up room, which should be as fire-proof as convenient and have provision for the water draining away readily after a fire.

Heavy Driving.

The six or eight cylinder cop-bottom or hard-waste breaking machines especially are very heavy to drive, and other initial machines are by no means light, so that the opening room should be as near the driving power as may be convenient.

Running each cylinder at possibly 800 revolutions per minute, a machine of the largest character, i.e. eight cylinders, may require as much as 38 I.H.P. The practice of having only a fast pulley on such a machine and having to stop the driving engine in order to stop the breaker, is not to be commended, and it is better to use fast and loose pulleys as on an ordinary opener or scutcher.

One method of distributing the driving in the case of a six or eight cylinder machine is to drive down by a wide belt to each alternate cylinder and to drive each intervening cylinder from a belt-driven one by means of an endless band.

Between the fluted feed rollers and each cylinder there is often placed a steel full-width plate, somewhat after the style of the mote-knife on a carding engine.

The material being driven on to the edge of this cutting plate is more or less broken or cut up, the shape, angle and sharpness of the blade being subject to some amount of variation. The cotton should be kept in good condition and well set to prevent hard, thready waste ends. In some cases the cylinders are reversed after several weeks' running.

The Soaper. (See Figs. 18 and 19.)

As stated, a soaping arrangement is often attached to the delivery end of a cop-bottom or hard-waste breaking machine. The object of the soaper is to constantly spray a mixture of soap and water upon the opened waste that is being taken up the delivery lattice. The soap-water is put into a small tank which contains a roller of wood or other material, partially immersed in the water and driven slowly round from one of the cages. Naturally the roller picks up some of the soap-water and this is continuously brushed off in a fine spray by a brush quickly revolved from the cylinder, the soap-water spraying on the waste. This soap-water solidifies the waste and prevents the latter from flying about, but the mixing of soaped waste should stand from one to two days before using, to secure uniform saturation.

Sometimes other kinds of waste in addition to cop-bottom or

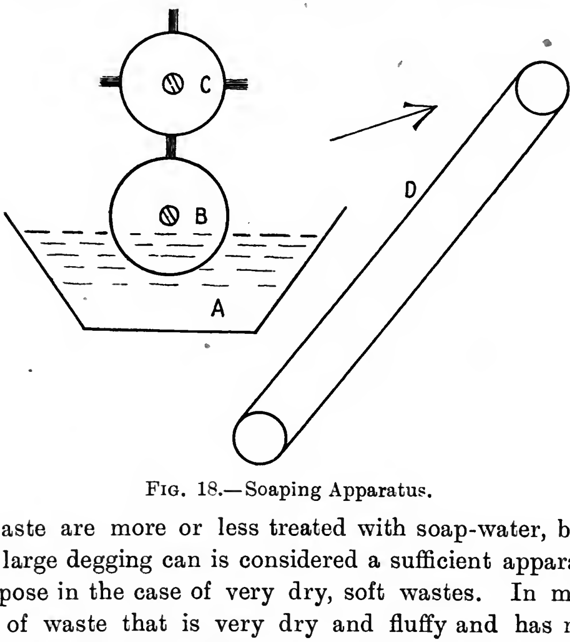


FIG. 18.—Soaping Apparatus.

hard waste are more or less treated with soap-water, but more often a large degging can is considered a sufficient apparatus for the purpose in the case of very dry, soft wastes. In making a mixing of waste that is very dry and fluffy and has not been treated by a soaping machine, every layer of waste may be soap-watered by the degging can before another layer is put on. The soap-mixture may consist of about 1 lb. of soft soap (or its equivalent) put to a gallon or more of water and sufficiently boiled to obtain a thorough mixture.

If a soaping machine be used, the boiling or mixing tank may be connected by a pipe to the small tank of the soaper, the latter being possibly fitted with a ball-top to automatically control the refilling.

Such is the fluffy, light character of the cotton waste as it leaves a six-cylinder cop-bottom breaker, that it is often deemed necessary to spray it with soapy water as it leaves the machine. A soaping machine is applied when ordered, and is attached to the delivery end of the breaking-up machine. The soapy water tends not only to make the waste stick better together, but also slightly adds to the weight. The soaping arrangement stops the waste from flying about, but the waste should afterwards stand for a day and a night before using at the next machine, to permit a reasonable amount of re-drying. The soaping apparatus is not indispensable to one of these hard-waste breakers, but is often useful, and must be ordered and paid for as an extra. In fig. 18 A is the tank of soap-water, B the soap-roller, C the spray-brush, D the delivery lattice.

Fig. 19 shows a Pickering machine with a soaper attached.

Single Cylinder, Three Cylinders, and Six Cylinders.

These beech lag and spiked cylinders are used in a horizontal direction, usually have a down-stroke, and may have any speed up to from 750 to 850 revolutions per minute. As stated, it is possible to make machines with only one cylinder, with as many as eight cylinders, or with any number between these extremes of one and eight. In a single cylinder machine the hard waste to be opened is placed upon a feed lattice in the usual way, and then passes between three fluted rollers to the cylinder. It is not essential that a fan be used in this one-cylinder machine, as the air current created by the quick revolution of the cylinder will be found sufficient to carry the cotton to the wire cage from whence the cotton is delivered behind the machine. A one-cylinder machine might occupy a floor space of 12 ft. 2½ in. by 6 ft. Driving pulleys 12 in. by 6 in. wide. Speed of cylinder about 800 revolutions per minute. There might be used a strap driving counter-shaft from main shaft 5½ in. width, the length depending upon local circumstances. A strap 5 in. wide might be used to drive the cylinder from the counter-shaft, the high speed of 800 revolutions per minute making it advisable to use a counter-shaft. To drive cross-shaft from cylinder use a belt 8 ft. 10 in. length by 2 in. wide. To drive the slow motion shaft from cross-shaft use a belt 11 ft. 6 in. length by 1½ in. width. The brush of soaping apparatus from the cylinder may take a belt 10 ft. long by

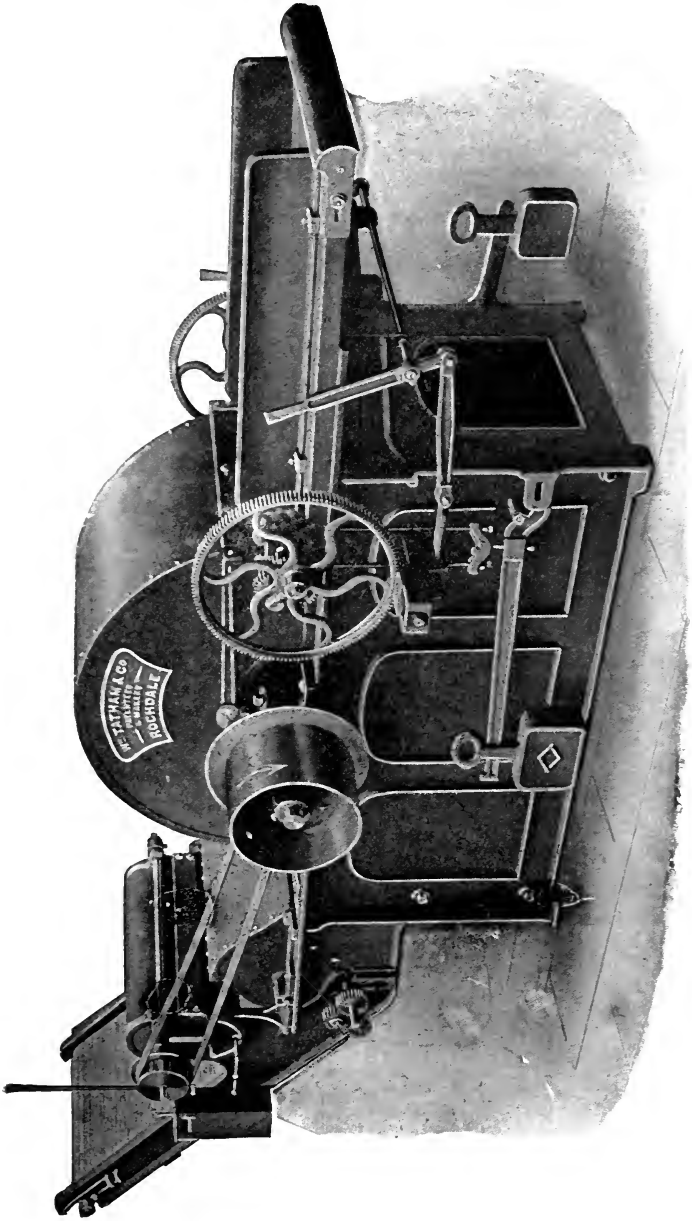


Fig. 19.—Pickering Machine, with Soaper attached.

$1\frac{1}{2}$ in. wide. The rope for driving the roller of soaping apparatus from delivery cage may be 3 ft. 8 in. long by $\frac{3}{8}$ in. diameter. According to the number of cylinders employed in a machine there would be certain of above belts duplicated.

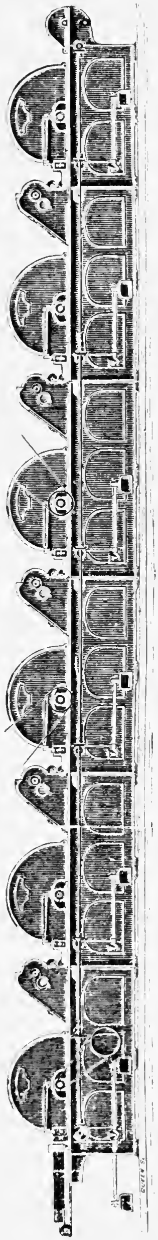


Fig. 20.—Six-Cylinder Machine without Fans.

Six-Cylinder Machine. (See Fig. 20.)

There are several important benefits resulting from using one machine with six cylinders rather than passing the same waste through a machine with one to three cylinders two or more times. If the waste concern is of any size, so as to provide sufficient and full work for the six-cylinder machine, the latter is to be strongly recommended, and especially if the hard waste is fine or very hard twisted, a machine of even eight cylinders is often deemed advisable. It has been found that by using single-cylinder machines, and passing the same waste six times through, about 600 lb. of waste per full working day could be treated; but by using a six-cylinder machine, 1200 lb. per day may be opened and cleaned sufficiently. One man can readily attend altogether to the six-cylinder machine, and in this way a distinct saving in cost of labour is obtained. Any of these machines can be made to work, either with or without fans, although the use of fans will help to carry away the dust if the cotton waste is very dirty. Cop-bottom waste, however, is usually quite clean, unless it has been thrown amongst the sweepings. In a six-cylinder machine, the material, after leaving the first cylinder, passes over the wire cages to a pair of heavy rollers, where it is compressed and then conducted, automatically, to the feed rollers of the second cylinder and similarly to all the other cylinders. It is to be noted that it is common to drive all the six cylinders at the same speed, say at the rate of 800 revolutions per minute. In its passage from cylinder to cylinder the cotton waste acquires an evenness that cannot be obtained from repeated hand-feeding, and this is all in the direction of obtaining a superior quality of treatment of the waste. There is also an increase in production due to the increase in speed given to the feed rollers at each succeeding cylinder. An idea of the six-cylinder machine as constructed by an eminent firm will be gathered from fig. 20.

Cotton Waste—System of Machines.

Previously we have given a description of the Oldham willow as extensively used for the first opening of dirty soft waste. Complete systems of machines for treating such waste differ with different firms, but a particular system much in evidence is recapitulated below:—

1. Improved Oldham willow such as described.
2. Single scutcher, either of the ordinary cotton type or containing certain special features, such as hopper feeders on the one hand, or extra beaters on the other hand.
3. Breaker card supplied with two full width laps in order to get uniform work and delivery by means of Scotch roper.
4. Finisher card having the waste fed to it on the Scotch feed principle, and equipped with either a ring-doffer condenser, or a leather tape condenser.
5. Waste mule supplied with long condenser bobbins of cotton waste strands. As an alternative a continuous waste spinning frame may be used for producing the very coarse yarn spun out of dirty soft waste.

The Scutcher.

Although the method of applying a hopper feeder to the breaker carding engine, and supplying this with loose cotton is, at the present time being strongly advocated by some people, it is yet a very common practice to make the cotton waste into laps on the scutcher. Such a scutcher can be made of any suitable width, and usually this width is considerable, reaching possibly 48 in. or 49 in. The piano feed regulator may be either left off or it may be applied if desired, much on the same lines as for an ordinary cotton scutcher. It is best to have the pedal levers pivoted on knife edges, as these give a very sensitive action, and are probably less liable to be adversely affected by the dust and fly, which cannot be entirely prevented from getting to these parts. It is probable also that the modern principle of dispensing with the bowl box of the piano motion will be found particularly suitable for a cotton waste scutcher, since the newer lever systems are far less liable to be adversely affected with dust and fly than any motion in which the bowl box and sliding bowls are retained. In some cases just one ordinary scutcher beater only is used, and is built with two or three blades, just according to order; in either case each blade is planed on both edges, so that when one edge becomes worn the beater may be turned end over end, so that it is reversed in its bearings, and unworn edges are put into action. Naturally the framing should be strong in order to treat cotton waste without excessive breakage of parts, and all gearing should be well covered in. It is also good practice to have the beater pedestals working in self-oiling bearings.

Extra Beaters. (See Fig. 21.)

As previously stated, practice varies greatly in regard to the machines used for the blowing-room treatment of cotton waste, and scutchers, for example, may be built with just one beater as described, or double scutchers may be used in which there are two blade beaters, or even three if desired.

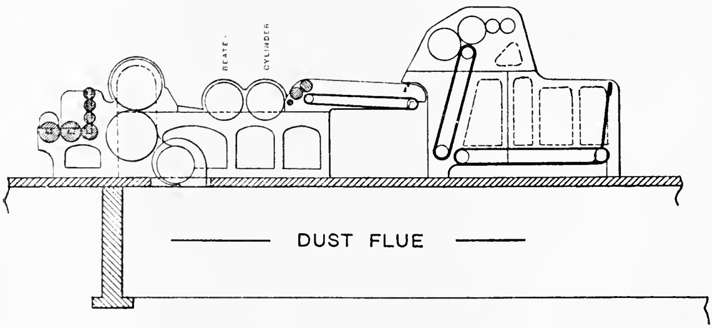


Fig. 21.—Scutcher for Cotton Waste.

Messrs. Platt, for example, make a special form of scutcher in which there are two beaters placed together, but only one fan and one pair of cages are used. In passing from the feed lattice to the first beater or picker cylinder the cotton waste is guided by rather large diameter fluted press rollers, and held down to the smaller diameter feed roller. The waste passes between the feed roller and the noses or short ends of pedal levers which form part of the piano feed regulator. As stated, the first beater is more in the nature of a spiked cylinder, and contains a large number of closely set small steel spikes, which give a most thorough separation and opening out of the cotton waste, somewhat after the style of the well-known Kirchner or carding beater. It is fair to assume, indeed, that the action of this picker beater more resembles that of the licker-in of a carding engine than that of a blade beater. However, in this case both kinds of treatment are obtained because the blade beater is right close up to the picker beater, with no intervening feed rollers, cages, or other parts. As a matter of fact, one single large curved top cover is made to fit over the top of both beaters. There is a somewhat peculiar shroud or casing to each blade beater to prevent the soft cotton waste from stringing round and adhering to the blade, thus assisting the work of the stripping plate. It is perfectly obvious that this double and varied treatment will be very effective in opening and cleaning soft dirty waste. Following the second or blade beater there are the usual two cages and fan, followed again by four calendars and the other lap-forming parts. The driving pulleys on the ends of spiked cylinder and blade beater are recommended at 12 in. diameter by 4 in. width, giving a speed of 1075 revolutions per minute. A scutcher of this type, with both cylinder and beater, may absorb about 5 I.H.P. when working without hopper feeder.

To secure the best results, both in regard to cleaning, opening, and for making regular laps, it is best to apply a hopper feeder to this double beater scutcher, although this takes up a little more space, and will absorb more in first cost. The hopper feeder has well proved itself as a most efficient attachment to either opener or scutcher which is fed with cotton in a loose state, since it will treat the desired weight of cotton or cotton waste most effectively without injury to the fibre, and with a minimum amount of attention. In the case under notice the pulleys to be placed on the stripping cylinder of the hopper feeder are fixed at 10 in. diameter by 3 in. by 3 in. wide, and the speed about 300 revolutions per minute.

Cop-bottom Breaking Machine.

For the early treatment of cop bottoms or any hard waste, the Oldham willow and other machines with ordinary beaters and cylinders containing porcupine knives or full-width blades, do not appear to give a sufficiently individualized treatment of the fibres.

We may remind our readers that the term "hard waste" is applied in a general way to all waste into which the final spinning twist has been introduced, and which, therefore, is of a much closer and harder nature than any waste made at any of the machines coming before the mule or ring frame. Cop bottoms, spinners' hand waste, reelers' waste, winders' waste, doublers' waste, thrums from slashers, and weavers' waste, all come under the general expression of hard waste. Cop bottoms form probably by far the largest class of this kind of waste, and the first hard waste breaking machines are often termed cop-bottom machines. Such machines will most effectively break up into a soft fleecy mass almost any kind of hard cotton waste, which latter may afterwards be re-spun and manufactured into sheetings, cheap towels, cotton blankets, and flannelettes, or be converted into wadding, gun cotton, etc.

There are various makers of these hard-waste breakers, and since their introduction various detailed improvements have been discovered and applied by one machine-making firm or another. The makers claim that the materials used in the construction of the machines are of the best, and that care is taken to have every part well finished and well fitted. It is claimed that such machines are also effective for cleaning opener and scutcher droppings, although we have described the Oldham willow as being an excellent machine for such waste. The use of these machines is not confined to the cotton-waste trade, but they may be also used for treating woollen and worsted waste, flax, hemp, and jute waste, or in short almost any kind of waste produced from any of the leading textile fibres, excepting perhaps the more expensive silk fibre.

Single-beater Lap-forming Scutching Machine, with Hopper Feeder. (See Fig. 22.)

These machines are especially constructed for working waste, and prepare the laps for the breaking carding engine.

Specification.—Hopper feeder with upright spiked lattice, and with improved grid arrangement. Single scutcher with patent feed regulator. Improved pedal motion. Consolidated lap end with four compression rollers. Two bladed beater. Fan for down-draft. Improved ring pedestals for beater and fan. Positive knocking-off motion. Patent lap roller.

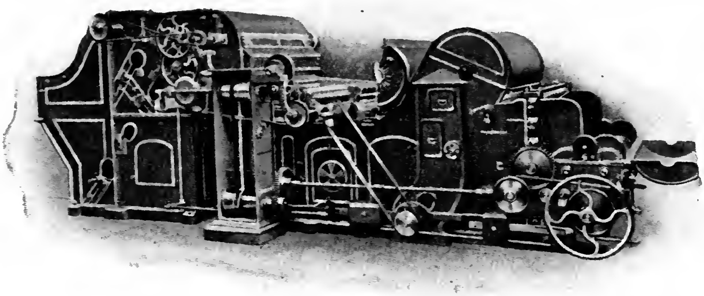


FIG. 22.—Tatham's Scutcher with Hopper Feeder.

Special Features.

The hopper feeder is driven through the cone drums on the scutcher, ensuring an even and regular fleece.

The cone drums are of large diameter, ensuring an effective drive.

Production.—About 20,000 lb. per week of fifty-six hours.

Dimensions, Weights, Speeds, etc.

Space Occupied.		Driving Pulleys.		Approximate Weights and Outside Measurement.		
Length.	Width.	Diam.	Speed per min.	Gross.	Net.	When Packed.
19 ft. 6 in.	7 ft. 6 in.	12 in. on Beater.	1300 to 1400 revs.	155 cwts.	106 cwts.	397 cub. ft.

The Scutcher Bars and Lap-licking.

The scutcher used in the cotton-waste business is usually very much on the usual cotton lines but the grate bars beneath the scutcher will probably be set very close together on account of the short nature of the material operated upon. In some cases of clean waste indeed blank plates are placed beneath the beater with few if any grate bars, so that the benefit of the opening effect of beater may be obtained without losing any of the material as droppings.

Cotton waste is often very liable to licking owing to its soft, short nature, and especially is this true of broken-up hard waste treated with the soaping apparatus. For this reason it is a very common practice to use a creel in front of the calenders containing waste yarn or slubbing which runs in with the lap and helps to keep each layer to itself. This involves a certain expense and labour in keeping the creel bobbins going.

There is, however, another serious evil attendant upon this practice, viz. that of marking the wire on the carding engine, and often considerable damage has been done in this connexion. An arrangement, however, has been devised by which a number of wires act on the cotton sheet near the cages, and stroke the lap sheet into a more solid condition, thus diminishing the lap-licking evil.

A regular lap is quite as important in the manipulation of cotton waste by the condenser system as it is in ordinary cotton-spinning, since there are draw-frames to make uniform slivers. For this reason when cotton is fed loosely to the scutcher—a very common occurrence—it is usual to apply a hopper feeder to the scutcher. As a matter of fact—apart from the question of expense it is probably a still better practice to use two hopper feeds to the scutcher, the second one being equipped with a regulator which keeps the cotton in the feed box at something like a uniform height. In cases of a very small plant the scutcher may be omitted altogether, and each card fitted with a hopper, but if there are say half a dozen or more breaker cards it will probably pay to use the scutcher with hopper, and feed the breaker cards with laps of cotton waste. In such a case a girl may easily attend to the scutcher.

Although scutchers for cotton waste sometimes contain beaters or cylinders of a special character, such as picker cylinders, the more usual practice is to employ an ordinary double or treble-blade beater. Productions much as for cotton, say 8000 to 14,000 lb. per week. It is much more satisfactory to have a hopper feeder attached to the scutcher, as hand-feeding and spreading is likely to give variations in the weight per yard of the laps.

The link or tripod regulator is the best for such a scutcher, on account of the amount of fly and dirt, since these arrangements do not need the bowl box and its friction bowls. Such distinctive features as beater blades, shrouded to prevent cotton sticking, cross-cut feed-rollers to give a good grip on the short fibre, fluted calendar rollers, special creels for holding cops from which the yarn is run off into the lap to prevent lap-licking—are more or less found on scutchers for cotton waste.

Attention to oiling and cleaning, the production of good selvedges on the laps, good exhaust flues for the dust, good belts and ropes kept under proper tension are as important in these scutchers for cotton waste as in those for ordinary raw cotton. It is also best to have down-drafts with the dust cellar below the breaking room.

Hard Ends.

One of the most frequent evils in using cop-bottom or other hard waste consists in hard ends, or portions of thready waste not sufficiently broken up. A waste-spinner naturally dislikes these hard ends as they prevent drafting-out and cause many broken ends. Possible causes are cylinders in the cop-bottom machine out of order, or under-speeded, or slack belts and ropes for driving the cylinders, or uneven feeding of the waste. Insufficient gripping of the cotton by the feed-rollers at this machine may lead to plucking the waste through in lumps.

The Crighton.

The ordinary single Crighton is sometimes used instead of the willow for soft waste and is best fitted with an inner oil chamber to the footstep of the Crighton shaft, this being surrounded by a water-bath to keep the footstep cool. Also the Crighton is best fitted with a grid which can be raised or lowered as required, so as to put the bars closer to or farther from the beater. This particular feature is helping the Crighton to be adopted to good Egyptian cotton in ordinary fine spinning, since it helps in preventing cat-tailing of the cotton or stringing the same.

CHAPTER IV.

THE CARDING OF COTTON WASTE.

There are very material differences between a modern carding engine used for ordinary cotton carding and those used for the carding of cotton waste. In a general way the most noticeable difference is seen in the fact that the revolving flat card is now almost universally adopted for ordinary cotton spinning, whereas the roller and clearer card still reigns pre-eminent for the carding of cotton waste. The more open treatment of the cotton fibres in the roller and clearer card, the turning over and mixing of the fibres by the action of the rollers and clearers, the ability to pass comparatively heavy bodies of fibres through the roller card, and also its ability to treat cotton as much as required without taking out much waste, are features which have helped to maintain the supremacy of the roller and clearer card for cotton waste, long after it has completely lost its hold in the treatment of raw cotton in the ordinary cotton spinning and carding processes.

Rollers and Clearers.

It will be as well if we just remind our readers of the distinctive feature of this particular style of carding engine. Instead of flats being placed near the upper half of the cylinder, a series of what are termed rollers and clearers are placed in this position, a roller and a clearer necessarily working in partnership with each other, and six or seven pairs of these rollers and clearers filling up all the available space. Each roller or worker has a comparatively slow revolution, so that its surface speed might average 28 or 30 ft. per minute, while its companion clearer, although of smaller diameter, has the much higher surface speed of possibly 400 ft. per minute. In waste carding, owing to their comparatively high number of revolutions, and their small diameter, the clearers are often made of wrought-iron tubing, each of the six clearers having a diameter of possibly $2\frac{1}{4}$ in. or $2\frac{1}{2}$ in.

They are usually driven directly from the cylinder by a long endless belt, the driving pulley on cylinder often reaching 30 in. or more in diameter. Assuming the cylinder to make 150 revolutions per minute, the diameter of driving pulley on cylinder to be 30 in., and the driven pulley on end of each clearer to be 9 in. diameter, a clearer speed would be attained as indicated below :—

$$\frac{150 \times 30}{9} = \frac{150 \times 10}{3} = 500 \text{ revols. per minute.}$$

The wrought-iron tubular construction combines strength with lightness, and makes the clearer able to withstand the comparatively rough work and strain set up in carding cotton waste. Distinctively different conditions exist in regard to the roller or worker, as this not only has a very slow speed—scarcely $\frac{1}{16}$ part of the surface speed of the clearer—but it also has more than double the diameter, six inches being a common diameter. As a consequence the rollers are more usually made of cast-iron with hardened ends, although occasionally they are made of best selected and thoroughly well seasoned pine, on iron beams. Both clearers and workers may be fitted with shell bushes or shrouded ends, with the object of preventing dust and fly from getting to the bearings. For the rollers it is a common practice to have sprocket chain and pulley driving, as this suits the steady, slow, but non-slipping drive that is required to meet the case.

Action of Roller and Clearer.

The action of each pair of rollers and clearers may be described somewhat as follows: Both roller and clearer are set up to be just clear of the cylinder teeth, and also just about the same clearance from each other. They have the same direction of revolution, so that their contact surfaces move in the same direction as the cylinder, although their direction of revolution is exactly opposite to that of the cylinder. It is to be particularly noted, however, that the wire teeth of the clearer point in the same direction as those of the cylinder, at the point of juxto-position, whereas those of the roller are pointing against those of the cylinder.

Assuming now that there are some entangled portions of fibre upon the wire teeth of the cylinder, these would probably pass the first clearer and reach the roller which is further from the licker-in. The slow revolution and the oppositely pointing wire teeth of the roller would now help to open out and card the entangled portions of fibre, some of the fibre passing forward with the cylinder, and some adhering to the teeth of the roller. When these fibres on the roller come opposite the clearer, the latter will probably sweep the fibres from the clearer owing to increased speed of clearer and direction in which the teeth point. In exactly the same way the still greater surface speed of the cylinder will cause the latter to take the fibres from the clearer, so that the fibres will have then been transferred from cylinder to roller, from roller to clearer, and then back again to the cylinder. It is highly probable that the cotton will have been now sufficiently opened so that it will penetrate the cylinder teeth and be now carried forward by the cylinder to the doffer. One pair of rollers and clearers would be utterly inadequate in operating upon all the entanglements of fibre, and any such that may escape one pair will probably be acted upon by a subsequent pair. It is quite possible for some portions of fibre to be operated upon and transferred backwards and forwards several times over. Just as in the case of the flats of a revolving flat carding engine, a good proportion of dirt and impurities of one kind or another are fastened in or upon the teeth of the cylinder, roller, and clearer, so that we have the dual carding operation of opening and cleaning of the cotton. In the case of having six pairs of rollers and clearers there will be only six really and fully effective carding points, namely, the nearest point of each of the six rollers to the cylinder; while there will be twelve carding points of much less value represented by the nearest position of clearers to cylinder and roller to each clearer. A very little reflection will lead anyone to the natural conclusion that the opening and cleaning capacities of rollers and clearers are much inferior to those of the flats of a revolving flat card, and all experience has demonstrated this, so that for ordinary cotton carding purposes the roller and clearer card has nearly been defunct. In such cases one single revolving flat card appears able to do quite as much effective carding as one double roller and clearer card.

In spite of all this, double roller and clearer carding is the almost universal system in connexion with the carding of proper cotton waste, and reasons for this are given near the beginning of the present article. The double roller and clearer card so largely used for carding American cotton a quarter of a century ago contained only one feed part and one delivery, although having two cylinders and two sets of rollers and clearers. This system is not in favour for the carding of cotton waste, the accepted method being to employ separate breaker and finisher cards, each with its own feed and delivery arrangement. In what is termed the Scotch feed, however, the cotton is automatically transferred from breaker to finisher.

Specification of Cotton-waste Card.

By way of conveying a general idea of the construction of a cotton-waste carding engine the following specification of an eminent machine-making firm is given: Single breaker carding engine, 50 in. on the wire, with lattice feed to receive two laps from scutcher; one pair of feed rollers $2\frac{1}{4}$ in. diameter when clothed with inserted wire; one humbug roller $3\frac{1}{8}$ in. diameter when clothed with inserted wire; taker-in $9\frac{1}{2}$ in. diameter, clothed with inserted wire; cylinder 50 in. diameter; seven rollers, 6 in. diameter; six clearers, $2\frac{1}{4}$ in. diameter; one clearer, 4 in. diameter, next above licker-in, with or without dirt box; one wood fancy, 12 in. diameter; one fancy stripper, 3 in. diameter; doffer, 30 in. diameter, and improved fly doffer comb; galvanized iron rail between fancy, with door; wood cover over doffer. (See Fig. 23.)

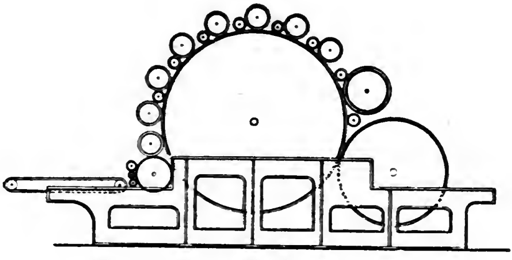


FIG. 23.—Breaker Card.

"Wood cover over doffer, with door to fit close to cover over fancy; recess in bends for traverse of Horsfall's card grinder; taker-in rollers and clearers with wrought-iron case-hardened ends, and cast shrouds at each end which case up the same;

rollers prepared for chain or band driving; wood covers and cover holders complete, and including division sheet with door, improved casing to licker-in, and tin-bar casing to cylinder with patent setting arrangement."

The Cylinder.

Except in the methods of starting and stopping the cylinders and in regard also to kind of card wire employed, there is little difference between the cylinder of a cotton-waste card and that of an ordinary cotton card. As regards driving, the differences may come in more particularly when automatic mechanism is employed for transferring the cotton waste from breaker to finisher carding engine. Take, for example, the best-known arrangement for the purpose, viz. the Scotch feed, it is necessary to stop and start both the breaker and finisher cards almost simultaneously, and to do this in the readiest manner often the two may be driven from the same top counter-shaft from which a separate belt each reaches down to breaker and finisher. The counter-shaft itself may be driven from another belt running on fast and loose counter-shaft pulleys. By moving this one belt from loose to fast pulley both cards may be started at one time, and the reverse movement of belt will stop both cards together. Various individual parts of the card may be stopped and started independently on much the same lines as for a cotton card.

The Wire Covering.

Referring now to the wire covering, it will be understood that this should be of a coarser and stronger character than for cotton counts of 40's or 60's, for example. It is well known that many descriptions of card clothing exist, and in particular are there many sorts of wire more or less in use. For cylinders and doffers two rival forms of card clothing have been in competition for a great many years, viz. filleting and sheeting. Fillets of card clothing cut to about 2 in. wide, made of sufficient length to clothe a whole cylinder without piecing, and wound in a close pitched spiral upon the cylinder, have almost driven the old sheets of clothing out of the market as regards ordinary cotton cards. In the carding of cotton waste, however, distinctly different conditions obtain, and it is quite a common practice to cover the cylinder of a cotton-waste card with sheets of card clothing in preference to fillet. Perhaps the greatest reason for this use of the sheets is that the spaces between the sheets on the cylinder materially help in the clearance of the large proportion of the leaf, dirt, seeds, and other defects in cotton waste, which would be a more difficult matter in the case of an unbroken fillet. In other words, what is lost in carding power by having a smaller number of wire points acting on the cotton is more than compensated for by the greater facility for the above defects to escape. The removal of the dirt and seed can be affected also with less risk of damage to the wire teeth.

Methods of Feeding the Breaker Card.

The methods of feeding the cotton waste to the breaker carding engine, and the methods of giving the cotton to the finisher card differ from the practice usually obtaining in orthodox cotton carding. One very distinctive method of feeding the breaker card consists in the use of an automatic feeding arrangement much after the style used for openers. The well-known hopper feeding principle has been successfully employed for waste cards in this country by certain firms who have made certain modifications so as to suit the character of the waste. The use of this hopper feeder entirely obviates the necessity for shaping the cotton waste into laps in the blowing-room at any of the machines, and yet makes the work of feeding the card very easy and automatic. The machine is fitted with a patent weighing arrangement by means of which the feed lattice is stopped when a certain weight of cotton, which can be regulated at will, has been deposited in the receptacle. At regular intervals this receptacle is opened, and the cotton dropped on the constantly revolving feed lattice of the carding engine, so that an even weight of cotton is always deposited on a certain length of lattice.

Comparing this feeder with that for an ordinary cotton opener there are radical differences in the construction and operation of the apparatus for equalizing the cotton, and for cleaning the same from the spikes of the elevating apron. The various motions are capable of very fine adjustment, and it is stated that a very regular feed can be obtained from this automatic feeder. For heavy, dirty waste, which would become too much matted if made into laps, this feeder is specially suitable, as it delivers the material to the carding engine in a loose condition. This system does not compete, for certain sorts of waste, so much with the more usual one of feeding with laps, as it does with the method of spreading the cotton by hand upon the lattice at the back. In spite of the manifest advantages of the hopper feeder, there are some people who still prefer the hand-spreading method, and although this is the more costly system as regards labour, there is not the first cost of the feeder to be debited to capital. In a manner of speaking this automatic feeder is a kind of cross between the one used for a cotton opener and one used sometimes in the wool trade. Nearly all our readers are familiar with cotton openers, but they

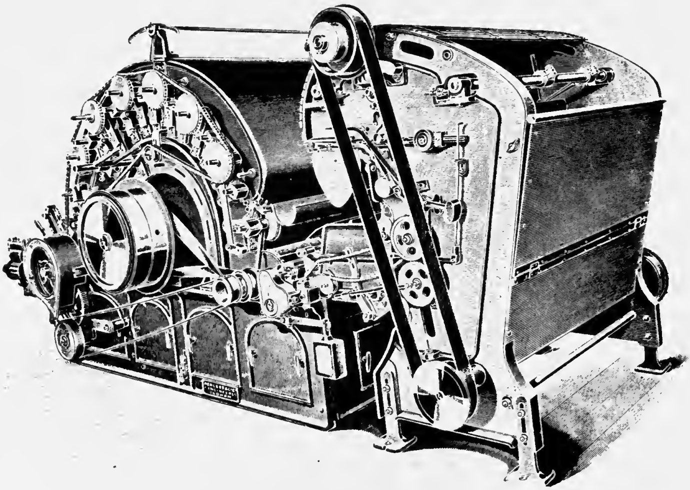


Fig. 24.—Breaker Card with Hopper Feeder.

are not familiar with the wool machine, and a very brief description of one is given below. In one case used in the woollen trade the wool is automatically taken up, weighed, and fed uniformly to the scribbler, which is almost the equivalent to a cotton opener or scutcher. This is known as the Bramwell automatic feeder, and was going in the wool trade before hopper feeders were introduced to the cotton trade. In this machine the wool is put into a large box having a grating at the bottom for any dirt to fall through; and the wool is taken upwards by a spiked or toothed elevating apron. Towards the top of the apron the wool comes under the operation of an oscillating comb, which strokes back any large pieces of the material, the remainder being spread more or less uniformly along the surface of the elevator. On the other side of the elevating apron there is another combing arrangement which sweeps the wool from the lifting apron and passes it along to a kind of weighing scale. This scale is built up of two curved wings, held together by suitable weights, and the whole suspended on steel knife edges. When the scale has received the required quantity, it liberates a small trigger, which causes a projection to catch on one of the teeth of a revolving disk connected with an automatic clutch, which disengages the driving belt operating the toothed apron, thus instantly stopping further delivery of material to the scale, which now remains at rest. When the proper time arrives the wings of the scale are opened, and the wool is deposited upon the feed-lattice in a perfectly opened state and in excellent condition for the cards. Some of the ideas incorporated in the foregoing description are utilized in the automatic feeders for waste breaker cards, but are altered and improved to suit the special circumstances of the case.

Double Lap Method.

When it is remembered that draw frames are almost unknown in the treatment of cotton waste, and in the condenser system there are absolutely no machines between the finisher card and the spinning mule, it will be then understood that some effort

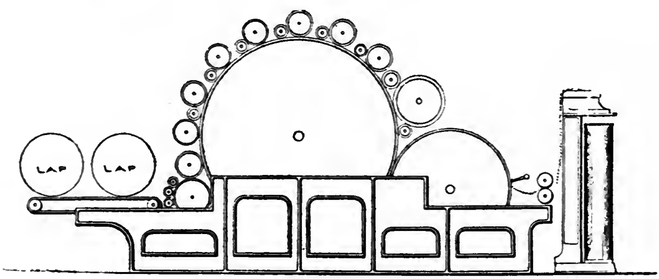


FIG. 25.—Cotton Waste Carding Engine.

must be made to secure a uniform sliver or strand from the carding engine. As regards the breaker card there are mainly three rival methods designed to secure the requisite uniformity of feed, and the carder must choose which one of the three he shall employ. First of all we have the hand-spreading system in which the operative spreads the cotton as uniformly as possible upon the feed lattice; and let it be remembered that hand spreading of cotton even for a scutcher has been known to give exceedingly level work when done by a sufficiently careful operative. As a rival to this we have the automatic feeder above alluded to.

A third system—shown in fig. 25 and very extensively adopted—is to place two full-width scutcher laps upon the lattice feeder of the breaker card, one behind the other, so that we have a doubling of the laps, and a mixing of the cotton which produces an excellent effect in levelling up the work. In this connexion it may be thought that even this is a very limited doubling effect as compared to that which is common to ordinary cotton spinning. While this is so we are not to forget that a 10 per cent error in counts too coarse would give us a 90's yarn instead of 100's, a 10 per cent error in 5's waste condenser yarns would only make half a count in difference, and if too coarse would give us $4\frac{1}{2}$'s counts instead of 5's. Furthermore, a slight error in counts of a cotton waste yarn need not appreciably affect the quality of a cheap cotton blanket; nor make the actual weaving process much more difficult; but properly spun cotton yarns always need to be as uniform as we can reasonably get them to be. The double lap system has the additional benefit of utilizing the piano-feed regulator at the scutcher, so that we have two factors which in this system help to give a level sliver, viz. the doubling effect, and the regulating effect of the piano motion.

Single-Breaking Carding Engine.

(40 in. or 48 in. wide on wire.) (See fig. 26.)

For comber waste broken-up cop-bottoms, and other kinds of hard waste, with patent side-drawing and single coiling and can motion.

Specification—Pattern C 7.—One cylinder 50 in. diameter. One doffer 25 in. diameter. One taker-in 9 in. diameter. Seven rollers 5 in. diameter of iron, or 6 in. diameter wood lagged. Seven clearers 3 in. diameter. One fancy 7 in. diameter wood lagged, driven by rope direct from the cylinder. One humbug roller 3 in. diameter under the feed roller and taker-in. Improved concentric bends. Steel cover and shell ends to taker-in. Polished mahogany covers over rollers, clearers and fancy. Rollers driven by chain or rope. Dish feeder with one fluted roller $2\frac{1}{4}$ in. diameter, and arranged to receive one scutcher lap.

Improved pattern doffing comb and motion. Patent side drawing with endless belt to convey the sliver from the doffer to the single coiling and can motion.

Special Features.—The concentric bends are of an improved type, and the roller, clearer, and fancy brackets, etc., are adjusted by means of $\frac{9}{16}$ in. screws and two hexagon nuts, both vertically and sideways, one screw-key now fitting all the nuts, and the combination provides a strong, simple, and good arrangement.

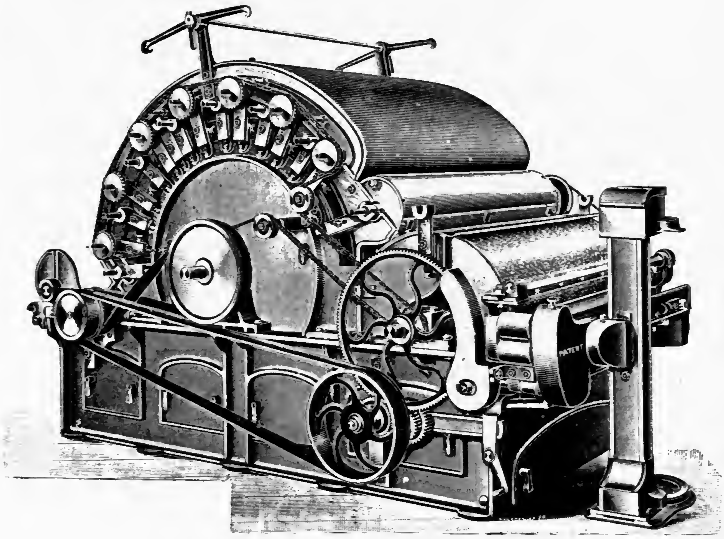


Fig. 26.—Breaker Carding Engine.

Self-oiling ring bearings to fancy.

Patent side drawing. By means of this arrangement the doffers can be run at a high speed even when carding the shortest material, and breakages very seldom occur.

The doffing comb is very strong, the driving motion has been re-designed, and the crank arm is secured to the doffing comb by means of a split boss.

Extras Supplied if Ordered.—Special steel-hinged cover and rail to separate the fancy from the roller above, and filling-up pieces with small grooved shaft under the fancy, with shell ends to bearings as illustrated.

(In lieu of extending the mahogany cover fitted with door over the fancy as per specification.)

Shell ends to roller, clearer, and fancy bearings.

Feeder arranged to receive two scutcher laps.

Angle-bar undercasings in halves, with improved setting arrangement to cylinder and taker-in.

Taker-in covered with inserted wire.

Illustration.—The pattern of bend illustrated has been superseded by the concentric pattern shown on page 20.

Unless the steel cover over fancy is specially ordered, the mahogany cover is continued over the fancy and fitted with door.

Production.—About 1000 lb. of broken-up cop-bottoms, comber waste, etc., per week of fifty-six hours.

Dimensions, Weights, Speeds, etc. (See fig. 26.)

Space Occupied.		Driving Pulleys.			Power Required.	Approximate Weights and Outside Measurement.		
Length.	Width.	Diam.	Width.	Speed per min.		Gross.	Net,	When Packed.
10 ft. 3 in.	6 ft. 10 in.	20 in.	For 3 in. belt.	75 to 90 revs.	About $1\frac{1}{2}$ I.H.P.	68 cwts.	52 cwts.	320 cub. ft.

Methods of Feeding the Finisher Card.

Previously we have given a discussion and description of the method of preparing laps for the finisher carding engine by means of the Derby doubler. It must, however, be understood that several systems are more or less in use in cotton-waste carding for transferring the cotton from breaker to finisher cards. There are, for example, the Derby doubler, the lap drum method, the Scotch feed, and the improved lattice feed. Moreover, either in treating cotton waste or in wool and worsted carding there are other feeding arrangements such as bank feeds, balling machines, Blamire's feed, Skelton's feed, and spooling frames. With these latter four of five arrangements we do not propose to deal ; as they refer so little to existing practice in the carding of cotton waste, we can well afford to ignore them. As a matter of fact, the Scotch feed and the Derby doubler are far and away the most used of any feeders or other arrangements for preparing the cotton ready for the finisher card.

The Lap Drum.

A very few words will suffice to say all that is necessary about this process. There is a large drum connected to the delivery of the breaker or the scribbler which aids in the rolling up of laps by frictional contact with the fleece of cotton stripped from the doffer by an ordinary doffer comb. A stop-motion may be applied by which knocking off occurs when any required thickness of lap has been attained. The lap drum is not used now as much as it formerly was, and it is a very primitive and simple arrangement. Simplicity of itself is no fault, but unfortunately this is accompanied by irregular work, and by a considerable loss of production owing to frequent stoppages while the full laps are being removed in turn from the drum. The necessity for doing this work somewhat frequently practically makes the card an intermittent machine, and it has become an axiom in carding that a carding engine should be a continuous worker, and even in ordinary cotton carding few people will entertain the idea of having a card fitted with an automatic stop-motion of any kind.

With the Derby doubler system the delivery of the breaker card is quite on the well-known principle of an oscillating comb for the doffer, a pair of calenders, and an ordinary can and coiler motion, which permits changing empty for full cans without interfering with the working of the card. With the Scotch feed and improved lattice arrangements the saving in labour is even distinctly greater than with the Derby doubler as we explain below in the present article.

The Scotch Feed. (See Fig. 27.)

The Scotch roper and Scotch feed arrangement is probably better than any other for most kinds of low grade cotton wastes; it automatically collects and condenses the cotton from the breaker card, and feeds the same to the finisher card in an equal and continuous manner. Apart from any saving of labour that may result from not using the Derby doubler, there are some classes of cotton waste which it is not wise to pass through the Derby doubler, as, for example, waste that is of an oily character, or low grade wastes, which are better left in the open fleecy condition given by the Scotch feed. Such wastes, compressed by the weighted rollers of the doubler, become too matted and consolidated, and this puts more work upon the parts of the finisher carding engine. Naturally this remark applies somewhat to all classes of waste, but not to the same extent to clean, soft better sorts of waste for the finer counts of waste yarns. In such cases the Derby doubler maintains the fibres in a more parallel condition, and in particular it tends to give a more level and uniform sliver and yarn than any other system, especially in the finer counts. This is, perhaps, the greatest argument for the use of the Derby doubler, since it needs special attention of itself, and the coilers and cans of the breaker also need attention. The crossing of the fibres given by the Scotch feed is an advantage in very coarse, soft wefts, since crossed fibres give a fuller and more oozy finished yarn than do parallel fibres, the full appearance being well suited to cotton blankets and flannelettes. For the coarser low grade wastes the Scotch feed system imposes a good deal less work upon the taker-in of the finisher card, and there is much less danger of damaging the cloth of the taker-in.

In the Scotch feed system the cotton waste is stripped from the doffer of the breaker by an ordinary fly comb, and is delivered upon a lattice running along the lower front of the doffer, and at right angles to the doffer. This lattice collects and condenses the fleece of cotton from the doffer, and as a rule turns the fleece round at right angles, while it is condensing the same into a ribbon perhaps four inches in width. The lattice itself may be about five inches in width, and for thick, coarse work the sheet or ribbon of cotton may attain that width. Except in some tandem cards the narrow ribbon of cotton waste passes between three calender rollers at the side of the breaker card, thus being compressed and consolidated by a two-fold compression into sufficient compactness to stand its own weight without breaking. This completes what may be termed the delivery part of the breaker card and the term "Scotch roper" is often applied to the arrangement as so far described, leaving the term "Scotch feed" to be applied more specifically to the remainder of the arrangement. This narrow sheet of cotton waste is now lifted up by an overhead combination of pulleys and narrow lattice work, revolving at about the same surface speed as the three bottom calenders, the top lattices also being only about five or six inches in width.

Assuming the breaker and finisher cards to be placed side by side—and not tandem—in relation to each other, the ribbon of cotton waste is lifted several feet upwards in a vertical line so as to depend upon its own weight, and then it is carried across the alley-way to the finisher card at the feed part which is in a line with the delivery of the breaker. The top lattice is extremely light and flexible, and built in a very open manner, but of sufficient strength to do all that is required. This lattice is capable of delivering the cotton all across the width of the feed part of finisher, and the cotton sheet drops down in a more or less slanting line to the lattice of the finisher upon which it is guided by a travelling roller and carriage arrangement. This distributing carriage is always moving backwards and forwards along the feed lattice, and is always laying the ribbon of cotton from side to side of the card in a double thickness, so that one layer practically overlaps the next one in front of it, and has its own rear half overlapped by the next succeeding ribbon. In this overlapping a doubling effect is produced which serves to give a reasonable amount of uniformity to the strands of cotton delivered by the finisher.

To permit the cotton ribbon to be spread from side to side of the card, the top flexible lattice of the feeder extends to the far side of the finisher card, and the cotton ribbon can then drop in almost a vertical line with the whole of the top lattice almost horizontal. As the tin or brass rollers of the distributing carriage move towards the opposite side of the card, the ribbon of cotton is drawn more and more out of the vertical line, and the distance of the top lattice from the carriage must be diminished, or else the cotton ribbon would be at once broken. To do this a thin cord—or in some cases a light rod—extends upwards from the travelling carriage to the end pulley of the top lattice, and pulls the latter downwards so as to bend the top lattice downwards from near the middle. A weighted lever arrangement pulls the top lattice straight again upon the return of the carriage, and as then permitted by the connecting band or rod. A somewhat ingenious arrangement is used to give the light rollers in the travelling carriage not only a reciprocating motion, but also a rotary one. A vertical shaft reaches upwards to give the requisite rotation, and has wheel gearing at its upper and lower ends, the whole of which it is necessary to constantly move backwards and forwards along the card front. For the reciprocal movement an endless chain or belt may be used which carries a stud or pin loosely connected to the base of the travelling carriage. It is easy to see how this revolving chain takes the carriage parts in any one direction, but the reversing of the movement presents somewhat difficult features. The driving stud passes round a pulley at each reversal, and has to slide up or down as may be in its connecting slot with the carriage. Perhaps this arrangement may be best compared with some of the travelling scavengers sometimes used for automatically cleaning the roller beams upon mules spinning coarse yarns and making a good deal of fly. As stated, the top lattice must be very flexible, and may, for instance, be composed of very flexible side belts, connected by light but strong wood cross-bars, although practice varies in this respect. The top lattice of the Scotch feeder may be driven round by a thin cord reaching upwards from the calenders which deliver the cotton finally from the breaker card. This card is carried from one pulley to another of the top lattice in the required manner.

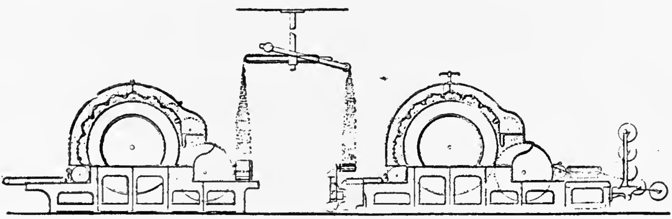


FIG. 27.—Hetherington's Carding Engines with Scotch Feeder.

It is not absolutely essential for breaker and finisher cards to be placed side by side, and in many cases the two machines are placed tandem, or one behind the other. To meet such a case one method of operating the Scotch feeder is to drop the cotton from the doffer comb upon two short lattices, which both revolve towards the centre, and in this way converge and condense the cotton fleece into a loose ribbon form, and then the ribbon passes through calenders working in a line with the middle of the doffer instead of at the side. There is no difficulty whatever in arranging the overhead carrying motion and the traversing Scotch feeder to suit card installations in which the front or delivery of the breaker is laid tandem with the feed of the finisher instead of zigzag.

As shown in fig. 27, the Scotch feed is a convenient method of conveying the cotton waste from the breaker doffer to the feed lattice of the finisher card, and its use is practically equal to two doublings. The fleece of cotton, as taken from the doffer of the breaker by the doffer knife or comb, is drawn away in a long sliver upon a narrow cross-lattice moving parallel with the doffer comb and face of the doffer.

This lattice delivers the sliver thus formed through a conductor to the condensing rollers, from which it passes to an overhead lattice creeper, half of which is balanced and can swing up and down.

From the end of the swing balance the sliver passes down to a pair of rollers in a frame which is moved backwards and forwards from one side of the finisher-card lattice to the other by a slowly travelling belt.

As it moves from one side to the other, the rollers which it contains deposit the sliver regularly upon the feed lattice just underneath, the speed of the which can be so regulated that the thin edge of one sliver overlaps that of another, thus producing a regular feed. A cord is attached to the travelling frame, and passing round a pulley fixed in the centre of the card is made fast to the swing balance of the overhead creeper, the end of which is also vertically over the middle point of the traverse of the frame. In this way the end of the overhead creeper is drawn down as the travelling creeper approaches the end of each traverse and allowed to lift as the centre is approached.

Tin Rollers.

The tin rollers in the travelling frame have pinions on the ends of their axles, which gear one with the other. The ends of the rollers work in a piece pivoted in the centre which enables each of the rollers in turn to be put in gear with a stud pinion, compounded with a band pulley around which a cord passes and is attached to each side of the card.

The Derby Doubler. (See figs. 28 and 29.)

Double carding in the cotton trade is nearly as old as the factory system itself, since it was very soon demonstrated that sufficient cleaning and opening of the cotton fibres could not be obtained from single carding in many cases with the cards then in use. Double carding in the ordinary cotton trade has not entirely disappeared even yet, although in most cases it simply seems to drag on a weary existence for want of sufficient money and enterprise to clear the cards out, and replace them with the revolving flat. It ought to be said, however, in this connexion that a few firms still find a market for super-carded yarns, and pass the same cotton through two revolving flat cards to produce the required effect. The particular and principal purpose of the present article is to describe the method or methods of preparing the slivers from the breaker card into a suitable form for feeding to the finisher card. Practically the only method in use in connexion with the double carding for ordinary cotton spinning purposes was to employ a machine termed the Derby doubler. This machine is practically a combination of the lap-forming rollers and other parts of a scutcher with the sliver and spoon lever stop motion of a draw frame. The Derby doubler in such a case usually produced laps equal to the full width of the finisher card, say, from 36 in. to 44 in. in width as required. According to the width of the lap and the thickness of the sliver, the number of cans of sliver used at the feed part of the machine used to vary from about 55 to 70, or more. For instance, in one particular case the present writer had to do with, the lap produced was 39 in. wide, and 60 back cans were used, the finished slivers being suitable for a $4\frac{1}{2}$ hank roving. This particular machine was discarded long ago to make way for single carding. In connexion with the cotton trade, the Derby doubler is now, or has been, employed in three different connexions. (1) As the medium between breaker and finisher in ordinary cotton carding; (2) to fulfil a similar purpose in the treatment of cotton waste; (3) to prepare laps for the cotton comber in mills which do more or less of combing. As stated, the machine is now almost obsolete for ordinary cotton carding, and it is a good illustration of the truism that extremes meet, when we find that it is yet in general and extensive use for fine cotton spinning, and is also largely employed in the coarse cotton-waste trade. As used for the several purposes above explained, the Derby doubler differs very little in principles of construction and action, but there is considerable difference in size and some difference in detail. To take the two extremes, we have already stated that full-width machines taking up to 70 slivers at a time, for laps 40 in. or more in width, were used in ordinary cotton carding, and this would be quite possible in carding cotton waste if it were deemed the most convenient practice. Usually, however, in the cotton-waste trade it is the practice to make the laps half the width of the card, and to place two of these end to end at the finisher card in order to use the full width. Contrasting the full width laps with those used in fine cotton spinning, it is very seldom these latter exceed 12 in. width, and more usually the width may be 9 or 10 in. only, requiring possibly 20 cans of sliver to complete the full width of each lap. It must be noted that in the fine cotton spinning trade the machine is perhaps more often given the designation of "Sliver lap machine," and its purpose is to convert the requisite number of slivers into narrow laps or sheets of cotton suitable for placing in the creel of the combing machine. It would dreadfully crowd the comber and inconvenience the operatives if the cans of sliver were taken directly to the feed part of the comber.

Confining our remarks now to the Derby doubler as used particularly in the treatment of cotton waste, it is the usual practice to place the requisite number of cans of sliver from the breaker card in suitable position adjacent to a **V**-shaped table, the long formation of which lends itself to the disposition of the cans along the sides of the **V**. (See figs. 28 and 29.)

Each sliver is drawn out of its can through a small, round aperture on a narrow slit in a polished guide plate, which prevents kinks or knots of sliver from passing forward, such entanglements being perforce drawn out straight, or else the sliver is broken, the former being the more common result. As stated, the number of cans may vary somewhat, the standard in one case being taken at each lap to be $24\frac{3}{4}$ in. wide, and requiring as many as forty-eight cans for each lap. Two of the laps are afterwards placed end to end behind a breaker card of 50 in. width.

In another case, for waste carding the **V**-shaped feed-table is usually made to hold as many as sixty slivers at one time, but this or any less number may be used to produce laps possibly 23 or $23\frac{1}{2}$ in. wide, and two of these are placed side by side on the feed-table of the finisher card of 48 in. width. Leaving the knot preventer, each sliver passes over a spoon lever, which is part of a clever device for automatically stopping the machine when any one sliver breaks, or any one back can of sliver runs empty. It is quite important that laps should not be made with absent slivers, as this for one thing would inevitably lead to unlevel yarn, besides interfering with the good working of the laps at the finisher, hence the extreme value of the automatic stop-motion. Without its application the operative would have to exercise a much closer supervision upon the cans and slivers, and this would take up a good deal of time now given to other purposes. Each spoon lever is finely balanced, so that the weight of the sliver keeps the spoon or head part down, and therefore holds the tail or opposite end of the spoon out of the path of an oscillating bar, or else a rotating wing roller. Absence of the cotton permits the tail of the spoon lever to enter the path of the oscillating bar, and to arrest the movement of same. In this way a latched spring rod is released, and a strong spiral spring at once moves the driving belt upon the loose pulley. There is no essential difference in principle between this stop-motion and the mechanical stop-motion used on the draw frame by the same makers. The spoons may be arranged neatly down each side of the **V**-shaped table and the slivers are conducted by suitable guides, and drawn round almost at right angles, so as to come close together to form an equal sheet of cotton. Mere placing side by side would scarcely give a sufficiently homogeneous sheet of cotton, as the several slivers would retain too much of their individuality. To obviate and partially overcome this separateness it is usual to pass the sheet of cotton between heavy calenders, much the same as on an ordinary scutcher, this being a very convenient thing to do. Finally, the laps are formed upon almost the same exact principle as upon a scutcher.

Such is a description of the process upon the Derby doubler. An average machine of this description might occupy a floor space of 13 ft. 8 in. × 6 ft. $2\frac{1}{2}$ in. Driving pulleys about 12 in. diameter by $1\frac{3}{4}$ in. width for both fast and loose pulleys. Speed of driving pulleys about 200 revolutions per minute. Speed of line shaft and diameter of drum on same proportioned to give the above. Power required per machine about one I.H.P. Gross weight about 50 cwt., net weight 40 cwt. Measurements about 125 cubic ft. The length of the driving belt required would of course be decided by the position and height of the line shaft or counter-shaft. It may be explained that for different makers there may be a different gearing arrangement from pulley shaft to calenders, and lap rollers and a lower speed of pulley shaft would be required in such cases.

Derby Doubler for Cotton Waste. Wm. Tatham and Son, Rochdale.

This machine is for the purpose of forming the slivers taken from the breaking carding engine into laps for the finishing carding engine.

It is found that the yarn produced from installations where this machine is adopted shows the best result as to regularity of counts and appearance of the yarn. It is especially suited when spinning counts, say 5's to 12's, from broken-up hard waste, comber waste, etc.

Two designs of this machine are made, either as fig. 28 to make laps half the width of the finishing engine feeder, or as fig. 29 more recently introduced to make laps full width of the finishing engine feeder.

Specification.—Machine to make half-laps, fig. 28: For engines 48 in. wide on wire it is prepared for forty-eight cans to make

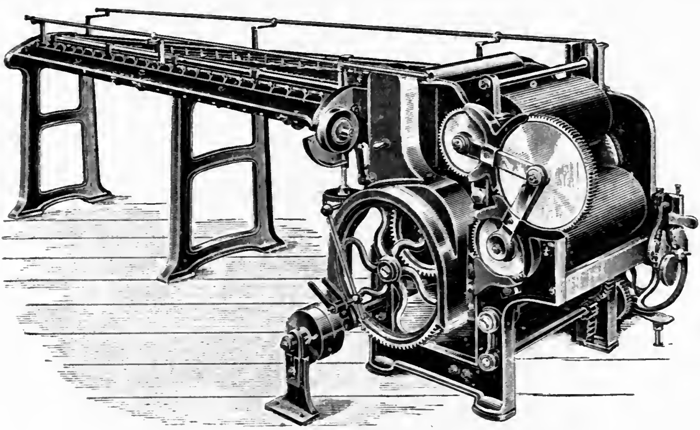


FIG. 28.—Derby Doubler for Narrow Laps.

laps $23\frac{1}{4}$ in. wide. For engines 40 in. wide on wire it is prepared for forty cans to make laps $19\frac{1}{4}$ in. wide.

Machine to make full-width laps, fig. 29: For engines 48 in. wide on wire it is prepared for ninety-six cans to make laps $46\frac{3}{4}$ in. wide. For engines 40 in. wide on wire it is prepared for eighty cans to make laps $38\frac{3}{4}$ in. wide.

An automatic stop motion is fitted which stops the machine when an end breaks or a can runs empty, also a knocking-off motion to stop the machine when the lap is full diameter.

Illustrations.—Fig. 28 machine to make half-width laps. The slivers from the cans (which are not shown) pass over the spoons to the taking-in rollers, then the slivers are drawn over the **V**-shaped table and pass between heavy calender rollers to the lap-forming arrangement. The laps are wound on to a wooden barrel 4 in. diameter, and are kept in position endways by two disk plates set close to ends of calender rollers. The laps are consolidated by means of a top calender roller, which lifts as the laps become larger in diameter.

Fig. 29 machine to make full-width laps. The construction and working is the same as above described, with the exception that the laps are formed in a different manner. These are wound on to a hollow wooden barrel 4 in. diameter, kept in position endways by two disk plates fitting close to ends of calender rollers. A lap rod is passed through the disk plates and wooden barrel, and pressure is applied to ends of the lap rod by means of two vertical racks.

The main advantage of full-width laps is that there is less likelihood of irregular yarn caused sometimes by the clearance between the half-laps varying in width.

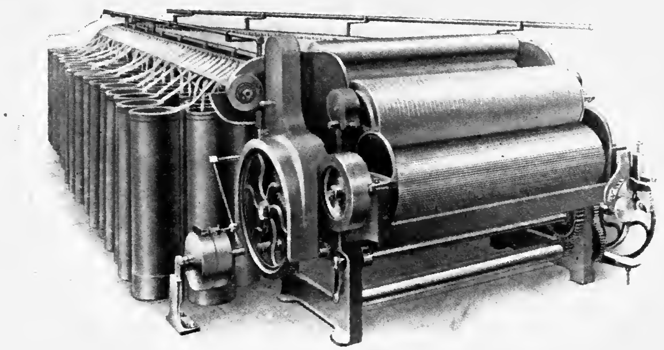


Fig. 29.—Derby Doubler for Wide Laps.

It is advisable that a Derby doubler as used in the treatment of cotton waste should be strongly built at the lap head, or otherwise breakdown may occur too frequently. It is the modern practice to make the various parts to template so that they are interchangeable, this being a convenience in the case of renewal or breakdown.

It is usual to apply a full lap automatic stop-motion to each Derby doubler, and naturally such a motion will be simplified and modified from the one used on a scutcher, so as to suit the fact that there are no cages to be stopped and started, and no fan or beater to be considered.

Dimensions, Weights, Speeds, etc.

Machine to Make Half-Width Laps. *See Fig.* 28.

Size of Machine.		Space Occupied.		Driving Pulleys.			Power Required.	Approximate Weights and Outside Measurement.			Approximate Production per week of 56 hours.
No. of Cans.	To make Laps	Length.	Width outside Cans.	Diameter.	Width.	Speed per min.		Gross.	Net.	When Packed.	
	In.	Ft. In.	Ft. In.	In.	In.	Revs.		Cwts.	Cwts.	Cubic Feet.	
48	$23\frac{1}{4}$ wide.	14 0	7 0	12	$2\frac{1}{4}$	300	About 1 I.H.P.	49	37	125	10,000 lb.
40	$19\frac{1}{4}$ wide.	11 3	7 0	12	$2\frac{1}{4}$	300	About 1 I.H.P.	45	34	120	8,500 lb.

Machine to Make Full-Width Laps. *See Fig.* 29.

96	$46\frac{3}{4}$ wide.	20 11	8 8	12	$2\frac{3}{4}$	300	About $1\frac{1}{2}$ I.H.P.	80	60	200	15,000 lb.
80	$38\frac{3}{4}$ wide.	18 6	8 0	12	$2\frac{3}{4}$	300	About $1\frac{1}{2}$ I.H.P.	65	52	170	12,500 lb.

It has been usual to make 2 laps each 24in. wide on the Derby doubler and put these end to end behind the finisher card. An objection to this practice is the bad piecing in the middle of the card width where the two lap ends come together. Partly for this reason the Derby doubler is now sometimes made to produce laps the full 48 in. width.

The Derby doubler appears to find more use in the manipulation of hard waste, and the Scotch feed more in the case of soft waste and perhaps lower counts.

The card clothing for cylinder needs an exceedingly strong foundation, as much as $\frac{3}{8}$ in. thick sometimes.

Improved Lattice Feed. (See fig. 30.)

It must be particularly noted that the Scotch feeder always turns the web of cotton and therefore the individual fibres over at right angles to the direction in which they leave the breaker, and presumably the fibres are thus more crossed with each other than in the Derby doubler system. It is doubtful whether any workable system of automatic transference of cotton waste from breaker to finisher could quite overcome the crossed condition of the fibres, owing to the doubling up of the fibres which must always occur in transferring cotton from cylinder to doffer, and to the manner in which the doffer comb cleans the cotton fibres from the doffer. It is possible, however, to have a method which does not cross the fibres as much as the Scotch feed, and which does not cross the ribbon of cotton at all, but feeds it with all the fibres pointing the same way in which they leave the breaker. Messrs. Asa Lees & Co., of Oldham, attain this particular object by means of their improved lattice feed, or the "Soho" feed, as it is sometimes termed, after the name of the firm. When the "Soho" feed is employed the fleece of cotton from the doffer of the breaker drops down a suitable slide, and is folded by a pair of rollers upon a floor lattice in front of the delivery of the breaker card. Upon this lattice the rollers deposit many layers of cotton one above another, and so make a double sheet of cotton waste, about 16 in. wide, and which may consist of as many as twenty thicknesses of cotton web. The bottom lattice itself, upon which the folded cotton web has been deposited, always has a sideways movement similar to the much narrower one of the Scotch roper delivery, and in this way the 16 in. width of cotton is continually given to a double elevating lattice arrangement for all the world similar to that used for lifting the cotton up from bale breaker to top of cotton mixing stack. The double vertical lifting lattices carry the cotton over to the finisher card, and at this point the cotton is laid upon the feed lattice of the finisher, with a continual half lap almost exactly as in the case of the Scotch feeder. The fleece or ribbon of cotton in this case never is turned round at right angles as with the Scotch feed. The double lifting lattices, the distributing rollers, and the top lattice work have all to be of sufficient width to deal with a sheet of cotton 16 in. wide as against 5 in. wide with the Scotch feeder.

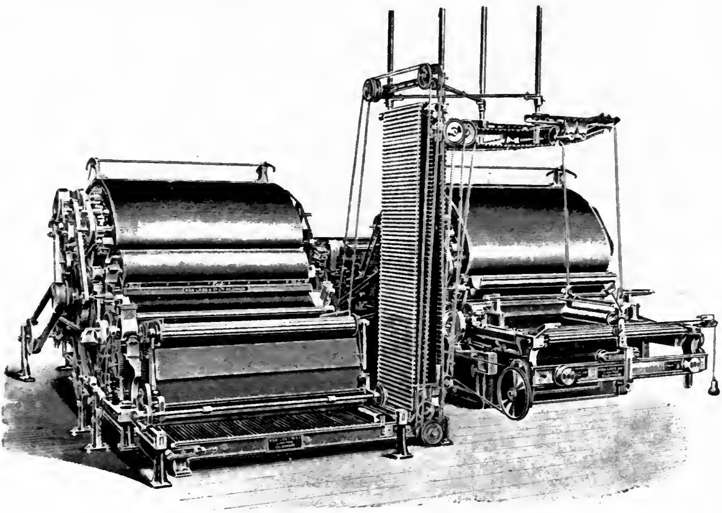


FIG. 30.—Improved Lattice Feeder.

A press lattice or press board may be employed at the feed lattice of finisher to keep the cotton waste well down to the feed rollers. It may be noted that both the dish feed with one feed roller and also the double feed roller system are more or less in use in cotton-waste carding. Also in regard to the Derby doubler system, it has been previously pointed out that most people make narrow laps upon the Derby doubler, and then place two of these end to end at the finisher card. Some people, however, are beginning to favour the one wide-lap system, partly because there is sometimes a thin, weak place in the cotton web from finisher, due to the two narrow laps not coming perfectly up to each other in the middle of the card.

The "Fancy" and "Humbug" Rollers.

To any person more or less conversant with ordinary cotton carding these two names, "Fancy" and "Humbug," sound very curious, as neither one nor the other name is applied to any part of an ordinary card, nor are the equivalents of those two rollers used at all. The "fancy" is an extra roller 10 in. or 12 in. diameter, placed after the last of the ordinary rollers in a waste card, and immediately over the doffer. The special object of the "fancy" is to raise the short fibre a little out of the cylinder wire, so that the doffer can then strip the cylinder much more perfectly than it otherwise could. The "fancy" has a very high surface speed—faster, in fact, than any other part of the card,—even exceeding the surface speed of the cylinder itself by possibly 20 per cent or so. It may be built of wood, covered with somewhat coarse wire, and set to penetrate the teeth of the cylinder for possibly $\frac{1}{16}$ in. or so. In this way, with the contact surfaces of cylinder and fancy revolving in same direction, the effect is to raise the fibrous material more or less out of the cylinder teeth. There may be a galvanized iron rail between the "fancy" and the next roller above it, and an iron cover over the "fancy," with door. The "fancy" may be applied to both breaker and finisher cards, in each case being driven from cylinder by belt and flat pulleys, the driving pulley on cylinder reaching 30 in. or more in diameter on occasions. It does not always happen that the "fancy" can keep itself sufficiently clean, and in many cases it has fitted to it a small stripper, which cleans the "fancy," and returns the fibre again to the cylinder, much in the same way that the stripper or clearer acts for its own roller.

The Fancy Roller.

In reference to the use of the fancy roller in the present systems of cotton-waste carding, it is well worth noting what Evan Leigh said in regard to the "fancy" more than thirty years ago, as then used for ordinary cotton carding. "For heavy carding a fancy roller, which is a roller which overruns the periphery of the cylinder, is sometimes used with advantage. Its object is to prevent the cylinder from choking, and therefore rolling and nepping the cotton. No engine can possibly card well unless the main cylinder can be kept clear, therefore, the fancy roller, by running about one-sixth faster than the cylinder, lifts the cotton that would otherwise get wedged in the wire of the cylinder, and thereby admits of heavy carding. It may be applied to any part of the cylinder which is most convenient, but is generally put under or immediately over the licker-in; the former is its most natural position, but the latter is the most convenient position for setting. The value of a fancy roller depends upon circumstances. In situations where there is little room for the amount of carding required, and where quality is not so much an object, there is no doubt of its utility, when properly applied and carefully attended to; but under other circumstances its expediency may fairly be doubted. Those spinners who put 30 per cent more cotton through their cards by the use of the fancy roller, would do well to remember that it is a kind of cheap carding which is not all gain, as it requires power in driving, great care in oiling and setting, adds to wear and tear, and the quality of work with heavy carding can never be relied upon; besides, the subsequent operations cost more, and the value of the yarn is less, therefore, old and experienced spinners are seldom found hurrying cotton through their cards, as they find it more profitable, on the whole, to put down a few more carding engines, and card light. To those who card waste and spin shoddy, the fancy roller is, perhaps, the most useful. The action of the fancy roller on the whole appears to be beneficial only where very heavy carding is wanted, any where the engines cannot be depended upon to stand true; but from the fact that the surface of the fancy runs in the same direction as the cylinder, only a little faster, it has to overtake and run past it, which is a very different kind of stripping to that effected by slow motions when the surfaces move in opposite directions. With the fancy roller it is necessary to strip out the cylinder occasionally by hand, when much cotton is often found wedged in the wire, which is detrimental to its proper action. This is especially the case where the fancy is not properly set and well attended to. There is comfort and safety in light carding; but when cotton is pushed through cards at an undue speed, the least negligence on the part of a carder or his assistants, the smallest variation in the quality of cotton, a change from dry to wet weather, and a number of other small matters, are productive of irregularities in a mill, and consequent loss, which more than counterbalances the apparent saving in hurrying cotton through the carding engine. It has before been observed that where a fancy is used great care should be taken, first that it is balanced to a nicety; secondly, that it should be so driven that its periphery runs with certainty a little faster than that of the cylinder (say about one-sixth); thirdly, that it should be clothed with wire having nearly straight teeth; fourthly, that it should be set close to the cylinder, without touching, otherwise the cotton is driven down into the cylinder wire, and gets wedged in."

We must remind our readers that present cotton-waste cards have the fancy placed over the doffer, and its teeth penetrate those of the cylinder.

Single-Finishing Carding Engine. (See fig. 31.)

(40 in. and 48 in. wide on wire, fitted with improved ring-doffer condenser.)

Specification—Pattern C 8.—One cylinder 50 in. diameter. One doffer 25 in. diameter. One taker-in 9 in. diameter. Seven rollers 5 in. diameter of iron, or 6 in. diameter, wood lagged.

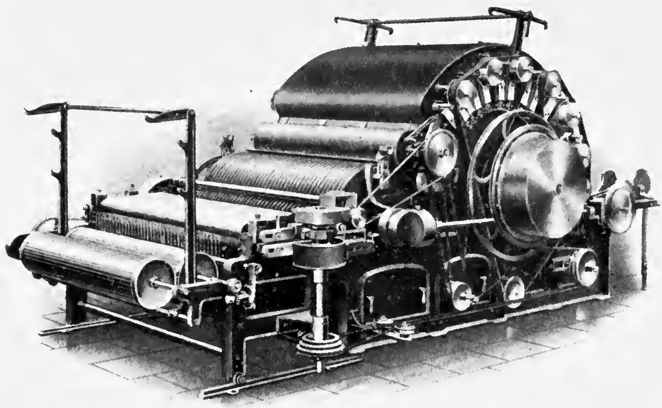


FIG. 31.—Single Finishing Carding Engine.

Seven clearers 3 in. diameter. One fancy 7 in. diameter, wood lagged, and driven by rope direct from cylinder. One humbug roller 3 in. diameter under the feed roller and taker-in. Improved concentric bends. Steel cover and shell ends to taker-in. Polished mahogany covers over rollers, clearers, and fancy. Rollers driven by chain or rope. Dish feeder with one fluted roller $2\frac{1}{4}$ in.

diameter, and arranged to receive four half-width or two full-width Derby doubler laps. Improved pattern doffing comb and motion, and improved ring-doffer condenser with dividing roller, one pair bobbin drums, inside pressing rollers, rope driving from cylinder, etc. The condenser system is generally adopted when a level, soft, full or oozy yarn for weft is required.

Special Features.—The concentric bends are of improved type, and the roller, clearer, and fancy brackets, etc., are adjusted by means of $\frac{9}{16}$ in. screws and two hexagon nuts, both vertically and sideways, one screw-key now fitting all the nuts, and the combination provides the strongest, simplest, and best arrangement on the market.

Self-oiling ring bearings to fancy.

The doffing comb is very strong, and the driving motion has been re-designed, and the crank arm is secured to the doffing comb by means of a split boss.

Messrs. Tatham say:—

"The ring-doffer condenser is found from experience to make the best quality of yarn; it is simple in construction, easy to work, and most suitable for broken-up cop bottoms. The doffer is clothed with card rings, the slivers from which are kept separate by means of leather dividing-rings $\frac{1}{4}$ in. wide. The counts of yarn regulate the number of rings, which range from about 26 rings for No. 5's to 40 rings for No. 10's counts. After being doffed the slivers are carried forward by means of a grooved dividing roller to a pair of endless rubbing leathers, which, by the combined action of a crossways and forward movement, roll or condense the slivers into threads; these are next wound on to long bobbins provided with steel flanges which are taken direct to the mule."

Extras.—Special steel-hinged cover and rail to separate the fancy from the roller above, and filling-up pieces with small grooved shaft under the fancy, with shell ends to bearings. (In lieu of extending the mahogany cover over the fancy as per specification.)

Shell ends to roller, clearer, and fancy bearings.

Angle-bar undercasing in halves, with improved setting arrangement to cylinder and taker-in.

Patent for perfecting side-ends.

Taker-in covered with inserted wire shows the engine fitted with the special steel-hinged cover and rail over fancy, and filling-up pieces, with small grooved shaft under fancy as named in extras; if desired, same can be supplied with the mahogany cover continued over the fancy and fitted with door as named in specification.

Production.—About 650 lb. of broken-up cop bottoms, comber waste, etc., for counts, average 8's, per week of fifty-six hours.

Dimensions, Weights, Speeds, etc.

Space Occupied.		Driving Pulleys.			Power Required.	Approximate Weights and Outside Measurement.		
Length.	Width.	Diam.	Width.	Speed per min.		Gross.	Net.	When Packed.
14 ft. 1 in.	6 ft. 10 in.	20 in.	for 3 in. strap.	65-85 revs.	about 2 I.H.P.	80 cwts.	60 cwts.	360 cub. ft.

Tatham's Breaker and Finisher Cards Combined with Scotch Feed. (See fig. 32).

It is mostly adopted for 1's to 5's from soft waste such as scutcher droppings, card fly, clearer caps, strippings, sweepings, oily waste, etc.

Specification.—Single breaking carding engine, pattern C 7, 48 in. wide on wire, with one cylinder 50 in. diameter. One doffer 25 in. diameter. One taker-in 9 in. diameter. Seven rollers 5 in. diameter of iron or 6 in. diameter, wood lagged. Seven clearers 3 in. diameter. One fancy 8 in. diameter, wood lagged, and driven by rope direct from the cylinder. One humbug roller 3½ in. diameter under the feed rollers and taker-in. Improved concentric bends. Steel cover and shell ends to taker-in. Rollers driven by chain or rope. Plate feeder with one pair of fluted rollers arranged to receive two scutcher laps. Improved pattern doffing comb and motion, and patent side drawing with endless belt, gearing and cover. Angle-bar undercasings in halves, with improved setting arrangement to cylinder and taker-in.

Patent Scotch feeder with sliver conductor, overhead creeper and balance for traverse of sliver, and one pair feed rollers prepared for covering with inserted wire or filleting.

Single-finishing carding engine, pattern C 8, 48 in. wide on wire, with one cylinder 50 in. diameter. One doffer 25 in. diameter. One taker-in 9 in. diameter. Seven rollers 5 in. diameter of iron

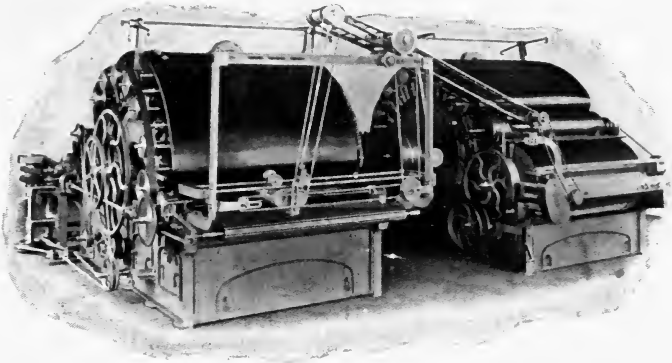


FIG. 32.—Breaker and Finisher Cards Combined by Scotch Feed.

or 6 in. diameter, wood lagged. Seven clearers 3 in. diameter. One fancy 8 in. diameter, wood lagged and driven by rope direct from cylinder. One under-clearer to fancy. One humbug roller $2\frac{1}{2}$ in. diameter. Improved concentric bends. Steel cover and shell ends to taker-in. Polished mahogany covers over rollers, clearers, and fancy. Rollers driven by chain or rope. Improved pattern doffing comb and motion. Angle-bar undercasings in halves, with improved setting arrangement to cylinder and taker-in, and improved ring-doffer condenser with dividing roller, one pair bobbin drums, inside pressing rollers, rope driving from cylinder, etc.

Special Features.—The concentric bends are of an improved type, and the roller, clearer, and fancy brackets, etc., are adjusted by means of $\frac{9}{16}$ in. screws and two hexagon nuts, both vertically and sideways, one screw-key now fitting all the nuts, and the combination provides the strongest, simplest, and best arrangement on the market.

Self-oiling ring bearings to fancy.

The doffing comb is very strong and the driving motion has been re-designed, and the crank arm is secured to the doffing comb by means of a split boss.

Messrs. Tatham say :—

"The ring doffer condenser is found from experience to make the best quality of yarn ; it is simple in construction and easy to work. The doffer is clothed with card rings, the slivers from which are kept separate by means of leather dividing-rings $\frac{1}{4}$ in. wide. The counts of yarn regulate the number of rings, which range from about 14 rings for No. 1's to 30 rings for No. 4's. After being doffed the slivers are carried forward by means of a grooved dividing roller to a pair of endless rubbing leathers, which, by the combined action of a crossways and forward movement, roll or condense the slivers into threads. These are next wound on to long bobbins provided with steel flanges which are taken direct to the mule.

"The patent Scotch feeder is an arrangement which takes the web from the side drawing of the breaking engine, and crosses same in even layers on the feeder creeper of the finishing engine. The feeder is made from new models constructed on an improved principle so as to dispense as much as possible with change wheels in case the web is to be altered in weight. The driving of the overhead creeper, the traverse of the carriage, and the turning of the web rollers in the carriage are all driven from the creeper roller on the side drawing, and not one part of the mechanism from the breaking engine and another part from the finishing engine. It can also be worked at a quicker speed without breaking the web. Also the overhead lattice is supported from the feeder sides, thus obviating a pillar being fixed to the ceiling or on the floor."

Extras.—Special steel-hinged cover and rail to separate the fancy from the roller above, and filling-up pieces with small grooved shaft under the fancy, with shell ends to bearings. (In lieu of extending the mahogany cover, as per specification.)

Shell ends to roller, clearer, and fancy bearings.

Patent for perfecting side-ends.

Taker-in covered with inserted wire.

Illustration.—The illustration shows the breaking and finishing engines set side by side, but they are occasionally set tandem to suit floor space requirements. For illustration of ring doffer condenser see page 270.

Production.—About 1000 lb. of soft waste counts 1's to 5's per week of fifty-six hours.

Space Occupied.—Breaking engine, 11 ft. 4 in. by 6 ft. 10 in.

Finishing engine with ring-doffer condenser, 13 ft. 7 in. by 6 ft. 10 in.

Methods of Delivering Cotton Waste from Finisher Cards.

Previously we have somewhat fully described the various methods of transferring the cotton waste from breaker to finisher carding engines, and we have definitely referred to and described the lap drum method, the Scotch feed method, the Soho feed, and the Derby doubler system.

The Preparation System.

In the same way there are various methods of dealing with the cotton at the delivery of the finisher card, the best known methods being: (1) the coiler system, (2) the ring-doffer system, (3) the tape condenser. Tape condensers are made in various forms and under different specific names. The first or coiler system is quite an old form, and is perhaps the most of any similar to the ordinary cotton card. Instead of one can or coiler only being used, the comparatively thick fleece of cotton is divided out into four or six parts upon the doffer, principally through the medium of the requisite number of dividers placed between the cylinder and doffer. Each one of these four or six portions is formed into a sliver and coiled inside an ordinary card can in the usual well-known manner. The card front presents the novel appearance of having four or six cans of sliver, all being filled at one time, and each now quite independent of the others. The cans may be the same size as ordinary cotton cans, or they may be rather less in both diameter and length. Assuming we desire to make a yarn equal to about 7's counts at the mule, then each card sliver may equal $1\frac{1}{8}$'s or $1\frac{1}{4}$'s counts, and at the slubber it is convenient to produce a $4\frac{1}{4}$ hank bobbin of much the usual size from an ordinary slubber or intermediate. The bobbins from the slubber are taken direct to the waste spinning mule, and are here put into a creel, after the approved cotton spinning method. This is, of course, a departure from the orthodox method of condenser waste spinning, and equally it is a departure from ordinary cotton spinning. This "preparation" system, or quadruple coiler system of cotton waste carding and spinning appears to be losing ground in favour of the more extreme system of adopting the condenser.

The Ring Doffer System.

The ring doffer condenser system is a present day rival of the tape condenser in the carding of cotton waste, and in England, at any rate, the ring doffer appears to be holding its own against its more ambitious rival, the tape condenser, although the latter permits cotton to extend over all the full width of the doffer in a continuous fleece, whereas the ring doffer only has strips of cotton interspersed with spaces. It must be understood that in what is termed the ring-doffer system the doffer is not covered with a long fillet wound spirally round the doffer in one piece from end to end. There are simple rings of fillet placed on the doffer, each one complete of itself. Suppose thirty-one slivers or slubbings were required to be made at one time, then thirty-one independent endless rings of fillet, each $1\frac{1}{8}$ in. wide, would be secured on the doffer, and between each pair of fillets there would be an endless leather band $\frac{3}{8}$ in. wide. During grinding the leather bands are ground at the same time as the wire of the filleting, and should be as smooth as can be got. It must be now understood that as the cotton is transferred from cylinder to doffer, the cotton fibres naturally divide out at the leather rings, and each $1\frac{1}{8}$ in. fillet takes its own particular portion of the cotton, and makes one particular strand of cotton. The cotton naturally follows the wire-covered portions of fillet instead of the smooth rings of leather, and thirty-one individual strands result from thirty-one rings of fillet. Leaving the doffer each strand or end of cotton enters a **V**-shaped space in what is termed the dividing roller, and a natural condensing action takes place here, by which somewhat of a concentration of the sliver occurs. In a way of speaking, the use of the dividing roller gives a slight advantage to the ring-doffer, as compared with the tape condenser, and efforts have been made to imitate the dividing roller effect on the tape condenser.

Rubbers.

Leaving the dividing roller, the several strands of cotton come within the range of action of what are termed the rubbers. These consist of two endless leather bands reaching the width of the card, and presenting about 16 in. or so of surface for the cotton waste strands to pass between. The term rubbers is applied because they do actually and rapidly rub or roll each loose strand of cotton into a consistency and strength sufficient to enable the cotton to be wound on the long condenser bobbin at the card, and from this bobbin at the creel of the waste spinning mule, with comparatively little breakage of strands, although no twist whatever is put in the cotton until it is done by the twisting spindle of the mule.

As stated, the condenser attachment to a cotton-waste card is a very distinctive arrangement, having no equivalent in connexion with ordinary cotton carding. It is an arrangement by which very coarse slubbing ends may be produced at the delivery of the finisher carding engine, thirty or thirty-one separate ends being a very common number, although double that number may be attained in cotton-waste carding, and more than four times that number in the woollen or worsted trades.

There are various makes of condenser, but in every case it is necessary to first split up the comparatively wide, thick fleece of cotton deposited by the cylinder upon the doffer into the requisite number of individual strands, then to rub each one of these strands into sufficient consistency to wind on and off the bobbin without breaking; and finally there is the actual winding of the rubbed strands upon a suitable long bobbin.

The Tape Condenser.

What are termed steel tape condensers—a notable example being Bolette's steel tape—do not appear to be very much in favour, in this country at any rate, and practice is largely confined in England to the use of improved leather tape condensers starting with the doffer. In this case there is no very distinguishing feature in respect of the doffer, excepting perhaps in the coarseness of the wire that is used, and sometimes, at any rate, the doffer only having a diameter of 22 in. or so. The tape condenser permits all the surface of the doffer to be covered with wire clothing, whereas in the ring doffer something like one-fourth of the space is lost for carding purposes owing to the use of the leather rings. As against some former careless manufacture of doffers it may be said that it is now the practice at the machine shop to carefully turn the cylinder and doffer, and to finish them off in special grinding machines, although nothing like the fine and accurate setting of one part to another is obtained in the waste mill as in the ordinary cotton mill.

Unlike the case of the ring doffer, the cotton in the tape condenser is stripped from the doffer in a continuous fleece, and immediately passes through a pair of feed rollers to what are often termed the space rollers. It is at these space rollers that the cotton is first divided out into separate strands, whereas this initial division is done at the doffer itself in the ring-doffer system.

In the case now of a double condenser, which is perhaps the most common one for cotton waste, there are two sets of tapes, or one set conducted in a special manner round the space rollers so that the action is the same as having two tapes. Each leather tape may be, say, three-quarters of an inch wide, and it must be understood there are two space rollers—a top and a bottom one—and the leathers on top roller are opposite the spaces on the bottom roller, and correspondingly the leathers on bottom roller are opposite the polished metal spaces on the top roller. The cotton fleece having been stripped from the doffer by an ordinary doffer fly-comb, passes in a continuous width through the feed rollers to the space rollers, and between these latter rollers it is readily split up into two sets of strands or ends by the oppositely set tapes of leather. There may, for example, be thirty good ends, and one spoiled selvedge end of cotton waste, pass along to the top condenser rubbers, and the same to the bottom ones. One set of strands is conducted by guide rollers, and the tapes in an upward direction, and another set in a downward direction. With regard to the rubbers themselves, they are endless leather bands, the working width of the machine, two rubbers working together with the cotton between them. As regards the length of the rubbers or amount of rubbing space acting on the cotton at one time, an idea of this may be formed when we state that the centres or distance from centre of one rubber guide roller to the centre of the other may be $12\frac{3}{8}$ in. and $13\frac{1}{4}$ in. respectively.

The Rubbers.

It must be well understood that these rubbers have a double action, the one being a continuous forward movement, by means of which the cotton strands are delivered on to the long condenser bobbin. The other is a rapid lateral reciprocating movement of possibly $\frac{1}{2}$ in. stroke or so by means of which the cotton waste strands passing between the rubbers are rubbed as between the hands of a person, until they are sufficiently solid to wind on and off the long condenser bobbins. The eccentrics for imparting the lateral reciprocation to the rubbers are fixed upon a vertical shaft driven rapidly round by a cord from the cylinder, these eccentrics and their action presenting a somewhat imposing appearance to the person who first witnesses a waste card at work. As a rule it is possible to alter the extent of stroke imparted to the rubbers by these eccentrics. The rotary movement of the rubbers may be imparted by the wheel gearing at the opposite side of the card from the eccentrics. Leaving the rubbers, the numerous strands are conducted round a long condenser bobbin, which is driven round by frictional contact with a wood roller of possibly 5 in. or so in diameter; and it is possible for a full condenser bobbin to attain a maximum diameter of about 9 in. in a comparatively short time, varying with the speed of the card, and the thickness or counts of the strands of cotton. Assuming thirty good ends, each end or strand may occupy a width of about 1½ in. upon the long condenser bobbin, and there are guide wires suitably traversed sideways to help in placing the cotton ends upon the bobbin. Thus each strand is quite independent of its companion strands, although they are all wound side by side upon the condenser bobbin. This disposition is taken advantage of in the case of the can spinning frame described here some weeks ago, in order to draw the individual round portions of cotton over the end of the condenser bobbin in quite separate order, and to then use one coil in each shallow can at the can machine. It is usual to have each long condenser bobbin somewhat shorter than the combined spindle gauge of the number of spindles served at the spinning machines in order to allow for flanges, etc. In ordering machines, therefore, care must be taken that the long condenser bobbins are a little shorter than the spindle space; also that the number of spindles in the spinning machine absorbs the whole of the good threads placed upon the condenser bobbins. A waste mule of 300 spindles, for example, would absorb the full complement of ten condenser bobbins, each containing thirty good ends. Various devices have been used more or less in connexion with the narrow tapes of the tape condenser. In one recent example a special feature consists in the arrangement of the latter with a half-twist in it, and as they are in this way prevented from touching each other it is claimed they can be made wider than with other tape condensers. This helps in dividing the fleece of cotton more accurately, which is so much better for the uniformity of the produced strands of cotton, and therefore of the finally spun yarn. When any web of cotton has been divided by the tapes it is necessary to carry the strands without friction along to the rubbers. In recent machines the condenser is strongly constructed, and the eccentrics to give the motion to the rubbers are specially made with a view to reduce vibration. All wheels now have teeth cut from the solid by most makers.

Weights, Speeds, etc., of One-Breaking and One-Finishing Engines, 48 in. wide, with Scotch Feeder and Ring-Doffer Condenser. (See fig. 32.)

Driving Pulleys.			Power Required.	Approximate Weights and Outside Measurement.		
Diam	Width.	Speed per min.		Gross.	Net.	When Packed.
20 in.	for 3 in. belt.	about 100 revs.	about 4 I.H.P.	150 cwts.	112 cwts.	700 cub. ft.

Patent "Leather-Tape" Condenser. (See fig. 33, Tatham's.)

This condenser, built on the latest "Saxon" principle, is similar in construction to what is generally adopted by continental spinners; in this country it is occasionally substituted for the "ring-doffer condenser," particularly when a low cost of production rather than good quality is desired, and is used for both good and low grades of soft waste.

The production from the carding engine with "Tape" condenser is much greater than from carding engines fitted with the ring-doffer style of condenser, and is of especial advantage when it is desired to spin finer counts than, say, No. 3's in large-sized cops.

The web from the doffer is stripped by the doffing comb in a wide sheet which then enters the condenser. By means of the travelling leather tapes, in conjuction with certain rollers, it is split into slivers, which are then conveyed either upwards or downwards over rollers to the top or bottom pair of rubbing leathers and then on to the bobbins—two, three, or four, according to the number of threads and the gauge of the mule.

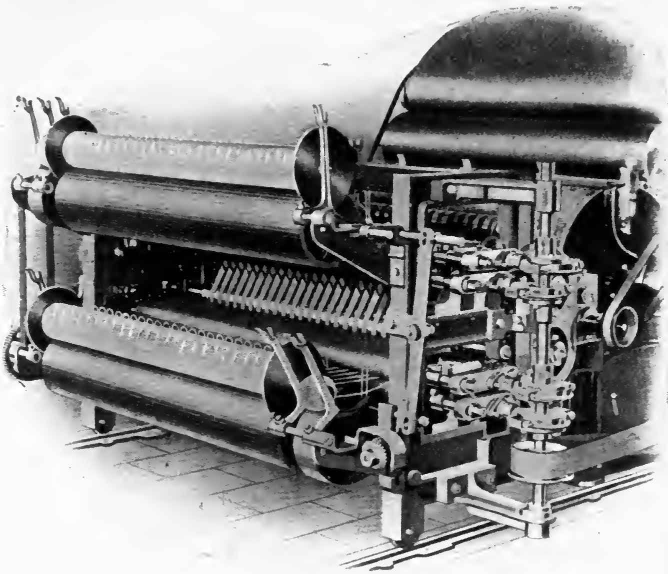


FIG. 33.—Leather Tape Condenser.

It is possible to take off as many as 120 threads from a carding engine 48 in. wide on wire.

Fig. 33 shows a patent "Leather-Tape" condenser arranged for fifty-two good and two waste threads on two bobbins.

Production.—About 1500 lb. per week of fifty-six hours, varying according to counts and class of waste.

Dimensions, Weights, Speeds, etc., of a Single-Finishing Engine with Patent Scotch Feeder and with Patent "Leather-Tape" Condenser.

Space Occupied.		Driving Pulleys.			Power Required.	Approximate Weights.	
Length.	Width.	Diam.	Width.	Speed per Minute.		Gross.	Net.
14 ft. 1 in.	7 ft. 4 in.	20 in.	for 4 in. strap.	100 revs. and upwards according to class of waste.	about 3 I.H.P.	107 cwts.	83 cwts.

Waste Carding, Side Slivers.

Many detailed improvements have been affected in regard to waste carding and spinning during recent years.

As elsewhere fully explained the doffer of a waste condenser card—made on the ring-doffer principle—is divided into equal spaces across its width by means of leather rings. The web is taken up by the filleting between these rings and is rolled by means of rubbers into threads.

There has always been a certain amount of trouble and loss in connexion with the end slivers, owing to their irregularity, and sometimes this has led to cloth being returned, owing to the yarn on the billey spun cops from these side slivers being so unlevel, and giving thick and thin places in the cloth. In other cases the side slivers have been allowed to go into waste for using over again before risking defective yarn.

In one device for overcoming this particular evil of side slivers, and giving better yarn and cloth thereby, the usual rings for dividing the doffer are employed, and in addition an extra narrow ring at each end to allow all sliver caused by the draught of the card and lumps adhering to the rollers to be doffed in the usual manner, but not to be carried through the rubbers. At each side of the doffer, opposite the irregular card slivers, tubes are fitted. The tubes are coupled to a principal tube connected with a machine (one for every eight cards) consisting of a fan and necessary gearing for driving the same and for producing a draught to draw the irregular sliver from the condenser card to a pair of cages, which deliver it in condition ready for going back to the lap machine without other preparation.

Patent for Perfecting Side-Ends in Carding Engines. (See fig. 34.)

This patented arrangement invented by Messrs. Kinsman and Hopkinson consists in arranging the number of rings on the doffer into equal spaces as required, and in addition an extra ring at each end to allow all irregular sliver—caused by the draught of the card—and lumps adhering to the rollers and clearers to be doffed by the comb in the usual manner, but *not* to be carried through the rubbers and on to the condenser bobbin.

At each side of the doffer are placed, opposite the irregular side slivers, vertical tubes which are fitted at each side of the dividing roller, carried down below same, and coupled to a main tube, at the end of which is fitted the machine as illustrated.

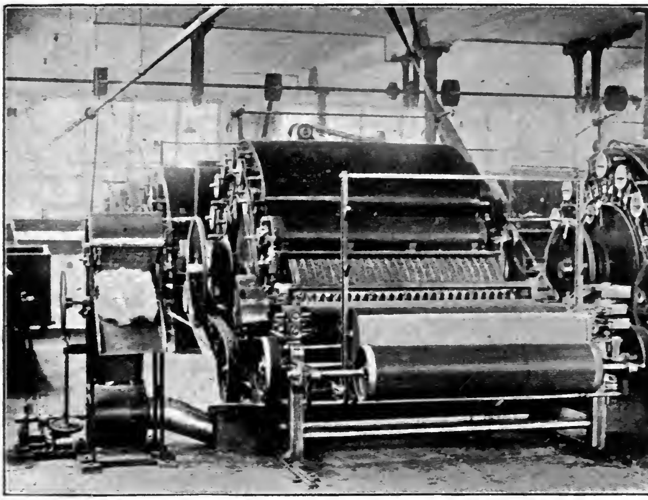


FIG. 34.—Tatham's Apparatus for Side Ends in Cotton Waste Cards.

The machine is provided with an exhaust fan to draw away the irregular sliver which passes down the tubes, and delivers the waste between two wire cages in a loose web (see illustration) in a state to be returned to the mixing. One of these machines will draw away the waste sliver from eight carding engines.

The patented arrangement surpasses anything hitherto devised to overcome the difficulties with regard to the side-end cops.

Advantages.—(1) The outside threads or rovings are made equal to any other thread with the minimum amount of waste.

(2) A cop can be made full size the mule is made for. This cannot be done when the cops from the side-ends are variable in diameter.

(3) The spinning is greatly improved. It is well known that about 25 per cent. of broken threads which have to be pieced up at the mule are from side-ends.

(4) The picking out and rejecting of side-end cops is now obviated, which means a large saving.

The patent machine saves endless trouble, and produces more regular yarn and consequently more even cloth.

Dimensions, Weights, Speeds, etc.

Space Occupied.		Driving Pulleys.			Power Required.	Approximate Weights and Outside Measurement.		
Length.	Width.	Diam.	Width.	Speed per min.		Gross.	Net.	When Packed.
2 ft. 8 in.	2 ft. 6 in.	4 in.	$1\frac{3}{4}$ in.	about 400 revs.	about $\frac{1}{4}$ I.H.P.	5 cwts.	3 cwts.	40 cub. ft.

Remarks on Cotton-Waste Carding.

In so far as this country is concerned, the use of the hopper feeder for automatically feeding the cotton in a loose level sheet to the breaker card is by no means as much in favour as the method of first making laps of the cotton waste at a scutcher much in the usual way. This latter practice permits the preliminary scutching treatment of the cotton waste, and also helps in the matter of uniform work by the use of the feed regulator at the scutcher. But this latter effect is also aided by the doubling of two or even three lap sheets together behind the breaker card. In just the same way it is common enough to feed four laps from the Derby doubler, behind the finisher card, two laps being placed end to end to make the full width of card. As a matter of fact sometimes six laps are used in this fashion behind the finisher card, so that cases exist in which three laps may be seen working at the feed of the breaker, and also six narrow laps working as three wide ones at the feed of the finisher.

During the twenty years or so of its existence the firm of Messrs. Tweedales & Smalley, has obtained a reputation in connexion with the manufacture of various machines, connected directly with cotton spinning. It is therefore not to be wondered at that they make also cotton-waste carding engines, since their works are adjacent to or practically in the centre of a portion of country in which there are very many mills devoted to the manufacture of yarns and cloths from cotton waste. They make an up-to-date carding engine set, in which the breaker card contains seven rollers and five clearers, with a " fancy " roller devoted to the slight raising of the short fibres of cotton waste from the main cylinder, in order to help in the transference of fibres from cylinder to doffer. This firm have adopted a positive driving arrangement for the feed, in which the chain is dispensed with, and machine cut wheels are used instead. The space between the licker-in and first clearer is quite filled in by steel plates. A stripping plate is arranged above the taker-in to facilitate stripping and grinding. The "fancy" also is covered in by means of a hinged plate, which can be lowered as required, the covering extending almost round the "fancy," except at its point of contact between itself and the cylinder. Extra carrier and tensioning pulleys are used for the rope which drives the clearers. The doffer comb is driven directly from a very large rope pulley fixed on the cylinder shaft instead of through the medium of the fancy roller, as in many cases. The finisher card may be constructed by this firm either to work on the Scotch feed principle, or to receive laps made at the Derby doubler. In the same way they have patterns for constructing the delivery part of the finisher card, either upon the condenser or upon the four-coiler system, in which latter case this part almost resembles the delivery side of a draw frame in which four cans are being filled at one time, all the four can bottom plates being driven from a common centre.

In connexion with the condenser, Messrs. Tweedales and Smalley introduce a reciprocating motion for the leather rubbers, which is very positive in its operation. In this way the rebounding of the rubbers is much reduced, if not altogether done away with, this being so much the better for the quality of the strands of cotton waste herewith produced. Cold-drawn seamless tubing is used for the rubbers to run on, and with the idea of securing the maximum strength with the minimum weight. It is necessary in this connexion to take up the stretch of the rubbers, and at the same time to maintain true running of the rollers and rubbers. The up-to-date breaker and finisher carding engines of this firm are constructed on sensible and acceptable English principles, without any elaborate devices.

Patent Automatic Feeding Machine for Breaking Carding Engines.
(See fig. 24.)

This machine takes the place of the single-beater lap-forming scutching machine. It is well suited in cases where a small plant is installed, and when wastes of various colours or of the lowest quality are to be carded.

The hopper of the feeder is kept supplied with loose material by the attendant, who puts in a quantity at intervals of time ; it is carried upwards by means of an inclined spiked lattice, and is then stripped by a comb and falls into a scale pan. After the required weight has been deposited the inclined lattice stops, the scale opens automatically at regular intervals, which can be adjusted to suit, and the material falls on the travelling lattice of the carding engine and is spread evenly so as to give a regular feed.

The feeder is driven by means of a belt from cylinder of carding engine.

Space Occupied.—When the patent automatic feeder is substituted for a double scutcher-lap feeder it adds 2 ft. 2 in. to the length of the engine.

Approximate Weights, Speeds, etc. (See fig. 24.)

Driving Pulleys.			Power Required.	Approximate Weights and Outside Measurement.		
Diam.	Width.	Speed per min.		Gross.	Net.	When Packed.
14 in.	3 in.	100 to 110 revs.	1 I.H.P.	$18\frac{1}{2}$ cwts.	$12\frac{1}{4}$ cwts.	72 cub. ft.

Tatham's Single Finishing Carding Engine with Patent Quadruple Coiling and Can Motion.

(40 in. and 48 in. on the wire.) (See fig. 35.)

The coiler or preparation system is recommended when broken up hard waste is to be made up into yarns where strength is required rather than evenness, and when counts finer than 8's or 10's require to be spun.

Specification.—One cylinder 50 in. diameter. One doffer 25 in. diameter. One taker-in 9 in. diameter. Seven rollers 5 in. diameter of iron or 6 in. diameter, wood lagged. Seven clearers 3 in diameter. One fancy 7 in. diameter, wood lagged, and driven by rope direct from cylinder. One humbug roller 3 in. diameter under feed roller and taker-in. Improved concentric bends. Steel cover and shell ends to taker-in. Polished mahogany covers over rollers, clearers, and fancy. Rollers driven by rope or chain. Dish feeder with one fluted roller $2\frac{1}{4}$ in. diameter, and arranged to receive two half-width or one full-width Derby doubler laps. Improved pattern doffing comb and motion, and patent quadruple coiling and can motion.

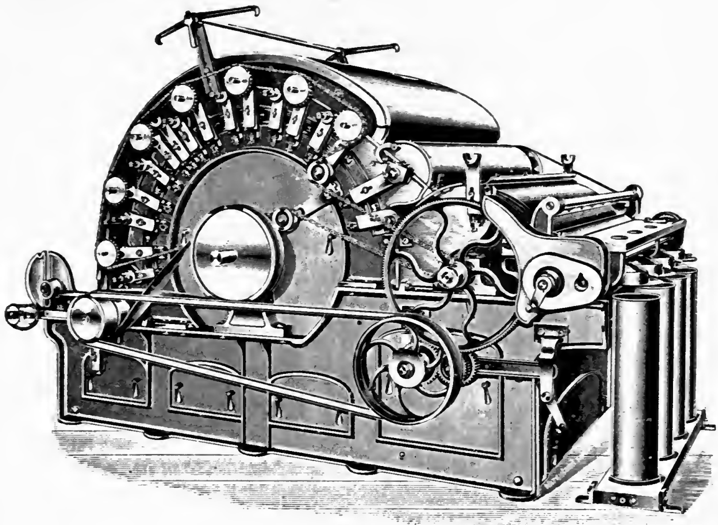


FIG. 35.—Finisher Card, with Quadruple Coilers.

Special Features.—The concentric bends are of an improved type, and the roller, clearer, and fancy brackets, etc., are adjusted by means of screws and two hexagon nuts, both vertically and sideways, one screw-key now fitting all the nuts, and the combination provides the strongest, simplest, and best arrangement required.

Self-oiling ring bearings to fancy.

The doffing comb and the driving motion have been re-designed, and the crank arm is secured to the doffing comb by means of a split boss.

Patent quadruple coiling and can motion. The fleece from the carding engine is separated into four or more slivers, either by steel-blade dividing apparatus, or by placing leather dividing-rings $\frac{1}{4}$ in. wide between the card rings on the doffer. The slivers then pass through funnels, between a pair of calender rollers to the coiling motion and into cans, which are usually taken to a slubbing frame, the bobbins from which are then ready for the creels of the self-acting mule or ring frame. Occasionally for the lower counts the cans from the finishing engine are taken direct to the back of the self-acting mule.

Extras.—Special steel-hinged cover and rail, to separate the fancy from the roller above, and filling-up pieces with small grooved shaft under the fancy, with shell ends to bearings as illustrated. (In lieu of extending the mahogany cover fitted with door as per specification.)

Shell ends to roller, clearer, and fancy bearings.

Angle-bar undercasings in halves, with improved setting arrangement to cylinder and taker-in.

Sextuple coiling and can motion, in lieu of quadruple coiling and can motion, for the finer counts.

Feeders to receive four half-width or two full-width Derby doubler laps.

Taker-in covered with inserted wire.

Fig. 35 shows the special steel-hinged cover and rail over the fancy, and filling-up pieces with small grooved shaft under fancy as named in extras. This is frequently applied to finishing engines in lieu of the mahogany cover with door being extended over fancy as named in specification.

The proved concentric bends have been substituted for the pattern illustrated.

Production.—About 1000 lb. of broken-up cop bottoms, comber waste, etc., per week of fifty-six hours.

Dimensions, Weights, Speeds, etc.

Space Occupied.		Driving Pulleys.			Power Required.	Approximate Weights and Outside Measurement.		
Length.	Width.	Diam.	Width.	Speed per min.		Gross.	Net.	When Packed.
10 ft. 0 in.	6 ft. 10 in.	20 in.	for 3 in. belt.	75 to 85 revs.	about $1\frac{1}{2}$ I.H.P.	75 cwts.	55 cwts.	350 cub. ft.

Adjustment of Rollers and Clearers.

It may be as well to expend a word or two upon the method of sustaining and adjusting the various rollers and clearers that are employed on a roller and clearer card, whether used for the carding of ordinary cotton or cotton waste. There is, of course, no flexible bend, and no equivalent adjustable bend, as used for the sustention and adjustment of the flats of a modern revolving flat carding engine. Each roller and clearer is supported by independent end bearings, each of which is secured to the rigid bend of the card, in a manner which permits of adjustment to the cylinder, and also to one another. Here it may as well be understood that the fine settings of 5-1000 in. and 7-1000 in. that we hear so much of in cotton carding are neither sought nor obtained in the usual practice of cotton-waste carding. A good cotton carder, or even a grinder, may well be astonished at the rough adjustments often deemed sufficiently good in the carding of cotton waste.

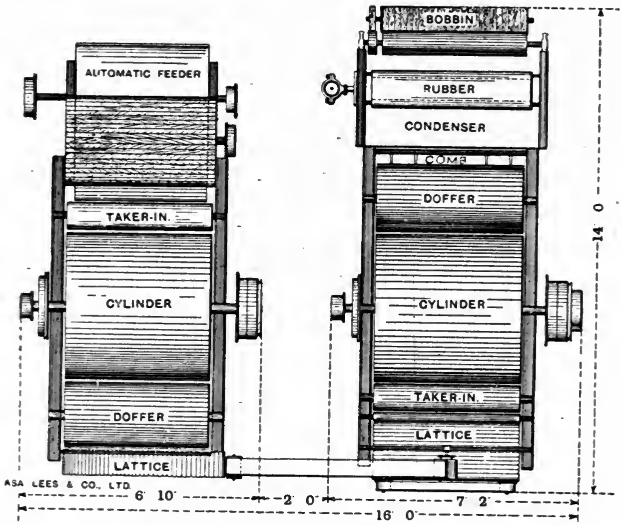


FIG. 36.—Plan of Breaker and Finisher Cards with Scotch Feed.

All the open ended roller brackets may be bolted to the semicircular frame, and equipped with finely threaded screws by which each roller can be raised or lowered to a nicety. The clearers may be similarly adjusted when the wire of either the cylinder or the smaller rotary body may become sufficiently worn. In like manner by other fine screws suitably disposed each roller may be properly adjusted to its companion clearer.

A sufficient amount of concentricity of rigid bend to the cylinder is provided for at the machine shop by the use of special machinery, and in at least one recent case, instead of forming the rigid bend all in one piece, separate and independent filling-in pieces are provided for the necks of the rollers and clearers. Necessarily these filling-in pieces are secured to the main bends by suitable bolts, and also the requisite finely threaded screws are provided for securing the adjustments before described. The filling-in pieces can be made to follow the curvature of the cylinder in the required concentric manner, and can be moved along the bend to the exact position required. Finished facings are used for the roller brackets to bed against, and therefore to obtain and maintain the requisite accuracy in working and in adjustment. Very fine plans of breaker and finisher cards are

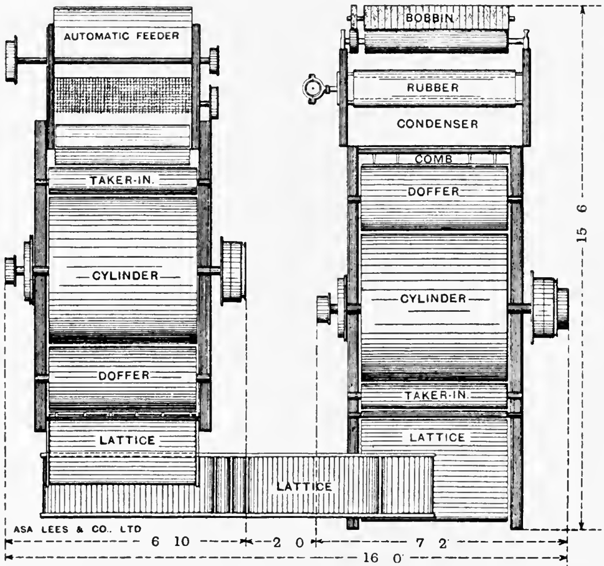


FIG. 37.—Plan of Breaker and Finisher Cards with Improved Lattice Feeder.

shown in figs. 36 and 37 by permission of Messrs. Asa Lees & Co., of Oldham. Fig. 36 indicates the Scotch feed and fig. 37 the Soho feed or straight-fibre feed.

Flat Card.

It has often been remarked that it is a peculiar circumstance that the roller and clearer card should retain its position, practically unchallenged for the carding of cotton waste, and yet it has become almost obsolete in the carding of ordinary raw cotton.

Why, for example, should the revolving flat card obtain a hold in this branch of trade, especially when it is remembered that double carding is wanted on the roller and clearer principle? Is it not possible to so modify the revolving flat card that single carding on this machine may do as well as double carding on the roller and clearer principle?

The "Humbug," "Fancy," and "Dirt" Rollers.

There are two special rollers used on cotton-waste cards which always attract a certain amount of curiosity on the part of the man accustomed only to ordinary cotton carding. These are the "fancy" and the "humbug". The "fancy" we have described previously as being used to raise the fibres a little out of the cylinder wire. The "humbug" roller is a different roller altogether, and occupies another position. It may be $3\frac{1}{8}$ in. diameter when clothed with inserted wire, and is placed beneath the feed roller and taker-in. This roller serves some slight cleaning purpose, and gives back to the licker-in some fibre that would otherwise escape, having a good surface speed.

The dirt roller is another common feature of the cotton-waste card, and is a very slowly revolving roller covered with coarse wire and placed immediately over the licker-in. It may have eight or nine revolutions per minute, and serves to take out hard ends, and some heavy dirt. Formerly used in cotton carding with roller cards.

It must be understood that neither the "fancy" roller, the "humbug" roller, nor the dirt roller are to be found upon the revolving flat carding engine for the ordinary carding of cotton. As a matter of fact, however, since a distinct position and use for these three rollers is found in cotton-waste carding, different people have considered whether it would be worth while to apply one or other to the flat card. At the present time cases exist in which modern revolving flat carding engines are working with special adaptations of the dirt roller placed over the licker-in, and for cottons containing a good deal of dirt there are to be found advocates for this very special practice. It may be possibly worth while considering how far the humbug, the fancy, and the dirt rollers may be applied to cotton cards, but the present writer is doubtful of their practical success.

General Remarks.

In our previous pages we have at some length described the processes and details relating to cotton-waste carding as carried out in this country. As stated, the subject is a very present day one, and without doubt a good many more individuals are now turning their thoughts a good deal more towards the utilization and manufacture of cotton waste than was the case a few years ago. This is true in more senses than one, because there is now in the first place the far more extensive use of such machines as roving waste openers, and many mills now use these machines to open out their own bobbin waste, and then mix the opened waste with their ordinary cotton mixings, whereas it was formerly much more common to sell the waste, although some people always did use up such waste and managed to pull and open it of a fashion by means of their ordinary blow-room machinery. Then, again, we have the extensive adoption of the comber for the combing of the strippings from the flats of the carding engines. There are also hard-end extractors for recovering the hard end from the crow laps, or under clearer waste of mules and ring frames, but these do not appear to have met with anything like the success accorded to cotton-waste combing, and to the opening of bobbin

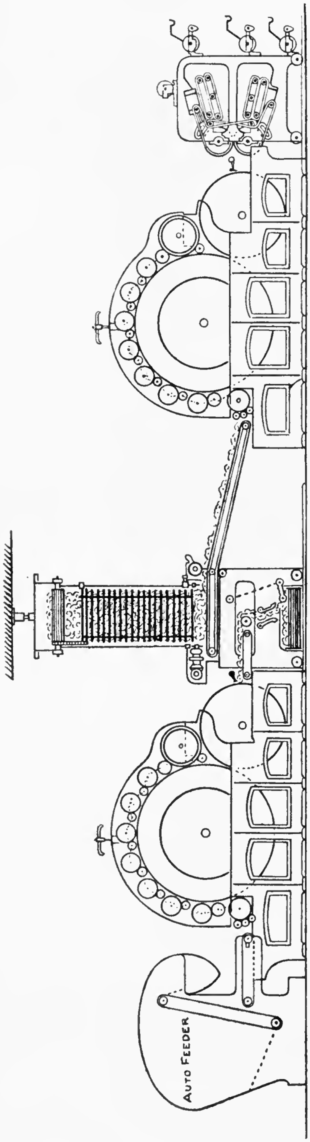


FIG. 38.—Breaker and Finisher Carding Engines.

waste. All these efforts are quite distinct from the treatment of hard waste and the lower qualities of soft cotton waste entirely upon the condenser waste spinning principle, and the production of condenser yarns after the manner we have been explaining.

The Universal Carding Principle.

We have previously described the ring doffer and the tape condenser carding arrangements as made by Messrs. Platt Bros. & Co., of Oldham, and Messrs. Asa Lees & Co., of Oldham, and the author paid a visit to the Phœnix Works of Messrs. John Hetherington & Sons, Manchester, in order to inspect the latest arrangements for cotton-waste carding, as constructed on the principles of Messrs. G. Josephy's Erben, of Beilitz, Austria. We saw the double waste carding set in full work, and studied it well. Some of the special features of this universal carding set it is our business to briefly explain at this point. The first features that presented themselves forcibly to the present writer were the feeding by means of a hopper at the initial end of the breaker card, and the straight fibre feed and wide lattice arrangement for transferring the cotton waste from breaker to finisher card. In a general way these features are explained in previous pages of this book and termed the "Improved Lattice Feed". Allowing for difference in detail of construction and arrangement it appears safe to say that the general features and principles of the "Soho Feed" and the "Universal Feed to Finisher" have a very strong resemblance to each other.

Universal Cotton Waste Set, 72 *in. Wide.*

We deem it best for our readers to give the specifications of this cotton-waste carding set, and for the breaker card this is as follows: Automatic hopper ~~feed~~ with large feed box, and automatic exact weighing scale; three patent spiral feed rollers; taker-in; cylinder or swift 50 in. diameter, with five pairs of rollers or workers and small clearers; universal double doffing; cleaning and separating device; main doffer 36 in. diameter. The web carried by Josephy's; patent diagonal or length fibre band feed to the carder.

For the finisher the specification reads somewhat as follows:

Automatic tabling, feed table with patent spreader and evener, three patent spiral feed rollers, single or double taker-in, swift or cylinder 50 in. diameter, with five pairs of workers and universal double doffing, cleaning, and separating device. Main doffer 36 in. diameter, and various improvements. Josephy's patent tape condenser, with narrow or broad rubbers as desired, and specially efficient patent rubbing motion, four bobbiners, with 92 to 200 good threads, six bobbiners with 150 to 240 good threads.

Tape Condensers.

It must be quite understood that the ring-doffer condenser is considered to be somewhat out of date on the Continent of Europe, although all our own investigation leads us to the conclusion that in England it is yet the favourite and most-used system for the carding of cotton waste, since it is the oldest and simplest arrangement. As previously stated, tape condensing is, however, on the increase in England, and the Josephy types claim to be up to date in tape condensers. The latest improved type of tape condenser combines all the advantages of Josephy's previously successful types. It has proved to be well adapted for various classes of materials, both long and short fibred, and also mixed. The latest type is made in three models: (1) With narrow rubbers and special rubbing stroke for all lightly rubbed materials, particularly as referring to cotton waste; (2) with broader rubbers for strong rubbing for wool and woollen waste; (3) with extra broad rubbers and three adjustable pressure rollers, and special rubbing motion to replace the cumbersome tandem rubber.

Josephy's latest improved fluted roller patent tape condenser is the general term applied to this condenser. It is claimed that very many of Josephy's tape condensers have been sold, and especially so when it is considered that quite a number of special devices relating to tape condensing have been placed on the market by different firms since the first introduction of tape condensing on the initiation of Ernest Gessner in 1868. Up to this time the ring doffer was the universal device for splitting up the fleece of cotton waste from the cylinder into the requisite number of individual slubbing strands. Since 1868 many improvements have been made in tape condensers, and, as before stated, we are informed that the old-fashioned ring doffer has become almost obsolete on the Continent, and is there considered to be totally inadequate in production required to suit an expending business.

It is probably not too much to say that simultaneously with the introduction and rapid adoption of the tape condenser on the Continent, combined with the splendid boom in ordinary cotton spinning following the Franco-German war, Lancashire to a great extent lost its business in the carding and spinning of cotton waste to Germany, Austria, and Belgium, and during the last thirty years the cotton-waste and allied trades have grown to such an extent in these countries that Lancashire has been satisfied to ship a very large proportion of its cotton waste to the Continent. This might not appear so bad were it not for the fact that much of this waste is spun into yarn on the condenser system on the Continent, various coloured effects are produced by bleaching and

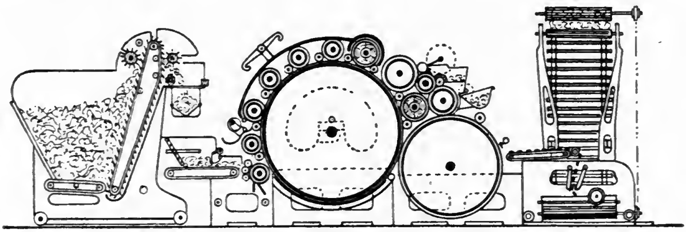


FIG. 39.—Cotton Waste Card with Hopper Feeder.

dyeing the cotton at one stage or another, various fancy effects are produced by knopping and other means, and then a good deal of such yarn is re-imported into England. In these days of cotton classes, text-books, increased education of operatives and managers, it does appear as if there ought to be now more of a tendency in England for all such work to be done in England, at any rate to the extent of not needing to import cotton-waste yarns. It ought to be the case that some of our largest spinning concerns —and there are now some very large ones—ought to make some profit out of using their own waste, especially in slack times. All this, of course, is quite apart from the type or special make of machinery put into use.

Double Doffing Arrangement for Cotton Waste Cards.

In regard to the Josephy condensers and the universal carding process, we have to refer now to a very special feature of this card, namely, the adoption of a particular arrangement of the two-doffer system, or the use of the ordinary doffer, and also an extra and smaller one, for the express purpose of more perfectly stripping the cotton waste from the main cylinder the first time of asking, and thus aiding in quantity and quality of carding. The Austrian machine makers can certainly claim to have paid so much attention to wool and cotton-waste carding engines as to take rank as specialists in this direction, and they have during many years past devoted a large outlay of capital, a great deal of time and ingenuity, and great energy to the further development of the principle originally put forth by Ernest Gessner, i.e. the problem of how to clear the main cylinder thoroughly from all carded material at every revolution of the same, and with comparatively small accumulations of dirt and fibre in the cylinder wire. It almost follows if such an effect can be produced without corresponding disadvantage, that the output will be greater and the yarn better.

It is claimed that in the universal carding engine Messrs. Josephy have solved the problem of more thoroughly cleaning the cylinder by the introduction of their double doffing arrangement. We have carefully studied diagrams relating to the original Gessner arrangement with two fancies and two doffers, and find that he employed two separate doffer combs and two lattices, which conducted the two separate webs to a pair of pressure rollers between which the two webs are combined into one web for the condenser. Now, let us point out the special purpose of the double doffing arrangement, as this is a very special feature not previously referred to in this book. In this case there are two fancies and two doffers, but there is only one delivery and only one fleece of cotton. The first fancy roller comes immediately after the last of the five workers, and it operates upon the principle that the cotton on the cylinder can be divided into two portions, an upper and a lower layer. The first fancy raises the upper layer of cotton from the cylinder, containing a very large proportion of the impurities, its surface revolving against that of the cylinder, and its teeth pointing against the teeth of the cylinder. The material picked up by the first fancy is conducted to the small extra doffer which is placed immediately above the large lower doffer, which latter occupies practically the same position as the doffer of any other card. The small doffer revolves in the opposite direction from the large doffer, so that their contact surfaces revolve in the same direction, and the top layer of cotton is given from first or top doffer to the second one. In its progress from cylinder to fancy and from fancy to top doffer, in this top layer of cotton the fibre is stretched, lashed out, and in a sort of manner the fibres are combed. The impurities, such as seeds, leaf, and hard threads, are removed by a cleaning device into troughs, and this refined web is passed through another carding process. At the same time the second fancy raises the remaining inside clean and well-carded fleece of cotton waste from the cylinder, and the two cleaned and equalized webs of cotton waste are joined together in the chief carding contact between the cylinder and second or chief doffer, to be then taken off this second doffer in one delivery by the fly-comb in the ordinary well-known manner.

In this way, by raising the cotton waste from the wire of the cylinder by the aid of two different fancies, and by using two doffers, a much more effective cleaning of the cotton from the main cylinder is obtained, and becomes almost perfectly empty of cotton after the chief carding contact. As a natural result much less cleaning of main cylinder is required than with the one doffer method.

Messrs. Josephy claim by means of this ingenious device to combine the productiveness of the double-doffer system, with the excellent quality of yarn often obtained by the one-doffer system; they claim to have made the universal carding set generally suitable for different textile trades, and for coarse, medium, and fine yarns. It is further claimed that these powerful machines occupy comparatively little floor space, especially when the universal carding machine is accompanied by the use of Josephy's continuous spinning frame. Coming down to definite productions, this firm quotes the following particulars, and offers a guarantee as to their genuineness: Universal carding set, patent tape condensers, 72 in. wide, both for hard and soft waste: No. 1's yarn, ninety-six good threads on tape condenser, 750 lb. of output in ten hours. Counts 6's, 610 good threads, 500 lb. output in ten hours. Counts 12's, 240 good threads, 310 lb. output in ten hours. Such productions—with equivalents in other counts—are stated to be obtained in Austria, Germany, Russia, and Belgium.

Naturally the use of a hopper feeder to the breaker card dispenses with the preliminary use of the scutcher, as laps of cotton are never made, the broken-up cotton waste passing straight from the bin into the hopper feed in a loose form. A strong point is made of the fact that ring doffers are not used, and that the tapes of the tape condenser are comparatively narrow. Certainly the ring doffer does limit the degree of fineness to which the material may be reduced at the condenser. It is claimed that from four to six times as many good threads can be given on this universal tape condenser as on the ring doffer, and that cop bottoms can be reduced to counts 8's or so at the condenser, and then reduced to 12's or so at the final spinning process without using much draught at this process. About 4's counts is good at the ring doffer to be reduced to 7's or 8's at the condenser mule.

Other Double Doffer Condensers.

Such of our readers as are familiar with ordinary cotton-spinning machinery but not with cotton-waste or wool carding must not imagine that the principle of using a double doffer is peculiar to the universal carding set, but a special arrangement of double doffer, double fancy, and narrow tape condenser is part of this carding machine.

There is, for example, another type of double doffer arrangement which anwers somewhat to the following description. The doffers may each be 22 in. or 24 in. diameter, and be mounted one above the other with both in actual contact with the cylinder, and the two doffers separated only by a space of about four in. Upon each doffer are mounted card rings upon the principle of the ring doffer previously described in these columns, each ring of fillet representing one end of cotton waste. There may be the usual dividing leather rings between the filleting rings, and the special feature to be noticed in this double-doffer system is that the rings of fillet upon one doffer are placed opposite the spaces of the other doffer. In a case, for example, thirty-eight good and two spoiled strands, then each doffer would be mounted with twenty rings of fillet of $1\frac{1}{8}$ in. or $1\frac{3}{16}$ in. width, with spaces between of the same width, these spaces being wider than is usual with the single ring-doffer system, and the width of the carding engine be suitable to the number of strands of fibrous material taken off the machine. Each doffer in this case is stripped of its strands of fibre by a roller stripper, and has its own set of rubbers, which may or may not be arranged each on the tandem system.

Among the disadvantages of this system may be mentioned that the two doffers rarely deliver slivers of the same weight or counts, since the upper doffer generally takes more than its share of fibre from the cylinder. This is so true that regularly the strands or slivers from the upper doffer are spun separately from those spun on the lower doffer. It is claimed that no such defect can occur on the Josephy or universal carding set, and this is a

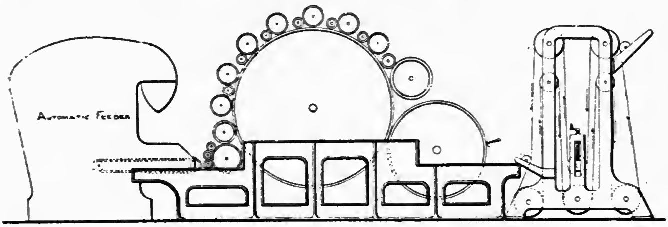


FIG. 40.—Card for Cotton Wadding.

strong point, because it has always been found difficult to adjust any condenser to strip simultaneously at two places, and deliver accurately two or more different sets of threads of the same counts. In any case a double doffer condenser should be expected to strip the cylinder more perfectly than a single condenser.

A wadding card as made by Hetherington's is shown fig. 40 and one on the lap drum principle in fig. 41 by same makers.

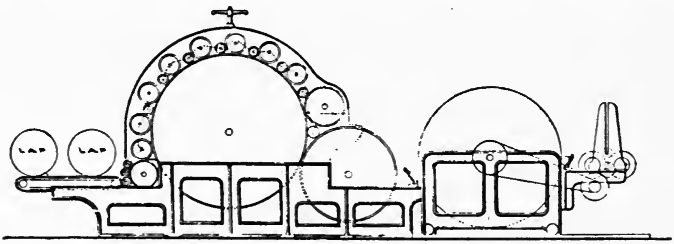


FIG. 41.—Card for Cotton Wadding.

Condenser Bobbins.

The long bobbin upon which the thin slivers from the condenser card are wound, and which is taken direct from the front of the card to the suitably arranged creel of the condenser mule, has given trouble on many occasions by developing one defect or another.

One defect has been the liability for the flanges to work loose upon the central spindle, and thus allow the end rounds of sliver to fall out of shape, thereby causing many breakages of ends to occur at the spinning machine.

This has been often due to a want of proper support of the flanges, as they have often been made with only a small hole just sufficiently large to admit the long spindle which passes right through the bobbin and is screwed up to bring the flanges tightly against the wooden ends of the barrel or core. In such cases when the latter shrinks the flanges become loose.

Yet another defect has sometimes been manifest in the flanges themselves, these being often made of thin sheet iron, so that when the bobbins are put down on the floor by the piecers the flanges either cut the floor if it is a wooden one, or themselves become damaged if the floor be of stone. In a particular improved make of long condenser bobbin, the core is turned slightly smaller in diameter than the main body at each end, and on these smaller portions are fixed metal ferrules, provided at their outer ends with square bosses in the form of four separate projecting pieces. The flanges are placed on these bosses and the projecting pieces turned back upon them, thus securing the flanges independently to the bolt. The latter is then passed through the hollow core of the bobbin and screwed up in the usual way. If the core shrinks longitudinally and the bolt becomes loose the flanges will still retain their rigidity and will also sustain the shock if bobbins are thrown on the floor.

The Waste Card Condenser.

It is claimed for the tape condenser that it is much more adaptable to different counts of sliver than is the ring doffer. Also that it is a more productive machine and will certainly give far and away finer counts, especially if a double or treble or quadruple condenser be used. It is claimed that 1000 lb. per week may be given by a double tape condenser for 6's. As against this it may be urged that English people are for the most part more accustomed to the ring doffer and use is second nature. Also that it is eminently suited to the medium and lower counts of cotton-waste yarns and to limited ranges of counts. Yet another item in its favour is its extreme simplicity and comparatively small liability to get out of order. The narrow strips of filleting on the ring doffer may be said to tear the web of cotton waste from the cylinder into strips or slivers, whereas the tape condenser obtains this division more by the exercise of pressure.

The use of the cams for the rubbers and the peculiar action of the rubbers makes a condenser appear a very complicated arrangement to a tyro, but really the whole thing is quite simple, and the cam shaft and various connected parts can easily be wheeled away for repairs to the leathers. Steel-tape condensers

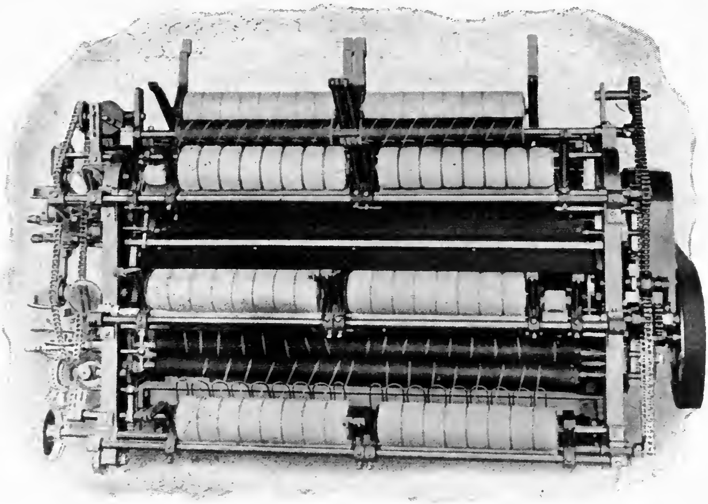


FIG. 42.—Condenser for Finisher Card.

have not met with much acceptance in England at any rate. There are some who consider the double-tape condenser the best one possible for cotton waste in the higher counts. A good illustration of a triple condenser by a well-known firm is given fig 42.

Feed Rollers of Card.

Practice varies somewhat as regards the feed rollers, since some prefer a pair of thin fluted feed-rollers, others one feed-roller with dish feed, while still others prefer a pair of feed-rollers with saw tooth wire, and perhaps this is the best in view of the objectionable things which sometimes come along with the cotton.

Special Rollers.

There appears to be somewhat more latitude for special ideas in cotton-waste carding than in ordinary cotton carding. For example, in some cases one of the rollers has been made to continuously oscillate across the cylinder in a similar manner to a long grinding roller. Probably this is done to lay the cotton well down on the cylinder, and for the same reason one of the rollers may be driven much more slowly than the others. These devices, however, partake a little of the nature of fads.

Preparation System.

This particular system, using a slubbing frame, and using creel bobbins at the mule, appears to be more especially used for coarse twist yarns in which greater strength is required than in weft yarns, owing to the friction and strain put on the twist yarn at intermediate stages, and at the loom by reeds and healds.

Waste Carding Engines; Double Cards.

It is rarely that double cards have been used for cotton waste in England, although it is usual to double card the cotton by passing it through a single breaker card and then a single finisher. By double card as above is meant a card with two cylinders and two doffers but only one feed and delivery.

Dirt Roller.

The dirt roller is of distinct service on a waste card as its coarse wire adheres to a good many hard ends and a good deal of dirt of various kinds. It always has a very slow rotation.

The Humbug.

This small roller (about 2 in. diameter) is placed beneath the licker-in and serves the purpose of preventing the escape of fibre. A similar roller may be placed beneath the doffer. There does not appear to be any particular reason forthcoming as to why these terms of "humbug" and "fancy" should be used.

The Fancy.

This roller goes at a quick speed, and practically raises a nap of cotton on the cylinder surface so that the doffer will afterwards take the cotton from the cylinder in an efficient manner. Its long wires should penetrate those of the cylinder from $\frac{1}{32}$ in. to $\frac{1}{16}$ in. deep.

Roughly speaking a scutcher for waste may cost about £100, a breaker and finisher card with condenser about £300, a hopper £30 to £35.

Condenser.

The rubbers should do no more rubbing than is necessary for the required consistency of the rovings, and may be possibly $\frac{5}{16}$ in. apart at the initial end, and easily close at the terminal end. Press rollers may be used in the centre of the rubbers to help in keeping them better to the cotton strands. The rubbers should be as straight and level as possible across the width. Tapes should be as accessible as possible to facilitate repairs or adjustments. It is considered best to have condenser bobbins which look as full as possible for the particular counts.

Combined Driving for Cards.

Formerly it was common enough to drive a finisher card independently from its finisher even with the Scotch or the lattice feeders, but irregular results were often obtained from this practice owing to one belt slipping more than its companion. By using a common driving belt to breaker and finisher, uniform starting, stopping, and driving are obtained in this particular respect.

Also in connexion with Scotch feeders and lattice feeders, chain driving for some of the details is found to do better than rope or belt driving.

Improved Waste Slubbing Frame for Preparatory System.

This frame has been designed especially for cotton-waste spinning, and is arranged to receive the cans from the finishing engine with quadruple or sextuple coiling and can motions.

The length of lift, diameter of full bobbin, size of top and bottom rollers, and other details contained in these frames, are found from experience to give the best results, and the patterns are quite up-to-date in every respect. The full bobbins are taken either to the self-acting mule or ring frame. (See fig. 43).

These frames are made in all lengths up to 152 spindles.

Specification.—Spindles $\frac{5}{8}$ in. diameter 9 in. lift, to make a bobbin $4\frac{1}{4}$ in. diameter 6 in. pitch, 24 in. staff. Flyers with single centrifugal pressers. Bobbin to lead. One line of tin rollers and guide wires behind. Three lines of bottom fluted rollers, 1 in.,

$\frac{7}{8}$ in. and 1 in. diameter. All bottom-roller necks hardened. Solid top rollers for one or two threads to a boss. Polished iron top clearers for stationary cloth. Improved cone-lifting and strap-tightening motion. Full bobbin stop motion. Automatic locking

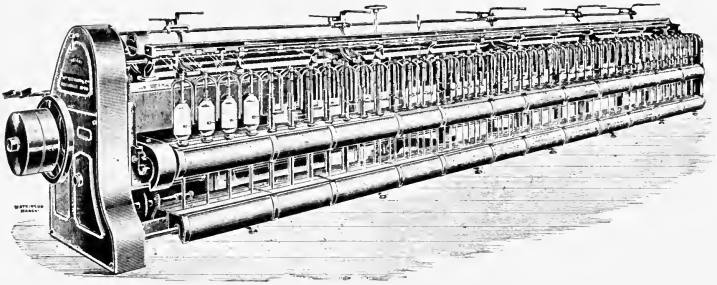


FIG. 43.—Slubbing Frame for Cotton Waste.

door to jack motion, and fitted with patent "grip" spindle rail and long collars, or collars can be fixed by two lock nuts ; patent "duplex" traverse bars and motion ; patent "endless" cone-drum driving belt ; Ormes' hank indicator.

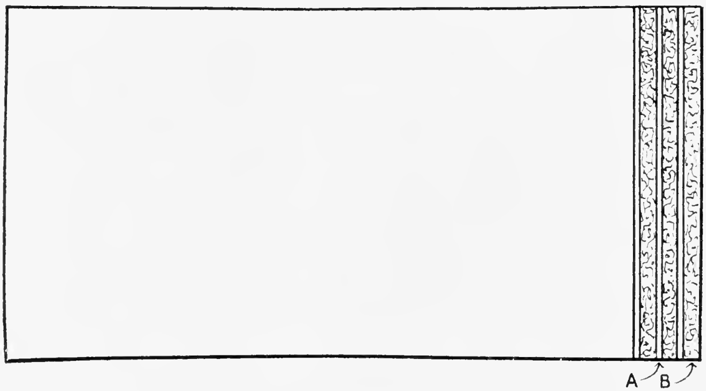


FIG. 43A.—Ring Doffer.
A represents the Leather Ring, B the Ring of Fillet.

Special Features.—Patent grip spindle rail. The long collars are secured by means of a split boss with set screw attached to the rails, giving a simple and true method of fixing same and effecting a saving in driving power.

Patent duplex traverse bars and motion equalize the pressure of the rollers upon the slivers, making the draught more regular, ensure even and lasting wear of the roller leathers, and improve the quality of the yarn.

Patent endless cone-drum driving belt is self-adapting to the taper and curve of cone drums, ensuring more powerful driving and accuracy of speeds.

Extras.—Patent self-locking loose boss-top rollers, in which the loose bosses are prevented from slipping off the axles by means of a small spring fitting in a groove in the axle, and projecting into a corresponding groove cut inside the loose boss.

Driving at both ends of frame.

Production.—One frame of say 144 spindles will follow four finishing carding engines. The slubbing bobbin varies from one to two hanks. (Fig. 43 shows a machine by Messrs. Tatham.)

FIG. 43B.—Grinding Frame and Grinding Roller for the Rollers of Cotton Waste Cards.

Dimensions, Weights, Speeds, etc., of a Frame of 144 *Spindles.*

Space Occupied.		Driving Pulleys, Fast and Loose.			Power Required.	Approximate Weights and Outside Measurement.		
Length.	Width, including space for cans.	Diam.	Width.	Speed per Min.		Gross.	Net.	When Packed.
39 ft.	4 ft. 6 in.	14 in.	for 3 in. strap.	360-400 revs.	about 3 I.H.P.	102 cwts.	90 cwts.	290 cub. ft.

CHAPTER V.

FINAL SPINNING MACHINES FOR COTTON WASTE.

Peculiar Spinning Machines.

To very many persons interested in cotton spinning it is not known that there are machines largely used in the spinning of cotton waste or wool which are entirely different in principles and practice from either the self-acting mule, the ring frame, or even the flyer-frame.

The Can Spinning Frame.

One of these peculiar spinning machines is sometimes termed the "Can Spinning Frame". In regard to the spindles, this machine is very largely built upon the lines and principles of the well-known pirn winding frame so extensively used in connexion with the winding of bleached and dyed yarns that have been treated in the form of hanks, and are again re-wound in cop form at the pirn winding machine, ready for use as weft in the shuttle of the loom. In the can frame the cotton strands from the long condenser bobbins are used, and are converted into yarn suitable for the weft of coarse goods. On the waste mule, however, the long condenser bobbins are placed in the mule creel in complete form as taken from the condenser, but this is not at all true of the "can spinning frame". In this latter case the long condenser bobbin is made with a removable end or flange, and each separate spool or round of cotton waste is drawn separately off the end of the long condenser bobbin. This comparatively small portion of cotton is placed inside a special can of the orthodox 9 in. diameter, but only about 3 in. or so deep. Each of these shallow cans is fitted with a lid containing a central aperture through which the cotton strand is withdrawn at the can spinning machine. The use of these cans constitutes the most distinctive feature of the machine, and gives the name to the machine, and it must be very particularly noted that the yarn is not twisted by the spindle, but by a moderately quick rotation being given to each can. The shallow cans of condenser cotton really form the creel of the machine, and they are placed low down and in front of the machine much the same as are the cops or bobbins of a winding frame. The loose cotton spool fits nicely inside the can and the cotton is withdrawn from the centre of the spool—and not the outside—and, as before stated, passes through a small aperture in the centre of the lid of the can. The manner in which the cotton thread is held at both ends and the relation of the hole in the can lid to the point at which the cotton is leaving the spool inside make it possible for twist to be inserted, there being some sort of resemblance between this twisting principle and that by which a draw-frame coiler is said to put a little twist in the sliver, although the can of the can frame revolves very much faster than the can of a coiler, and therefore much more twist is inserted. Compared with a spindle, however, the speed of the can is exceedingly low. For all that, this machine is not well fitted for making the finer counts of cotton-waste yarn—say, anything above 5's or so—not alone or so much because its twisting capacity is limited, but also because there is no draught in the machine either by roller drawing or carriage draught. The ordinary cotton waste condenser mule is, of course, limited in draught to about two, but to be readily able to draw a condenser end from 4's into 7's or 8's or so is far different from being forced to leave the end at 4's counts just as fed to the machine. This is one of the essential differences in effect produced by the can frame and other waste spinning machines. Strictly speaking it is not a spinning frame at all, but only a twisting machine, since technically speaking the term spinning implies both twisting and attenuation of the cotton. The machine appears to find a special vogue in producing up to about 4's counts of yarn from end-drawn condenser spools, such yarns being low twisted and particularly suited for very coarse wefts. Each strand of cotton emerges from the centre of the can, passes upwards and over suitable guides, and thence through the slit in the cone-shaped cup and upon the spindle in cop form. The machine is probably the simplest one ever devised for spinning or twisting yarns of textile fibres, and it therefore requires very little skill in handling—either from a worker's or foreman's point of view—while comparatively little power is required to drive it proportionately to the weight of yarn produced. The 9 in. diameter of can is made to correspond with the diameter of full condenser bobbin produced on the finisher carding engine, and its use compels a wide spindle gauge, this being about $10\frac{1}{2}$ in. The machine, however, is duplicate or double-sided like a winding frame, which it really more resembles than it does a spinning machine.

The Spindle and Cop.

A word now in regard to the spindle. To a mule or ring frame man who has never considered the cone-cup method of placing yarn in cop form, an examination of the resultant spool or cop will be surprising. Such cops are well built, and may be produced either on full length spools or without such foundation. Take the pirn winding frame for example, there is no attempt to twist the yarn in this machine, its usual vogue being to take hanks of yarn that have been bleached or dyed, and re-wind them into cop form ready for the loom shuttle. It is common to use a thin spool which has a base the shape of the top cone of a mule cop. The bobbin is placed on a very long and specially shaped spindle, which is driven round in the usual manner. The cone of the bobbin is placed vertically in cone cup with the apex of the bobbin pointing downwards so that the cop is built down the spindle and bobbin instead of upwards, as on a mule or ring frame. The rotation of the spool alluded to draws the yarn from the hank round suitable guides and through a slit in the cup and upon the bobbin itself. Because the base or initial portion of the spool is of cone shape, the lift of the frame guides and shapes the yarn in a cone form upon the spool. The next feature requires a moment's consideration on the part of one who has not previously studied this copping problem. As the cop attains a certain diameter of cone from base to apex, it becomes too large to fit in the metal conical cup, and naturally is forced upwards so as to continually wind the yarn lower down the bobbin, the manner of holding and driving the spindle readily permitting this. A natural and simple copping motion is thus provided for each spindle itself. Now this pirn winding and cop shaping principle is the one essentially adopted on the can spinning frame, with perhaps the one important difference that at any rate for the orthodox size of cop or bobbin built up on the pirn winder the yarn remains upon the thin bobbin, the bobbin itself is placed in the shuttle, and the yarn is drawn off the coned extremity just as is the case with a mule cop or a ring frame bobbin. In the can frame, however, the cops attain a very large size in order to hold a sufficient length of the very thick yarn, so that any dimensions of cope up to 10 in. in length and 3 in. diameter may be attained on this machine. These cops are taken from the spindle and used without any bobbin inside. Another feature about these cops—which appears almost startling when witnessed by a mule man for the first time—is that in the loom the yarn is not drawn off the end of the nose or top cone, but is drawn from the inside of the cop, starting at the base or thick part. This for one thing accommodates itself to the method of helping to hold the huge cop in the shuttle by a longitudinal thin rod or band pressing against the outside of the cop. This unwinding of the cop from the inside is done with little or no trouble, and an extremely small amount of loss by waste, and is very much facilitated by the special method of crossing the yarn upon the cone. Here it may be stated as a definitely established fact that the orthodox method of winding the yarn upon a mule cop is not always the best for the absolute prevention of halching and spoiling cop noses; and for uniform unwinding of the yarn at the next processes. This is demonstrated, for example, by the special yarn crossing motions sometimes applied to self-acting mules, and in one particular case that could be described a very large amount of time and money have recently been expended in order to entirely dispense with the Sharps-Roberts mule copping motion, and adopt a radically different one in order to get a better crossing effect. In the can spinning frame the yarn is much more crossed both up and down, 64 in. of yarn being taken several times across the length of cone, and this very much helps in preventing the cops from breaking and in giving easy and certain unwinding from the inside of the cop. As stated, the yarn is built up on a spindle revolving in a conical iron cup, and the spindle is gradually forced upwards by the increasing diameter of cop, until the latter is sufficiently long. The steel spindle is then drawn out and the cop removed from it. The full length being attained, each spindle and its companion can are promptly stopped by an automatic stop-motion, which acts separately for each thread so that the whole of the frame need not be stopped at one time. The machine is a double-sided one like a winding frame, and covers a considerable width over all, the length being anything up to about 80 cans, as required. Finally it may be stated that if the yarn is required to be bleached and dyed before going to the next process, the can frame may be easily adopted to wind the yarn in hank form instead of in cop form.

The can or cup frame is not very largely used in England, but its special province is in the case of very coarse yarns of perhaps 1's or so from some of the poorest material used up in cotton-waste spinning.

Such stuff will not stand any draught at all and this machine only twists without draughting. Much of this coarse cheap stuff

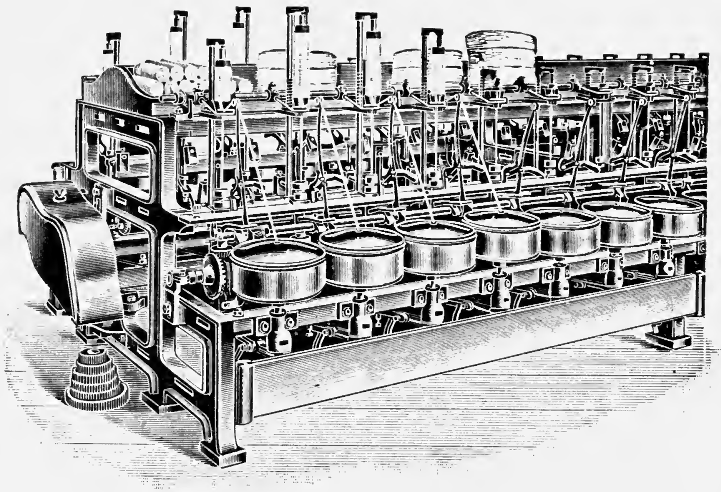


FIG. 44.- Cup-Spinning Machine (Tatham & Co.).

is, however, used in the backing and filling of some exceedingly good carpets and will take almost any colour in dyeing very readily.

The centre end of each small can of sliver is drawn through a small hole in the top of the can. A girl may mind the machine, and each spindle may be fitted with a knock-off motion. This is the kind of machine that is sometimes humorously said to spin double noughts (0,0's).

Cup-Spinning Machine.

The above machine is used for spinning a soft twisted weft yarn for low counts up to No. 3's, and the yarn is well adapted for cotton blankets, cleaning cloths, etc. (See fig. 44.)

Specification.—Spindles $10\frac{3}{8}$ in. gauge, one line to both front and back of the machine, with self-acting knocking-off motion to each spindle when a thread breaks or when the cop is full.

Special Features.—This machine takes the place of the mule and follows after the finishing carding engine. The full bobbins from the "condenser" are placed end up and the wooden barrel is pulled out, leaving the roving in the form of cheeses $9\frac{1}{2}$ in. diameter by 3 in. deep. These are then ready for the above machine and are placed in revolving spin-tops which make about 1300 revolutions per minute. The roving is drawn out from the inside, is passed through a small hole in the lid of the spin-top, and is twisted on its way to the square spindle inside the conical cup, which, by means of a thread guide moving up and down, builds the cop which is well crossed and solidly built about $1\frac{5}{8}$ in. diameter, or other size to suit shuttle.

The machine is made with as many as eighty-four spindles, forty-two on each side; it is simple in construction, and easy to work. The twist is altered by means of one change wheel. The labour cost is low, one girl will mind fourteen to twenty spindles according to the counts, and the output is large per spindle.

Approximate Production.

Counts spun . . .	No. 1's.	No. $1\frac{1}{2}$'s.	No. 2's.
Output per spindle per hour	1 lb.	$\frac{3}{4}$ lb.	$\frac{1}{2}$ lb.

Dimensions, Speeds, Weights, etc., of a Machine of Eighty-four Spindles.

Space Occupied.		Driving Pulleys.			Speed of Spin-tops.	Power Required	Approximate Weights.	
Length.	Width.	Diam.	Width.	Speed per minute.	Per minute.		Gross.	Net.
38 ft. 11 in.	6 ft. 3 in.	14 in.	3 in.	about 475 revs.	about 1300 revs.	about 3 I.H.P.	100 cwts.	80 cwts.

The Chapon Spinning Frame.

Previously we have described the "can" spinning frame and we now propose to describe the Chapon spinning frame (see figs. 45

and 46). The can frame and the Chapon machine have a good many points of resemblance in general construction and appearance, so much so that at a first glance a tyro might be inclined to think they were identical machines. There are, however, some very important differences in principles of construction and operation, as we shall make clear in the present article. Both these machines have a special vogue and capacity for the production of low counts of yarn, say, anything from ½'s counts up to about 3's or 4's from condenser bobbins. In both cases the cops are built up on the cone cop principle, as described previously, and in each case the cops are specially designed for use as weft in the weaving of such goods as cotton blankets, or in poorer stuff, as cleaning cloths, etc. In cotton blankets and similar woven goods this weft gives a very full appearance, superior in some respects to that obtained from yarn spun upon the self-acting mule. In each case the cop is formed in an iron cup, upon a long steel internal spindle, much similar to the pirn winding frame principle. The full length of cop is attained by the diameter of the cop itself continually forcing both cop and spindle upwards, and building the cop downwards. The completed cop is drawn off the steel spindle, which is lifted out for the purpose, and then replaced for the next cop. For the "can frame" and the "Chapon machine" cops alike box shuttles are used in the looms without shuttle tongues, the cop being held in its place by the external pressure of a light longitudinal band or rod, while the yarn is withdrawn from the inside and base of the cop, instead of from the apex of the top cone and outside surface, as is the invariable case with mule and ring frame yarn, and also in the case of cops or bobbins formed on the pirn winder. Although it is really a very simple machine the Chapon is somewhat more complicated than the can frame, simply because it is a more ambitious machine and has a somewhat greater scope. It has the advantage of using the full-length condenser bobbins in the creel in just the same way as on the waste-spinning condenser mule. The cone cup and long loose spindle are not only utilized for winding and shaping the yarn in cop form, but are also used for putting the twist in the yarn after much the same way as may be done in the well-known cotton-spinning machines. It is furthermore possible to construct a Chapon spinning frame so that the principle of roller draught may be utilized, and three pairs of rollers of small diameter may be used for this purpose—say, about $\frac{3}{4}$ in. diameter. It is not, however, the usual plan to construct the Chapon spinning frame with drawing rollers for the purpose of spinning cotton-waste yarns from condenser bobbins any more than it is the common plan to construct a waste condenser mule with such rollers, and the passage of the yarn from back bobbin to front spindle is on much the same lines as the mule spinning process. For example, the long condenser bobbins, each containing possibly from ten to sixteen strands which have been rubbed by the condenser rubbers into sufficient density and roundness to give satisfactory drawing-off at the spinning machine, are placed on tin surface drums of about 10 in. diameter, and are thereby unwound at a uniform surface speed. The width of the finisher carding engine may be variable, and thus give different widths of condenser bobbins, and the creel of the Chapon can be constructed to agree with this, but it is necessary to arrange one in relation to the other. For example, a Chapon spinning frame could be constructed to have ninety-six spindles in order to exactly measure out for eight back bobbins, each holding 12 ends; or there might be 104 spindles to agree with eight long back bobbins, each containing thirteen good ends from the finisher card. In the tin drum creel proper spaces are provided to hold the flanges of the long bobbins, and partly on account of this it is necessary to have each condenser bobbin somewhat shorter than the total space occupied by the several spindles which one bobbin serves. The spindle gauge is usually about $3\frac{1}{2}$ in. as compared with $10\frac{1}{2}$ in. of the can spinning frame, but the latter is a double-sided machine, while the Chapon machine only has spindles on one side, so that the comparison is more like 7 in. to $10\frac{1}{2}$ in., the duplicate can machine being wider than the Chapon. On this latter machine there are principally two sizes of spindles used, the No. 1 size being used to produce cops about 10 in. long and from 2 in. to $2\frac{1}{2}$ in. diameter, such as would be suitable for the lower range of yarn counts, say $\frac{1}{2}$'s up to 2's counts with 840 yds. per hank, as in ordinary cotton. For what may be termed the finer range of counts produced on the Chapon machine, say 2's to 4's, the No. 2 size of cop is more suitable, with any length up to 8 or 9 in., and a diameter of possibly $1\frac{3}{4}$ in. Each strand of cotton is delivered at a uniform rate of speed from the contact

FRONT VIEW.

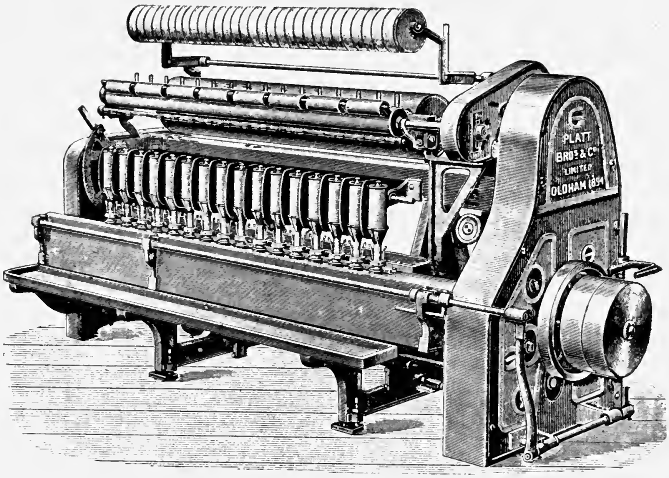


FIG. 45.—Chapon spinning frame. As used to spin very coarse yarns.

of the bobbin with the surface drums, and it passes between a

BACK VIEW.

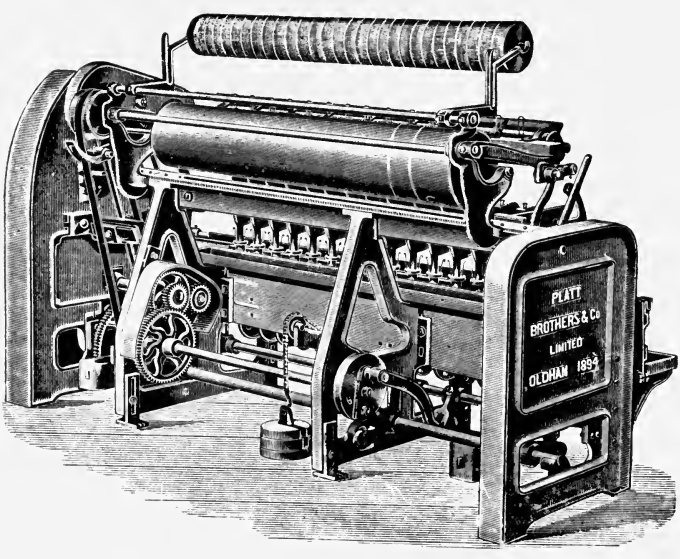


FIG. 46.—Chapon spinning frame. As used to spin very coarse yarns.

pair of positively driven conducting rollers, thence downwards to the eye or curl of a suitable rotating guide, through the slit in the conical cup, and upon the steel spindle passing down the centre of the cup. The guides or wire curls are given a sufficient traverse along the length of the cone of yarn while the height of the cone-cup remains constant, and the height of the spindle is being automatically increased by the thickness of the yarn in order to keep the cone part always equal in diameter and correct in height relatively to the cup and the traverse. To prevent the yarn from flying outwards too much, and to avoid twining of the threads, very deep smooth blinker separators are used between the spindles. Coming now to the rotation of the spindle itself and of the guide curls, it may be said that this is a much more important business than on the can machine, in which twisting is done at the creel can itself, and the spindle and cop wind and shape on the simplest plan imaginable just as on the pirn winding frame, each spindle or cop drawing its yarn from its own can at the variable speed required to suit the shape of the cone. On the Chapon machine there is a differential motion by which the bobbin or spindle and the guide curl ring are given different speeds in order to permit winding and twisting to take place simultaneously, somewhat after the winding and twisting of the rovings on a bobbin and fly-frame, but with distinct differences in principles and constructions, since on the Chapon frame the cotton is formed into a cop-shape and the spindle and bobbin form practically one piece. If the bobbin and the guide curl revolved at the same rate there would be twisting without winding, but each is definitely driven at a well-proportioned speed, so as to give a sufficient twisting and an amount of winding-on proportioned and equalized to the rate of delivery of cotton, first by the tin surface drums at the back, and then by the conducting rollers. (See figs. 45 and 46.) From a cotton spinner's point of view a particularly novel kind of differential motion is provided in order to accommodate the positive speed of cop to the uniform feed of cotton from back bobbin and to the varying diameter of the cop cone from apex to base. On the ordinary pirn winding frame the yarn is simply fed or drawn forward more rapidly when winding on the base of the cone of cop than when winding on the apex, and the whole thing is simplicity itself. It is an entirely different thing on the Chapon machine, in which the yarn is given off the long back condenser bobbins at a uniform speed. Assuming that winding has been made correct for winding on the apex of the cone of the cop when the lifter curls are in their lowest position, then, as the yarn is guided upwards towards the base by the raising of the lifter, the winding speed increases proportionately to the greater diameter of the base. To compensate for the quicker winding-on rate the guide rollers are given a well-proportioned downwards movement, towards the spindles, and this movement combined with the raising of the lifter curl wires gives the increase in length of yarn required by the greater diameter of cop. In other words, a differential winding-on motion is provided by causing the lifter and guide rollers to move towards each other, and give slack yarn as the winding point moves towards the base of the cone, while these two parts recede from each other and tend to take up the yarn when the winding-on point moves towards the apex of the cone of cop. This differential winding-on problem is a distinctly interesting and valuable one, and the comparatively rapid crossing of the yarn along the cone, not only facilitates the subsequent drawing-off of the yarn, but also helps to distribute the twist in the yarn sufficiently. The spindle speeds may be proportioned to the counts of yarn required, but are always comparatively low, reaching 700 or 800 revolutions per minute for counts 1½'s or 2's, with the larger dimensions of cop as above given, and up to about 1300 or 1400 revolutions per minute for 3's to 4's. It will be noticed that both counts and spindle speeds for this Chapon spinning machine are very much on a par with those obtaining on a range of bobbin and fly frames for ordinary cotton spinning including slubber, intermediate, and roving frames. There is, however, a much higher range of twist per inch put into the yarn from the Chapon frame. The production of this machine per spindle varies a great deal, according to class of waste used, ability of the operatives, twist per inch required, etc. This machine has been a good deal used on the Continent, and is understood to give a good production of soft weft; for sixty hours it is somewhat as follows:—

0·59	English	counts	=	34	lb.	per spindle.
1·18	,,	,,	=	28	,,	,,
1·77	,,	,,	=	22	,,	,,
2·36	,,	,,	=	18	,,	,,
2·95	,,	,,	=	14	,,	,,
3·54	,,	,,	=	12	,,	,,
4·13	,,	,,	=	9	,,	,,

THE SELF-ACTOR MULE.

Draughting of Cotton Waste on the Waste Mule.

Previously we have described two machines for the spinning of cotton waste which are rivals of the self-acting mule, especially in the lower ranges of counts from ·5 counts up to 4's or 5's. The can spinning frame of one or two firms and the Chapon spinning frame are the two machines alluded to, and are used to a considerable extent on the Continent of Europe, and to a much less extent in England for the spinning of cotton-waste yarns. They are much simpler than the mule, and are very productive, but have not the same capacity for varying and humouring the draught, and the twist in the yarn, the can frame being never made to put in draught, and the Chapon machine not being usually built that way. In England, at any rate, the self-acting mule is far and away the most used machine for the spinning of cotton waste or Barchant yarns. It is the almost invariable practice to use draught at the waste spinning mule, and there are three methods of draughting, all more or less in use, viz., (1) draughting out on the "ratching" or "second stretch" principle with the rollers entirely stopped; (2) draughting on the "gain" or "drag" principle with the carriage going faster than the delivery of cotton from the rollers; (3) draughting by rollers in the approved and orthodox fashion common to ordinary cotton spinning. The headstocks of mules for spinning cotton waste have been more usually constructed on the woollen mule principle with variable drawing-out scrolls instead of the uniform kind—that is, the type of scroll in common use for drawing in the carriage of an ordinary cotton-spinning mule has been adopted also for drawing the carriage out, this being suitable for the great amount of carriage draught required and the variable speeds of spindle adopted during the outward traverse of the carriage. To suit the varied requirements in regard to draught it is possible to have waste spinning mules constructed in three different styles in regard to the drawing rollers and roller beams. The first style—and, apparently, by far the most common one—consists in having two lines of bottom rollers, and one top line fitting upon and between these two, and all the rollers polished and without flutes or other departure from the smooth plain style. As stated, this is probably the most used of any, and is greatly extending in use, being specially adapted to the long condenser bobbins from good condenser carding engines. The bottom rollers may be fluted if required. The second style of rollers is very much on the lines of the ordinary three pairs of rollers in common use on a ring spinning frame or an ordinary mule for spinning proper cotton yarns. The three lines of bottom rollers are of very small diameter—possibly $\frac{3}{4}$ in. by $\frac{1}{2}$ in. by $\frac{3}{4}$ in., or even less in diameter for front and back—so as to suit the very short fibre to be found usually in cotton waste. The front and middle top rollers are also of small diameter, covered in the usual way with smooth closely woven cloth next to the iron, and roller leather tightly drawn over the cloth. These two rollers may be joined together by a little saddle and one link and lever weighting arrangement used for both of them. The back top roller in this case is usually plain and polished, and of about $1\frac{3}{4}$ in. diameter, in order to make it sufficiently heavy by self-weighting. It will be readily understood that using draught rollers in this way in a mule intended for spinning cotton-waste yarns, puts the process very much in the same category as ordinary cotton spinning, since rollers always tend to make fibres parallel, and draw out the cotton finer than is possible with either the "ratch" or "gain" principle of drawing. The rollers in this case are made adjustable, provision often being made for the distance between all three lines being altered, it being possible to separately alter the distance between back and middle on the one hand, or front and middle on the other hand. In some cases where waste mules are constructed with draught rollers in this way, it is the practice to also supply it with bobbins built on a bobbin and fly frame, this latter machine being supplied with cotton out of cans of sliver prepared at the delivery of the finisher carding engine, which in this case has the doffer web split up into about four parts. each of which goes into a can. This style of waste spinning is a compromise between orthodox cotton spinning and true waste spinning upon the condenser principle in which no drawing rollers are used for the cotton to go through on any machine, and no real attempt is made to put the fibres into parallel order in any of the processes. As a matter of fact present day practice apparently tends to run more and more in the way of discarding the preparation system of cotton-waste spinning, and for the condenser system to more and more increase in use. In the case of a waste-spinning mule in which three lines of rollers are used as above described, it is quite easy to discard the roller drawing principle at any time temporarily if required, in which case the front and middle top rollers and their weighting arrangement are taken away, and the $1\frac{3}{4}$ in. diameter solid back top rollers are brought forward to rest upon the front and middle bottom rollers on the self-weighting principle. In the third style an arrangement very common to woollen mule spinning is adopted, and only one line of bottom rollers and one line of top rollers are used, the top line being about $2\frac{1}{4}$ in. diameter, and self-weighted. As before stated, the most favoured style of rollers for a cotton-waste

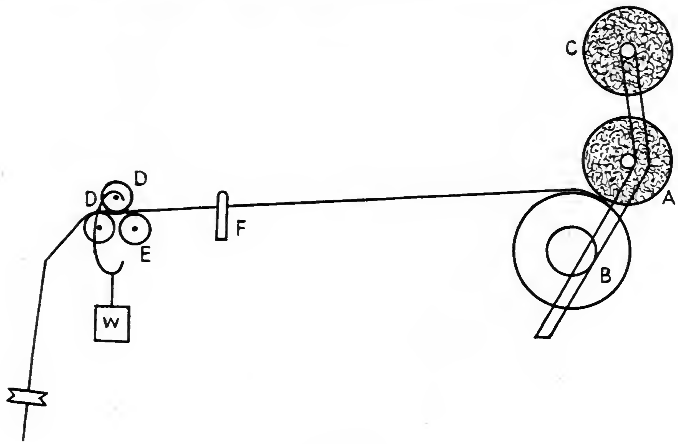


FIG. 46A.

References—
A Condenser bobbin in use.
B Grooved friction drum.
C Condenser bobbin awaiting use.
D Top roller.
E Bottom rollers.
W Weight.

mule consists in using two lines of bottom rollers with one line of top rollers resting on these, and this top roller may be of large diameter, self-weighted, or it may be of only about $1\frac{1}{4}$ in. or $1\frac{3}{8}$ in. diameter, dead weighted, and covered with cloth and leather in the usual cotton-spinning manner. (See fig. 46A.)

The Headstocks.

As regards the headstocks, although the woollen mule type of headstock has hitherto been most used, the cotton headstock has often been used for the spinning of cotton waste, being altered in order to spin from long condenser bobbins if required, and being equipped with a ratching motion for disengaging the rollers shortly before the carriage has finished its outward run. Elsewhere in this book we fully explain how quite recently most determined and most successful attempts have been made to fully adapt the cotton headstock so as to give most excellent results in the ordinary way of spinning cotton-waste yarns of good and so-called fine qualities. It is a somewhat noticeable fact that self-acting mules for the spinning of cotton-waste have very often indeed had the headstocks built upon the side rim principle, in which the rim shafts are parallel to creels and rollers, although the back rims are made if required for cotton-waste spinning, and the rim shafts are at right angles to the rollers and creels. It is possible that the side rim arrangement suits the woollen type of headstock somewhat better than it does an ordinary cotton spinning headstock, but in such cotton spinning it is seldom the side rim is adopted unless it is a very low room in which a countershaft running down the centre of the two mules will give a much longer down belt than would be obtained with the ordinary top countershaft of the back rim. In some cases, of course, the headstock is constructed on the side rim principle in order to suit the arrangement of driving shaft already obtaining in the room wherein the mules are to be placed. Side rims can and do give good results, but the writer on the whole prefers the back rim pulley arrangement.

Spindles and Productions.

Because of the very thick character of the yarn it is necessary to make big cops as a rule in order to restrict the number of doffing times at the mule, and to make the cops last longer at the next process. For this reason the spindle gauge or distance from centre of one spindle to centre of the next one is usually a wide one, say, anything from $1\frac{1}{2}$ in. or $1\frac{3}{4}$ in. up to $2\frac{1}{2}$ in., or so as compared with $1\frac{1}{16}$ in. or $1\frac{1}{8}$ in. as a standard for pin-cop weft, and $1\frac{1}{4}$ in. to $1\frac{3}{8}$ in. as a standard for twist cops in the ordinary processes of cotton spinning. It follows partly from the wide spindle gauge that the number of spindles per mule must be much less than for a cotton-spinning mule, yet another reason for a reduction in number of spindles being found in the great amount of creeling and doffing required, which reduce the capacities of the operatives as regards number of spindles. In a general way a waste mule containing

550 spindles may be considered a long one, while a more usual limit is from 450 to 500 spindles, and mules have been made with as few as about 300 spindles, or even less. Of course, this does not appear a large number as compared with the 1350 or so of many modern weft-spinning mules in ordinary cotton spinning. The production in pounds per spindle appears to be very great to an ordinary cotton spinner, it being quite possible to produce 6 lb. or 7 lb. per spindle per week of counts $3\frac{3}{4}$'s or 4's, with a mule carriage making about five draws per minute, and using a decent quality of waste, well carded and placed upon long condenser bobbins in proper fashion. Assume, for example, we have a pair of modern mules, each containing 500 spindles, and producing 7 lb. per spindle of counts $3\frac{1}{2}$ with 840 yards per hank: $500 \times 7 = 3500$ lb. per mule per week, or $3500 \times 2 = 7000$ lb. per pair of mules. This weight is as much as a factory of 20,000 spindles would produce at 70's or 80's counts, and is mainly due to the fact that it only takes $3\frac{1}{2}$ hanks of such yarn to make 1 lb., whereas it takes 80 hanks, or about twenty-three times as much length of 80's counts to weigh 1 lb. This is one of the points to be remembered always in comparing productions of cotton-spinning machinery, whether it be a mule, ring frame, carding engine, or other machine. When it is stated, for example, that certain carding engines are each doing 900 lb. per week, while others are only doing 400 lb. each, it must be remembered that the difference in weight is nearly all due to difference in density of cotton, and not to the fact that the cylinder, taker-in, or flats go so much faster on the heavy than on the light weight.

Cotton-Waste Mule with Cotton Headstock.

As stated previously, there is a good deal of resemblance between the spinning of cotton-waste yarns on the condenser principle and the spinning of woollen yarns. In each case it is sought to fell and intermingle the fibres rather than to make them parallel, and therefore in each case the use of drawing rollers is generally entirely omitted, and the strands of cotton are formed upon long bobbins at the condenser of the finisher card and taken directly to the creel of the condenser spinning mule. Naturally the draught or power of attenuation of the fibres of cotton or wool to anything like a really fine degree is quite impracticable, as the limit of draught by any other suitable means is very soon attained. Hence we have the long-established practice of using the woollen mule type of headstock in mules for spinning waste cotton yarns on the condenser system. In like manner there is a great resemblance in the finisher carding engines as used for these two materials, not alone in the fact that in each case the card is of the roller and clearer type, but also in the manner of dividing or cutting up the width of the fleece of fibres from the doffer into a sufficient number of individual ends, reaching usually from ten to thirty-one or so for cotton waste, and sometimes up to four times this number upon woollen condenser cards. One of the developments of recent years in connexion with the spinning of cotton-waste yarns has been the modification and application of the cotton-spinning type of headstock for the purposes of cotton-waste spinning upon the condenser principle. We now propose to describe a mule that has been brought up to date for this special purpose. In this case one particular and essential feature is the adoption of the carriage "gain" or "drag" principle for draughting the cotton out, to the utter exclusion of the "ratching" or second stretch principle, the well-known "slubbing" motion for the early opening of the roller-box not usually being needed or at all used in this mule. This mule being operated on in the condenser principle, there is, of course, no roller draught at all exactly as on the woollen mule principle. Take an example of spinning counts 7's to 8's from $4\frac{1}{4}$ hank condenser strands. Each long condenser creel bobbin may contain about thirty ends—one each for a front twisting spindle—the total length of the bobbin being about 48 in., and full diameter 8 in. or 9 in. This long bobbin is placed horizontally upon a fluted tin roller or drum of possibly 10 in. diameter or so, and is leaned backwards with its ends against the vertical creel stands. The tin drum method of driving ensures a sufficiently positive rotation of the condenser bobbin, and a uniform surface speed, whatever may be the diameter of the bobbin. The strands of cotton from these long bobbins are conducted through vertical guide wires behind the rollers much after the ordinary cotton spinning mule style for single rovings. Next the cotton passes through the rollers, which consist of two bottom fluted rollers upon which is placed a leather-covered roller weighted on the dead-weight principle to ensure a sufficient grip of the cotton ends. These three lines of rollers may be approximately about $1\frac{1}{4}$ in. diameter, there being probably a slight difference in diameter between top and bottom rollers to prevent fluting of the leather-covered top rollers. Finally, each cotton end passes from the rollers to its spindle, which usually has only a moderate amount of "topping," or distance from top of spindle to top of fluted front roller, and only a moderate amount of spindle bevel also. A large amount of either "topping" or spindle "bevel" would probably make it awkward to put in the required amount of "gain" or carriage draught without running some risk of the yarn drawing off the spindles when the cops were nearing their full length. (See fig. 47.)

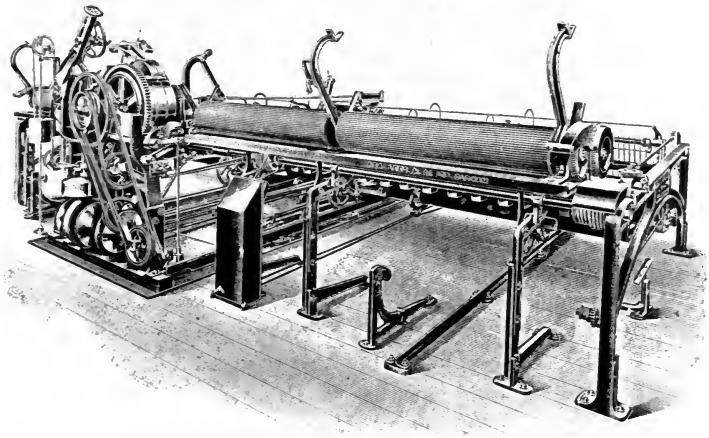


FIG. 47.—Cotton-waste Mule with Cotton Headstock.

Let us now deal briefly with the driving of the three primary and fundamental movements of this mule during draughting, twisting, and ordinary outward carriage movement. It will simplify matters and greatly help a cotton mule man to understand the mechanism and operation of this headstock if we state at once that the rollers and carriage are driven at a uniform speed during outward carriage travel, while the spindles have three different speeds during any one run out, each speed being definitely obtained from proper mechanism, and each controlled as required. We shall explain that the first motor or side-shaft for driving the rollers and carriage is driven in a different manner from what obtains in the ordinary cotton mule headstock, but from this side-shaft the driving of rollers and carriage is much the same as every cotton mule worker is acquainted with. There are, of course, no draught wheels for driving the back and middle rollers, as these rollers are not used, and there is a definite connexion between the driving of the rollers and carriage, so that the relative speeds of carriage and rollers may be adjusted to whatever amount of draught may be required. If, for example, it is required to put in a little more draught, this may easily be done by altering (*a*) a wheel which will drive the rollers more quickly without altering the speed of the carriage; or (*b*) by altering a wheel which will reduce the speed of the carriage without altering the speed of the rollers. If, for example, it was considered that the limit of carriage and roller speed had been attained consistent with the quality of the material and the piecing-up capacity of the workers, the above case would probably be met by altering that change wheel, which would reduce the speed of the carriage and leave that of the rollers unaltered. It is to be particularly noted that the outward speed of the carriage in this particular waste-spinning mule is kept at a uniform rate, whereas it is more usual in the woollen mule type of headstock to draw the carriage out at variable speeds by scrolls of much the same shape as those usually employed to draw in the carriage of an ordinary spinning mule. In the woollen mule type of headstock there is not as a rule any long back-shaft—although it is possible to have one—but in this new cotton headstock the usual long back-shaft containing the usual description of practically uniform drawing scroll is used, and the stretch of 64 in. is adopted, this being the well-known standard for ordinary counts of cotton yarn from all garden numbers from 20's to 60's or so. (See fig. 47.)

Driving for Variable Spindle Speeds.

We have endeavoured to word the descriptions so that anyone familiar with ordinary cotton mule headstocks would be readily able to understand the special features of this cotton headstock for spinning waste-cotton yarns upon the condenser principle. Without doubt by far the greatest difference in principle of construction, as between the headstock of this mule and that of an ordinary cotton spinning mule, consists in the arrangements for driving the spindles at three different speeds during each run-out of the carriage, while keeping the rollers and carriage at a uniform speed. Such variable speeds are necessary for the best results in spinning yarns on the condenser system without using draught rollers in order to keep the yarn sufficiently soft while the carriage draught is put in. It is the common practice to have either two or three speeds of spindle in any waste spinning mules, and, as stated, in this case the triple speed method is adopted. Now let us ask the close attention of our readers to the particular method of driving by which the three speeds of spindle are attained. On many cotton spinning mules there are two side-shafts, the one on one side of the rim-shaft being for driving the backing-off and taking-in, while that on the opposite side of the rim-shaft is for driving the carriage and rollers. These two drives are essentially maintained in the waste mule headstock under discussion, but with the very important and radical difference that the shaft upon which the driving of the rollers and carriage is centred, is not driven from the rim-shaft as in ordinary mules, but is driven by a separate belt from the counter-shaft or overhead shaft, there being a pair of fast and loose pulleys upon this auxiliary shaft, used for driving rollers and carriage. With the trains of wheels for driving the rollers and carriage from this fast and loose pulley arrangement we need deal no further, excepting that we may just state that in all essentials and principles they are much similar to those employed on any ordinary cotton mule. There is a free-wheel connexion, or catch and catch-wheel arrangement between this extra side-shaft and the rim-shaft, so that at the commencement of each outward run of carriage, for possibly 20 in. or more, or any proportion of the outward stretch required, the special side-shaft drives the spindles at a slow speed as well as the rollers and carriage, but afterwards it drives only the rollers and carriage, and the rim-shaft proper has never anything to do with driving these two latter organs. The rim-shaft is of very particular construction, and will be best understood by such of our readers as may be familiar with the method of obtaining single and double spindle speeds in the Threlfall special fine spinning mule, with two different diameters of rim-pulley. In this triple-speed cotton-waste mule headstock there are three belt pulleys, the centre one being loose on the rim-shaft. The front belt pulley is secured to the rim shaft, to which also are secured a ratchet wheel for the free-wheel motion at the front of the head-stock pulleys, and also a rim-pulley of small diameter at the extreme back end. The third belt pulley is secured to a long boss which runs loosely on the rim-shaft in the same direction, and has secured to it a second rope rim-pulley of larger diameter placed just inside of the small rim-pulley at the back of the head-stock. Such is the method of construction, and the exact action of these parts will be readily comprehended by anyone who now understands the construction. As the carriage starts out the ordinary down-belt for the rim-pulley is on the central loose pulley, and the auxiliary belt in not only driving the carriage and rollers, but also, by the catch and catch-wheel or free-wheel arrangement, is driving the rim-shaft, and therefore by the smaller rim-pulley is driving the spindles at a very slow speed. After the carriage has travelled perhaps 20 in. or 2 ft. the down belt is moved upon the front belt pulley, and at once takes command of the rim-shaft, and the ratchet-wheel or free-wheel on rim-shaft runs away from the driving catch of the auxiliary drive, which now only drives rollers and carriage. Arrived at perhaps 18 in. or so, more or less, from end of carriage traverse, the down belt is moved upon the back pulley, and the larger rim-pulley drives the spindles until twisting has finished.

Three Speeds of Spindle.

Referring again to the three-spindle speed mule for the purpose of spinning cotton waste on the condenser principle, it will be understood that any required proportion of speed may be obtained as between the first, second, and third speeds respectively, but the principle must always be observed of having an initial low-spindle speed in order to permit the carriage draughting of the cotton without thread breakage. This is so true that if a broken thread be pieced up on the mule just described before the carriage has travelled several inches away from the beam it is very likely to break down again, owing to the spindle half of the pieced thread having more twist than the roller beam half, and also owing to the weaker and thicker nature of the piecing portion. The carriage itself is made the medium for determining when the changes shall take place from lowest to medium spindle speed, and from medium to highest speed. This will be readily understood by those conversant with the single and double speed motions of fine spinning mules. There are, however, essential differences in principle; if we started double speed earlier we should speed up the rollers and carriage also until the back-shaft and roller-boxes opened. The waste spinning mule is more like a Threlfall mule, in which the double speed is obtained entirely from bringing a larger diameter of rim-pulley into use, so as to speed the spindles alone. There are some important details of practice which are affected by this particular feature, as, for example, supposing that the new waste mule with cotton headstock were altered—as it could be in about a minute or so—so as to change from medium to maximum spindle speed somewhat sooner in relation to the termination of the outward carriage travel, the effect would be to obtain more twist in the yarn before the carriage got out, so that less would be necessary after the carriage got fully out and during twisting at the head, and the mule would make a complete draw in a proportionately shorter time. It must be understood that the tin roller twisting motion is applied to this mule so that slippage of the rim-band does

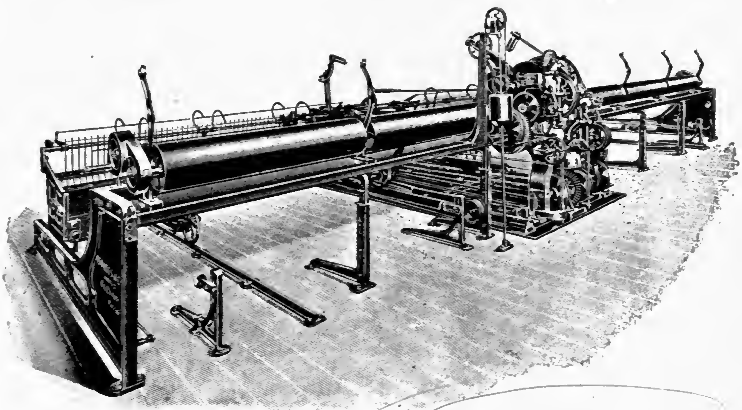


FIG. 48.—Cotton-waste Mule with Woollen Type of Headstock.

not affect the total twist per inch put in the yarn, and also that after the full twist has been put in the yarn backing-off occurs, whatever proportion of twist may be left for insertion during supplementary twisting after the carriage has come to a standstill. Also our readers must permit us to again remind them that the rim-shaft has nothing to do with driving the rollers and carriage, but only drives the spindles. The 3-speed motion just described is made by Messrs. Asa Lees & Co.

Stop-Motions.

For the purpose of changing the creel bobbins and performing various little duties, it is more often necessary to stop a waste-spinning mule than an ordinary cotton-spinning one, and it is quite common on a waste mule to employ a special application of stop-motion seldom found on a cotton spinning mule. During the last fifteen years or so it has become the usual thing in ordinary cotton spinning to apply a turnover latch or handle which the operative may turn over to be out of action any time when the carriage is coming out or going in, and may then expect the mule to stop at the roller-beam, because the down-belt has not been unlatched and allowed to move on the loose pulley. In the waste mule this idea is often carried out to the further extent of extending a wire rod underneath the faller shafts for a good portion or all of the length of the mule. By simply pulling at this rod the latch may be turned over from any position in the length of the mule, and this may often prove to be a distinct convenience. As a matter of fact, we quite fail to see why it should not be regularly applied to ordinary cotton-spinning mules, because it is simple and cheap enough, and can be placed out of the way beneath the faller shafts. In some waste-spinning mules the idea is carried out further still by using the long wire rod as just described, and arranging so that sliding it shall place the belt at once on the loose pulley at any point in the outward travel of the carriage. To do this it is common to latch the down-belt in position, and to arrange for a spiral spring to be always pulling at the strap rod as the carriage moves out. By moving the long rod, connexions are also moved so that the down-belt fork is promptly unlatched, and the belt is drawn upon the loose pulley by the spiral spring. This is a special application of the stop-motion principle which we scarcely think would suit most ordinary cotton spinning mules, because the need for its use would seldom arise, and it would make the stop-motion parts a little mixed up to also utilize the turnover latch principle, the strap-relieving motion, and the hastening motion. Before leaving the question of stop-rods we may first say a word about one of the latest little devices for locking the long stop-rod, or big starting and stopping handle of any self-acting mule, whether for waste or ordinary yarns. A wire loop or cross-bar of about 6's wire is hinged to the top of the standard, through which the stop-rod passes at the front; a suitable slot is cut across the top of the stop-rod in such a position that when the stop-rod is pushed home and the mule is stopped the wire cross-bar at once drops in the slot of the stop-rod, and must be lifted again before the rod can be moved into working position. To prevent this small locking or safety device from being troublesome during "whipping" a flat slotted sword-like steel bar is loosely fitted to the flat side of the front part of the stop-rod, and by simply moving this forward the wire lock is lifted out of action so as to leave the stop-rod free to be manipulated as required during the whipping operation. We are all too sadly aware of the accidents that have occurred owing to accidental movement of the stop-rod, and the present writer has a very vivid recollection of at least two occasions on which he himself very narrowly escaped serious injury owing to this very thing. We refer to this device because it was on a waste-spinning mule that we saw it in operation. It will be readily understood that either cotton-waste mules, ordinary cotton-spinning mules, woollen mules, worsted mules, twiners, or other machines using similar stop-rods may utilize a device of this kind equally well if desired.

Remarks on Three-Speed Driving and Waste Mules.

We hope our readers have thoroughly grasped the central idea of the three-speed motion of the cotton headstock as described for waste spinning on the condenser principle. It will be understood that by altering the sizes of the two back-rim pulleys for middle and highest spindle speeds, or by altering the train of wheels from auxiliary side-shaft to rim-shaft, any one of the three spindle speeds may be altered without touching the other two. By a larger driving wheel the first spindle speed could be alone increased; by a larger diameter of back-rim pulley the middle spindle speed as well as the first one could be increased, and by increasing the diameter of the larger of the two rim-pulleys we could get a higher double or final spindle speed. Altering any one of these would have to be considered in relation to the twist per inch, and the question of possible "striking through," or premature changing of the down-belt. In this three-speed motion it must be understood that the completion of the outward run is marked by the opening of the drawing-out box and roller-box, while both the ordinary down-belt and the special belt of the auxiliary side-shaft are moved upon their loose pulleys before backing-off occurs. Afterwards the ordinary rigging-band or vertical taking-in band takes charge of the mule, and first drives the backing-off, and afterwards draws the carriage in as on ordinary spinning mules. It appears to be the general opinion of cotton-waste spinners who have operated mules both on the woollen mule principle of "ratching" the yarn by the aid of slubbing motions, and the use of variable drawing-out scrolls, and have also had experience of waste-spinning mules which draught the cotton ends by the aid of "gain," and not "ratch," that the "gain" method is distinctly the better when condenser strands of finer than three hank or so are used. Take for example a waste mule spinning 7's counts of yarn from 4's condenser bobbins, it is claimed that more production and better yarn can be obtained from a cotton headstock with a continuous draughting of the cotton by carriage gain. Also the use of parallel scrolls for giving a uniform outward speed to the carriage appears to be favoured by many in such cases. The makers themselves make their claim in the following words: "This method of spinning produces a finer and much more even yarn, as the draught is put in continuously and gradually, and not all at the end of the draw, as in the older system; it enables coarser roving to be used than formerly when spinning the same counts, as it is possible to obtain a draught equal to half the draw; and it gives a larger production as the twist can be put in sooner than by the older system. The mule also, having a back-shaft, works more steadily, and therefore runs faster. It will be quite understood that automatic governing motions, or "strapping" motions, automatic nosing motions, and backing-off chain tightening motions can be and often are applied to a cotton-waste mule just as on an ordinary cotton mule. It is found also that the instantaneous click-locking motion is an advantage, as it prevents "clicking," or having both backing-off and winding-on clicks engaged at the same moment. In the cotton headstock described this "click" motion is on the cone principle, and is worked from the rocking-shaft in the carriage middle piece, and the click is engaged before the carriage begins to move by the same set of mechanism that does the locking of the fallers. We believe most people will concede that cone-click gearing and ungearing motions have done very excellent service when put on and adjusted to proper advantage, and often render efficient service in limiting the number of snarls put in the yarn, and in getting good solid cops. In the case under notice the winding click is made of steel, case-hardened, with teeth cut out of the solid. Another make of three-speed motion is shown in fig. 49.

Round of Movements in Cotton Waste Mule.

In a modern waste-spinning condenser mule operated entirely upon the "cotton" system the round of movements which make up a complete draw are much the same as for an ordinary cotton-spinning mule, excepting for differences in spindle speed and in the waste mule having no roller draught. Beginning at the roller-beam, we have a continuous and uniform delivery of cotton from the rollers, accompanied by a uniform speed of the carriage. In an ordinary cotton mule the speed of the third important factor, viz., the spindles, is also uniform, but in the waste mule the spindles invariably have either two or three speeds. The carriage

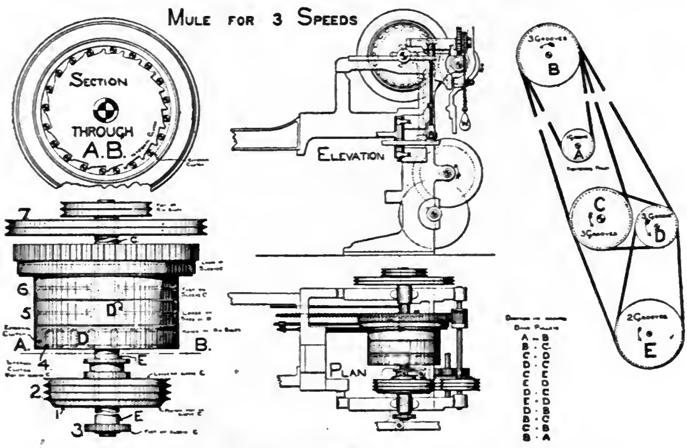


FIG. 49.—The New 3-speed Motion (Hetherington & Son).

having reached the end of the stretch the back-shaft and roller-boxes are opened, the twisting motion regulates the amount of twist put to the yarn at this period, and then the down-belt is moved upon the loose pulley. We then have backing-off, faller locking, variable return of the carriage, unlocking of fallers, and re-commencement of spinning in the orthodox manner. Let us compare this with the "cycle" of movements on the usual spinning mule for cotton waste on the woollen system. We again have the delivery of condensed cotton strands from the rollers, but this may be accompanied by a variable speed of carriage. The spindles have a very low speed for the greater portion of the run-out. When the carriage has moved a sufficient distance outwards, say, possibly about 40 or more inches out of about a 70 inch stretch, the delivery of cotton from the rollers is stopped while the carriage continues its forward movement. This is naturally accompanied by the requisite amount of "spindle draught" or "carriage draught," as it may be termed. These conditions may obtain until the carriage gets almost or nearly out, when the double spindle speed may be brought into action, so as to save time by introducing twist in the yarn as quickly as possible now that the conclusion of "spindle draughting" will permit of the insertion of the twist. We have, of course, the arrestation of outward carriage movement, and disengagement of drawing-out motion at the proper moment. During the supplementary twisting period we may put into operation the "draw-back" or "receding" movement of the carriage by which the carriage is slowly moved a short distance towards the roller-beam, in order to prevent the shortening and hardening effect of the twist from pulling the threads down. This is a particular feature of a mule operated upon the woollen headstock and "slubbing" motion principle. Supplementary twisting, double speed of spindles, and receding action of carriage may take place concurrently. After the conclusion of twisting, we have backing-off, faller locking, winding-on, shaping of cops, and return of carriage exactly as before described. It will be understood that the condenser system of carding and spinning, whether the mule "draught" be obtained upon the "drag" or upon the "ratching" principle, always produces a very full, soft-feeling yarn, with the requisite strength obtained from the rubbers of the card, the crossing of the fibres and spinning coarse numbers.

The Slubbing Motion.

It will be of interest and profit to many of our readers if we give a brief description of the mechanism by which the rollers are controlled, so as to deliver cotton for only a portion of the outward movement, in a cotton-waste mule operated upon the woollen headstock principle, and fed with condenser bobbins. Take an arrangement as made by one firm. The roller-box has one of its sides held in contact with the other half of the box by means of a latch-lever, while a specially disposed spring is always endeavouring to open the box, but is prevented during the required proportion of the outward carriage travel by the latch-lever above mentioned. A link-rod reaches down from the latch-lever, and is connected by a suitable crank-lever to a long rod running along towards the front of the headstock. Upon this long rod is placed an adjustable finger, which is acted upon when required by a bracket fastened in the carriage "square". In this

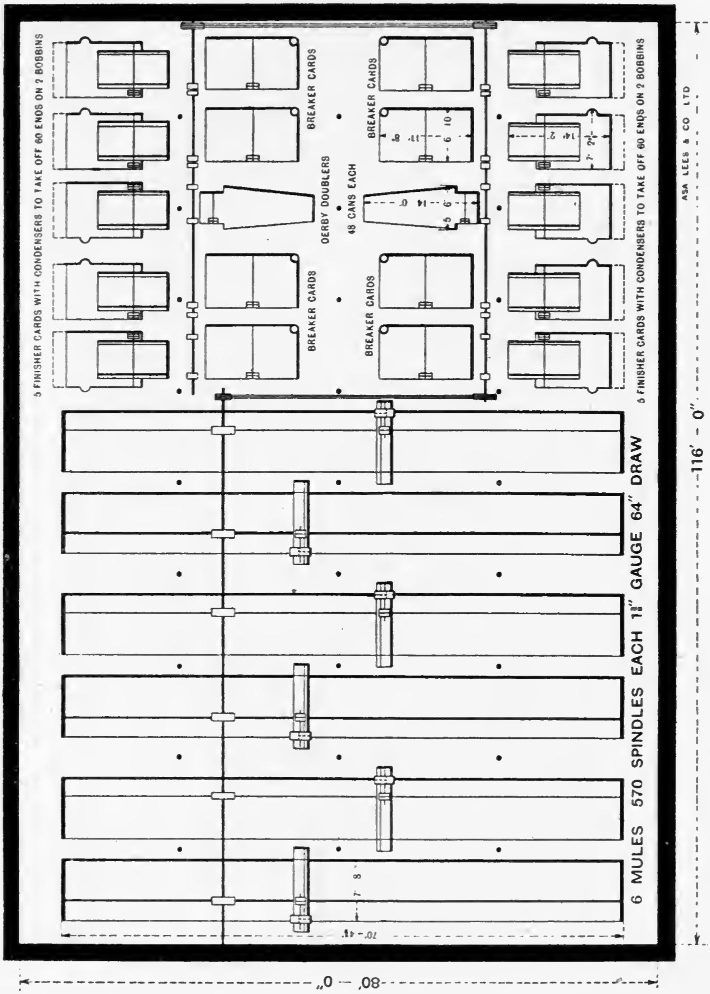


FIG. 49A.—This represents an Excellent Plan of a Complete Carding and Spinning Plant for a Cotton-waste Mill.

way a sufficient movement is given to the long rod, and is transmitted by the vertical link-rod to the latch-lever which holds the roller-box shut. The lifting of this lever releases the half of the roller-box, and this box is at once forced open by the proper spring.

It will be readily comprehended that the change brackets may be adjusted so that the rod may be moved and box opened when the carriage has made say 35 in., 40 in., 44 in., or any other proportion of the full outward stretch that may be desired. This is not the most common form of slubbing motion by any means, but it will be readily understood by most of our readers, and especially by those who are familiar with the recent trend of fashion in regard to the opening and closing of the roller-boxes in some mules put up for ordinary cotton-spinning purposes. It is well known, for example, that some ordinary cotton-spinning mules for many years had the roller-box opened and closed by the sliding action of a long rod as imparted by the carriage. More recently, however, it has become the favourite practice to open the roller-box exactly upon the principle explained as above for the sliding-rod slubbing motion of the waste-spinning mule. Instead of having the sliding-rod to actually compel the box to open, the rod now releases a kind of lever arrangement, and the spring does the real work of opening the box. This development has taken place largely because with the former practice the rod would drag along with the carriage more slowly sometimes than others, and there was not always the exact and prompt opening of the box which is requisite for obtaining absolute uniformity in the amount of "ratching" as required for fine counts of yarn. In the more recent system the real opening of the roller-box is left to the spring, and not to the rod, and better action is on the whole obtained, although skilful setting and maintenance of parts in good condition produced excellent results with the older system. Now there is no difference to speak of in principles of construction and action between the roller-box opening of fine mule just referred to and the new long rod method of opening the roller-box on some condenser waste spinning mules. It is, indeed, very apparently a fine example of the saying that "Extremes meet," since in the one case we have the use of the "ratching" principle for fine cotton yarns, and in the other case we find it used to an even far greater extent for producing the very coarsest of cotton yarns, while in almost all medium counts of yarn from American cotton—say, 10's to 40's, or finer ordinary cotton spinning—the "ratching" principle is practically ignored. In the fine mule the amount of ratching, however, is limited at from $\frac{1}{4}$ in. up to 4 in. or 5in. per stretch, whereas in a cotton-waste mule operated on the woollen mule principle with a slubbing motion, it is possible for the amount of ratch to reach to almost half the complete stretch, say, up to from 30 in. to 35 in. in a 70 in. stretch.

Wheel Slubbing Motion.

The more usual form of slubbing motion as used on a woollen mule headstock for spinning cotton-waste or woollen yarns is separated from the carriage, and there is no long rod, the release of the latch-lever of roller-box depending upon a train of wheels operated from the front roller itself. The present writer examined this form of slubbing motion as applied to cotton-waste mules with the woollen type of headstock, and as built by three different makers. A brief description of one only will be given, and it must be understood that in exact detail of construction the others differ from this one and from each other, but not in principle. The roller-box is held in gear by a latch-lever, exactly as in the case of the long rod motion, while a spiral spring is always trying to force the box open as against the pressure of the lever. In this case there is used a "slubbing" wheel containing a good deal of slotted space on its side, and not far from the edge or rim. The face of the wheel is numbered much after the style of the index wheel of a comber—although we do not think the marks of the slubbing wheel bear any relation to the teeth of the wheel as in the case of the index wheel— and a stud is secured at any required point in the slotted space. It is by the position of the stud in the slot, and in regard to the markings on the rim of the slubbing wheel that the release of the latch-lever, and the opening of the roller-box are determined in relation to the amount of yarn delivered and the exact distance travelled each draw by the carriage before the roller-box is opened. For example, by screwing the stud at a certain mark or number in the side of the slubbing wheel the roller-box might be opened and delivery stopped after the carriage had travelled 50 in. out of 70 total. If it were required to have 60 in. or only 45 in., or any other amount of yarn delivered before opening the roller-box, it would be a case of only putting the stud in the proper slot opposite the proper number on the slubbing wheel, and this need only be the work of a minute. In the case of the rod system the alteration would require no more time, and some markings on or near the long rod would serve to indicate exact amount of yarn delivered for opening at any particular mark. We are inclined personally to prefer the rod system mainly because the slubbing wheel requires other gearing for driving it round, and special means for returning it to its initial position for the commencement of each outward run. Of course, the long rod also must be pushed back to spinning position, but this is a very convenient thing to do. The slubbing wheel itself differs little with different makers, but the manner of driving it differs considerably. In the case under notice there is a train of two small wheels driving two large ones from front roller to slubbing wheel, with a carrier introduced for convenience, and to give proper direction of revolution to the slubbing wheel. The front roller wheel itself is very small, and the slubbing wheel distinctly large, not very much unlike the front roller pinion and crown wheel of an ordinary draught train of wheels. A sufficiently slow rotation of the slubbing wheel is obtained to prevent the stud from releasing the latch-lever of the roller-box until the carriage has gone sufficiently far. In order to return the slubbing wheel to its initial position for commencing a new draw a weighted chain arrangement is used, and the method of gearing has to be arranged to permit this return action. The use of this weighted chain is one of the details in which the slubbing wheel appears to be somewhat inferior to the long rod system, although long practice has probably reconciled the workers to the former method.

Self-acting Mule (Condenser System, fig. 50).

Such a mule as the one illustrated in fig. 50 is suitable for spinning a full, soft-spun, and level yarn from such cotton wastes as comber waste and various kinds of hard waste or soft waste.

The bobbins from the finisher card are placed on inclined stands and are unwound by contact with grooved surface drums. The roving is delivered from the rollers at a uniform speed, the carriage speed is uniform and the cotton strands are attenuated by the carriage speed exceeding the surface speed of the rollers.

Usually there are two lines of bottom rollers and one line of top rollers, which may be dead-weighted or self-weighted as required. Faller shafts, carriages, spindle footsteps, and bolsters are much the same as for an ordinary cotton-spinning mule.

The spindles may be arranged to have a uniform speed, a double speed or a treble speed as required, the latter being advisable for counts finer than 4's; and in this case the spindles start at each draw at the lowest speed, and have their maximum speed during the final portion of the outward run.

Most of the usual mechanisms applied to a cotton mule are applied to the condenser mule; such as automatic nosing, governing motion, and backing-off chain tightening motion. Fig. 50 shows the headstock as fitted with the 3-speed motion for spindles.

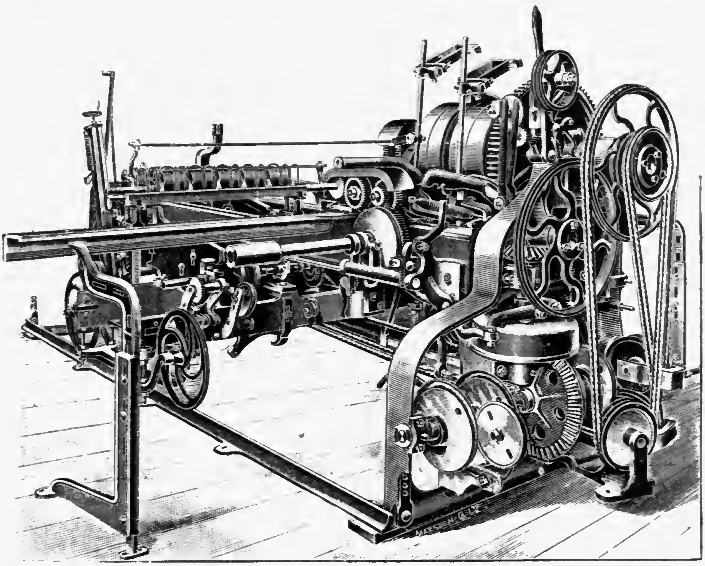


FIG. 50.—Self-acting Mule for Cotton Waste, on Condenser Principle.

If required, a carriage retarding motion may be applied by means of which it causes the carriage to start each draw a moment later than the roller, so that cut or thin places in the yarn are obviated.

The weekly production of such a mule might reach somewhat

as below stated . . .	1's	2's	3's	4's	5's	6's	7's	8's	9's
Lb. per spindle . . .	14	9	7	$5\frac{1}{4}$	4	$3\frac{1}{4}$	3	$2\frac{3}{4}$	$2\frac{1}{2}$

For 7's to 9's one mule might contain about 720 spindles $1\frac{3}{4}$ inches gauge.

For 2's to 3's one mule might contain about 500 spindles 2 inches gauge.

Slubbing Motion. Additional Remarks.

One of the important motions in a woollen mule is the slubbing motion, which regulates the length of condenser yarn delivered from the roller each draw. Its object is to permit any desired length to be automatically and accurately measured, and it also helps to give facility in changing the weight or count of yarn.

The slubbing wheel may be arranged at right angles to and is driven from the front roller coupling spindle, a pinion being fixed to the latter, which drives a compound carrier, and the pinion portion of double carrier drives the slubbing wheel.

The sliding clutch-box is held in gear with that fixed on the coupling spindle, by a lever which is lifted by a stud in the slubbing wheel when sufficient condenser yarn has been delivered.

The sliding clutch is then disengaged by a spring, and at the same time the pinion driving the slubbing wheel is dropped out of gear, and the slubbing wheel brought back to the starting point by means of a chain and weight. The clutches are engaged by a lever operated by a cam on the change cam-shaft. To deliver different lengths of yarn it is only necessary to move a setting stud to a figure indicating the required length on the face of the slubbing wheel, in order to accurately measure the number of inches delivered per draw.

When once set, the arrangement of this motion is such that it is impossible for it to overrun itself, or to vary the length of yarn delivered.

By this arrangement of the slubbing motion the spinner still has easy insight and access to the interior of the headstock.

Draw-back Motion.

This mule is also fitted with a draw-back or jacking-up motion to obviate the strain on the yarn due to twisting contraction. When putting a great amount of twist in the threads of a somewhat tender fibre they have a tendency to break off at the grip of the delivery rollers. The jacking motion causes the carriage to draw back a short distance and takes the place of the jacking roller delivery motion as applied to fine spinning cotton mules. The mule may be fitted either with long or short shaper. The mule can be adapted when required with mechanism for stopping the spindles, reversing the rollers, for the spinning of yarns of a fancy character, and for twisting two ends together.

The Reversing Motion is applied to mules spinning very short staple and with soft twist, in which at times much trouble has been caused by the threads breaking at the grip of the rollers. To overcome this defect the rollers are turned slightly inward immediately after twisting, so as to bite on the twisted yarn during backing off and winding on, instead of on soft material as just delivered untwisted from the rollers.

Spindle Stop Motion.

This is chiefly used when there is a considerable admixture of other material, such as China grass, tow, etc., with pure wool which prevents much draught being put in the yarn.

The "Draw-back" Motion.

In the case of a fine spinning mule putting in a good deal of supplementary twist with the carriage fully out, it is often found necessary to adopt means for preventing the yarn-contracting effect of the twist from breaking the threads down excessively. The established method in this case is to cause the rollers to deliver a small amount of cotton at this time by means of what is variously termed the "receding motion," the "roller turning" motion, or the "jacking delivery" motion. In the case for example of one mule, this motion consists of a train of wheels operated primarily from a small wheel on the roller side-shaft, which thus drives a special bottom shaft that reaches to the front of the roller spindle, and drives the front roller by a catch and ratchet wheel arrangement.

In another mule the whole of this mechanism is in front of the fast and loose pulleys, but is much the same in principle as the above, although apparently differing in detail.

Another firm employ a small sprocket chain arrangement, combined with a catch and catch-wheel for the purposes of their roller-turning motion.

In the original hand-mule of Crompton the difficulty was met by a slight pushing in of the carriage, and this obtained originally in self-actors, but the extra roller turning system has been in universal use in fine spinning cotton mules for a very long term of years, and is much better than the pushing in of the carriage, inasmuch as it does not shorten the length of yarn spun as does the draw-back motion, and it is much less clumsy, and does not in any way interfere with the arrangements for backing-off, keeping the winding click out of gear, or preventing the premature engagement of either the backing-off or taking-in frictions. At the close of a lecture by the present writer at the Bradford Technical College the question was discussed why the "roller turning" method should not displace the "draw-back" method in woollen mules as it had done in fine cotton spinning. At different times the writer has been asked the same question in regard to cotton-waste mules in which the same thing exists. Apparently the answer may be given somewhat as follows: In a fine spinning mule the roller draught is sufficient to prevent the slight portion of yarn delivered by the receding motion from affecting the counts of yarn or its regularity, whereas there is no roller draught at all in a proper woollen mule or in a cotton-waste mule on the condenser principle, whether with the woollen or cotton mule headstock, and the amount of receding is also much greater. Such mules are made to "jack-up" or "recede" in the carriage during supplementary twisting to the extent of 6 in. if required, and a good proportion of this 6 in. is sometimes required. This, of course, is far and away more than is ever wanted for a fine spinning cotton mule in which a delivery of $\frac{3}{4}$ in. to 1 in. is distinctly large, quite apart from the question of roller draught not being present in the waste spinning mule. Briefly, in a fine spinning mule the amount of "receding action" or yarn slackening seldom, if ever, exceeds from $\frac{3}{4}$ in. to 1 in., and this short length is subjected to the action of roller draught—although wanting in "spindle" draught—whereas in the cotton-waste mule there may be, for example, a matter of 3 or 4 in. of "receding" action or slackening of the yarn wanted, owing mainly to the very thick nature of the yarn causing the twist to shorten the yarn infinitely more than the same amount of twist will shorten the fine yarns. In this statement we have, therefore, an explanation of why the draw-back motion is maintained in woollen or cotton-waste mules, although it is obviously more inconvenient in more ways than one than the roller turning system.

In the triple spindle-speed cotton mule headstock described previously it is possible to put in almost all the twist as the carriage moves out, to strike through and back off almost immediately the carriage comes to a full stop, so that little, if any, of the draw-back idea need be used at all. A word or two may now be expended upon the manner in which the carriage is caused to "recede" or "draw-back," or "jack-up," or "push-back," as the action is denominated by different people. Naturally, the details of these motions differ with different makers, but in a particular case there is a small cone-pulley and thin rope arrangement, by which the tin roller shaft is made to drive a worm which gears with and drives a worm-wheel of suitable size. The worm-wheel is arranged to give motion by means of a rack-wheel to a horizontal rack attached to the middle piece of the carriage, but the various parts only come into active gear and operation when the carriage has moved sufficiently far out. By the drive just specified the horizontal rack is forced against the front framing of the headstock, which is, of course, immovable, so the natural result is the forcing inwards of the carriage, since something or other must give way. Anyone who understands the working of an ordinary cotton spinning mule will at once comprehend that various little devices must be adopted in order to prevent the premature engagement of the winding click on the one hand, or the taking-in friction on the other hand, while backing-off must also be prevented until "jacking-up" has finished; but yet the backing-off parts must be kept in position ready for acting when jacking-up has finished.

Winding Click Motion.

One of the best arrangements for keeping the winding click out of gear during the recession of the carriage is the cone-winding click motion by means of which the winding click cannot engage until the locking of the fallers, and yet engagement at the proper time occurs with the utmost regularity and promptitude. It is advisable to explain that for a great many years the more usual method of engaging the winding click on a self-acting mule was to arrange for the tightening of the winding chain to engage the click immediately upon the starting in of the carriage. This was the simplest possible method, and gave great satisfaction in numberless cases. This method of winding click engagement is still employed very extensively, but it has always had the defect of being likely to engage prematurely and prevent backing-off if the carriage happened to finish its outward travel unsteadily, or receded somewhat on the holding-out catch. Sometimes also the chain catch is widely set, and there is a slight initial loss in winding-on. For these reasons many have preferred the method in which the long rod which connects the holding-out catch with the taking-in friction, has also been made the medium for engaging the winding catch before the carriage starts inward. During recent years, however, what is termed the cone-winding click principle has become almost the most popular one for engaging and disengaging the winding click. This is operated from connexions to the locking-lever, or what is practically the same thing, from the rock-shaft in the middle piece, and this method of engagement, either with the cone principle or other equivalent one, appears to be rapidly superseding the others above specified, at any rate with several machine shops. With the oldest and simplest form of winding click, and some other forms, the recession of the carriage in a waste spinning mule working on the woollen mule principle, due to the draw-back motion, would engage the winding click before twisting was finished unless special preventive means were adopted. As stated, the cone-winding click depends upon the fallers locking for its engagement, and for this reason it is easy with the cone click arrangement to keep the winding catch disengaged during the draw-back action of carriage, and yet to obtain prompt engagement of the click at the completion of backing-off and the locking of the fallers. To describe one specific application of the cone-winding click to a self-acting mule: The ordinary spectacle spring for the winding catch is entirely dispensed with, and in its place is used a strong half-circular spring made from flat spring steel—it is not a spiral spring at all; this new spring being secured to the side of the winding plate or disc plate at one end, and having its other end pressing firmly upon the top of the winding catch and always endeavouring to engage the same. This arrangement obtains its particular name of cone-winding catch motion from the employment of a loose round boss which surrounds the tin roller shaft, and has one end or edge turned off to a conical or tapered outline. This coned end is forced underneath a tail or arm of the winding catch when the carriage gets home again, and in this way the catch is levered out of gear, and it is held out by the cone during all the way out of the carriage. At the completion of the backing-off, the movement of the parts connected with the locking of the fallers and disengagement of the backing-off friction, also removes the cone bush away from the arm of the winding click, when the semicircular spring on top of the catch promply puts the catch in gear, and holds it firmly there all the way up of the carriage. A strong spiral spring helps to force the cone beneath the arm of the click when the carriage gets in. This cone winding click therefore not only finds much favour with ordinary cotton spinners, but is even more specially adapted to the operation of a waste-spinning mule in which the draw-back action of the carriage is required.

Details.

At this point we will just give a simple recital of one firm's own statement with regard to special motions that may be applied to waste spinning mules. They say: "In these mules we generally apply the following arrangements: Patent rope tightening apparatus for rope taking-in; scroll-band tightening frame; patent clip for fastening check scroll band; click locking motion; patent automatic nosing motion; backing-off chain tightening motion; long copping rail with loose automatic front incline for regulating the locking of the fallers; patent step covers; special arrangements in connexion with the drawing-out and taking-in of the carriage, which cause it to stop in case of obstruction during drawing-out, and by which the spinning operations will automatically cease should the cam-shaft by accident make its change before the proper time; arrangements by which the mule may be suddenly stopped during the going in of the carriage, to prevent accident; safety catch to keep the mule stopped; special arrangements to disengage the taking-in friction by the going in of the carriage; also stop-motion for stopping the mule when the carriage is close to the roller-beam, by which the attendant can stop it from any part of the length of the mule, when requisite to replace empty condenser bobbins with full ones, or for any other purpose, without running to the headstock."

Special Motions.

There is no better illustration of the statement that "extremes meet" than is found in the case of the self-acting mule for fine counts when compared with that for the spinning of cotton waste.

A number of special motions are found advisable in spinning the fine cotton yarns, are not required for spinning medium counts, and come into action again when spinning the thick yarns from condenser carding. Single and double spindle speeds, and excessive amount of carriage gain are two of the best examples of this feature and are required even more in spinning condenser yarns than in spinning the finest counts.

There are also cases of using the jacking motion for condenser yarns, in which case the carriage is put on a slow speed for the last small portion of its traverse to permit of the gain or ratch without excessive thread breakage. More usually, however, a waste mule can do without a jacking motion.

Twist per inch, which is so important in fine counts, is of much less consequence in coarse counts, and there are perhaps no really accepted standards, sufficient being put in to keep the cotton together. Judgment is exercised as to what the cotton waste will do and then the twist is humoured to the material.

Cases have been known when the waste has more resembled sticks and old hay than cotton, but it is astonishing what can be done with such stuff if the carriage speeds, twists per inch, and carriage draught are skilfully adjusted at the mule.

Gauge and Speed.

It must be noted that the pitch of the slubbings in a single condenser finisher card, fixes the gauge of spindle at the mule.

For example in the case of a ring doffer with $1\frac{1}{8}$ in. ring fillets and $\frac{1}{4}$ in. ring leathers, the pitch from centre of one roving on the condenser bobbin to centre of the next one, would be $1\frac{3}{8}$, and this would fix the spindle gauge of the mule at $1\frac{3}{8}$. There might be thirty-four of such on one long condenser bobbin from a 48 in. finisher card.

If a 2 in. gauge were used there might be twenty-four rovings of rather low counts, taking a 2 in. spindle gauge at the mule.

It is quite possible to run a mule on about 6's or so up to five, five and a half, or even six draws per minute, with a 64 in. stretch and a cotton headstock, doing all the draughting by carriage gain as distinct from "ratch".

Formerly three and a half draws per minute was more like the average speed.

In cases of excessive breakage it may be better to keep the twist down during carriage draught, and finish the twisting with the carriage fully out and using a tin roller twisting motion.

Ring Frame for Cotton Waste.

The ring frame may be used for spinning cotton waste where a hard twisted thread is used, more especially for use as a twist yarn, and probably from rovings from the slubbing frame as treated, upon the coiler or preparation system.

These frames are built with patent flexible spindles and automatic spindle holder. Rings rolled from solid steel. Double tin rollers made from extra strong tin with self-lubricating pedestals. Three rows of top and bottom rollers of small diameter. Top clearers and underclearers with springs. Patent cap bar. Traverse motion for the rollers. Copping motion and thread-boards to suit requirements.

The range of spindle gauge is a wide one, but $2\frac{3}{4}$ in. gauge has been found to give good results with a lift of 6 in.

As regards production, a ring frame of say 300 spindles $2\frac{3}{4}$ in. gauge, 6 in. lift, would produce about 1200 lb. per week of fifty-six hours, spinning 8's, or 700 lb. of 12's counts.

The following particulars may apply to a frame of 300 spindles, $2\frac{3}{4}$ in. gauge, 6 in. lift. Length 36 ft. $9\frac{1}{2}$ in.; width 3 ft. Driving pulleys 14 in. by 3 in. to make from 600 to 700 revolutions per minute. About four horse power required.

CHAPTER VI.

THE USE OF COTTON-WASTE YARNS IN WEAVING.

The Weaving of Cotton-Waste Yarns.

In considering the adaptability of cotton-waste yarns to woven fabrics, it is necessary to remember that compared with yarns spun on the ordinary cotton system of equal counts they are deficient in strength and elasticity, but are of greater softness and fullness, and of an oozy fibrous nature.

In the majority of cases their weakness precludes their use in the form of warp, since they are unable to withstand the strain of shedding, the friction of the healds, reed, and shuttle in all but exceptional instances.

Woven Goods in which Yarns Spun from Cotton Waste may be Used.

Cotton-waste yarns are as a rule soft twisted and are very bulky. They are largely used in the manufacture of such goods as the following: Table covers, carpets, quilts, cotton sheetings, cotton blankets, flannelettes, curtains, cheap shirtings, cheap suitings, bath sheets and towels, cheap dress goods, cheap overcoatings, upholstery for all classes of furniture, cheap towels, cleaning cloths, sponge cloths, grey twills for such purposes as working drawers or overalls for spinners, miners, stokers, and other classes of workmen. The wide range of fabrics may be either plain or fancy, plain or coloured.

Improvements continue to be made whereby finer yarns are spun and this increases the range of fabrics for which cotton-waste yarns may be adapted.

In the weaving of cotton-waste yarns into fabrics of any kind it must always be remembered that in proportion to bulk these yarns are weak, and partly for this reason they are generally used as wefts, and the only strain therefore that is put upon the yarn is that of drawing from the shuttle and carrying through the shed that is formed by the warp.

Speaking generally the mechanisms of the looms used for weaving fabrics into which cotton-waste yarns enter, are very much of the ordinary kind. If there is any modification at all in any of the mechanism it is very often in connexion with the shuttle and shuttle boxes.

For example, the shuttle might be of increased size to take a larger cop, and this would also compel a larger shed to be made to permit the shuttle to pass through with sufficient freedom.

Frequently it happens that trouble is caused by these cops slipping from the shuttle tongue, thus causing excessive waste and other damage. With ordinary shuttles this might be remedied by opening the shuttle tongue to give a better inside grip of the cop. Possibly a remedy might be found by the spinner starting to build higher up the spindle, which would reduce the size of aperture in the cop but would give shorter cops unless there was previously some unused length of spindle above the apex of the full cop. In some cases it is considered advisable to re-wind the coarser counts into solid cops, which are very tightly wound, so that for equal dimensions a cop will last longer in the shuttle.

In the quiltings, suitings, and other cloths of this class the cotton-waste yarn is often used as backing weft in which there is a face warp while the backing weft shows only on the back. To put this in other words we may say there would be two wefts and one warp, but the waste weft remains at the back of the cloth, being stitched in by allowing some definite number of warp threads to interweave with same. The object of such cloth is to give warmth, weight and body and yet to keep the price comparatively low.

In regard to cotton sheetings these are generally of a coarse twill weave, and they can be produced very cheaply by using coarse or cotton-waste yarns, so that such sheetings are in extensive use at home and are also exported.

A large amount of this kind of cloth is produced and used in the United States.

Referring now to cotton blankets, these have a distinctly different feel and appearance from the cheap sheetings, the difference being largely due to the fact that the cotton blankets have a nap or finish raised upon them to imitate woollen goods. As regards weave this may be either of a plain or twill character.

The cheap shirtings in which cotton-waste yarns may be used may be of a satin weave, resulting in a fine warp face and a waste weft back.

Sponge or cleaning cloths represent a very different type from the foregoing, and may be regarded as among the very cheapest and lowest classes of goods woven from cotton yarns of any description. Sponge or cleaning cloths are as a rule composed entirely of coarse shoddy or waste yarns—both warp and weft—and are very open in the weave, partly to obtain an enhanced porous effect. As a rule the weave is of a plain character, or possibly a gauze weave may sometimes be adopted.

Large quantities of cotton-waste yarns are now being used in the upholstery trade, being woven into tapestry cloths, with good patterns, and really good effects produced by rich and tasteful dyeing.

From the nature of the cotton waste it is not practicable to spin any but yarns of low counts, which are therefore sold at a low price per pound, and are mostly used in fabrics of a bulky, heavy character but moderate price. The price of cotton-waste cards on the roller and clearer principle, using double cards, often with the Derby doubler interposed, together with other circumstances, often lead to good condenser yarns of the finer counts commanding a higher price than yarns of equal counts spun on the ordinary system, and the cloths containing the better and finer condenser yarns are often of superior appearance and finish.

A few of the leading cloths in which cotton-waste yarns are used may be more fully explained.

Cotton Blankets.—Ordinary qualities of this cloth such as are exported in large quantities to the Eastern markets, Africa and South America, are made with the plain weave, the warp being relatively fine in counts, say 20's to 24's. The weft ranges from 50's to 130's bump counts, i.e. 50 to 130 yards per ounce, this being a common method of numbering cotton-waste yarns of the coarsest nature up to three or four hanks per pound. A little further on in this treatise we give a list comparing cotton counts with bump counts. Better qualities for the home trade, sometimes sold as "charity" blankets, are made in heavier weights with twill weaves and with strong warps, say 12's to 18's, and perhaps with more picks per inch of coarse weft than if for export. The weft is from cotton waste of moderate quality such as "wash" waste and "clearers," taking a medium mixing for blanket weft and better qualities being obtained by adding cop waste.

Headings or stripes of coloured weft are usually inserted near each end of a blanket, the heading consisting of solid black or red bars or variegated strips according to the market for the cloth.

Referring to the loom shown in fig. 51 it is over-picked and provided with large boxes, and cranks of large throw to suit the size of shuttles and cops used, while the shedding is by under-tappet and top rollers. The loom shown has single boxes at either end, the shuttle being changed by hand to make the heading. Occasionally striped blankets are made, the strips being made in the direction of the weft and at close intervals.

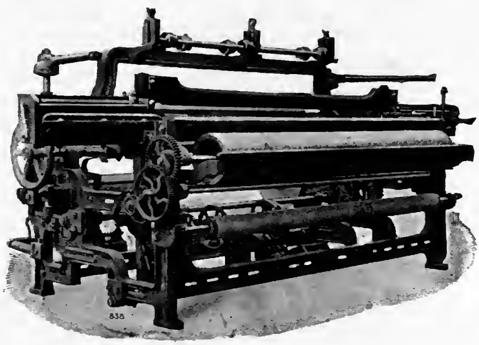


FIG. 51.—Blanket Loom (R. Hall & Sons).

For this style of blanket the loom may be fitted with a circular box at one end of the sley as by the fig. 52. The loom shown is provided with a positive take-up motion, and the cloth roller is set lower in the framing than usual in order that a considerable length may be woven before it is necessary to remove the cloth. Sometimes looms are provided with negative take-up motions in order that a uniform thickness of cloth may be maintained, notwithstanding that the thickness of weft may vary, this being a frequent occurrence in the lower counts and qualities of weft.

Raising Process.

After weaving, cotton blankets are passed through a raising machine which produces a dense woolly surface upon the cloth by partially scratching or dragging fibres out of the weft threads, the softness of the latter and the arrangement of the fibres being particularly suitable to this process. The raising machine in common use for cotton fabrics consists of a number of small rollers, each covered with fine teeth, and supported in bearings at the end of arms which are attached to a central shaft. The cloth is stretched tightly round the rollers, and when the central shaft is revolved, and the cloth drawn forward, the rollers also are revolved. Meanwhile the wire teeth have penetrated the soft spun weft threads and as they leave the cloth they drag the ends of fibres with them, thus giving a fine nap or pile to the surface of the cloth. Originally the nap or pile was obtained by scratching the surface of the cloth by card filleting, but while giving the

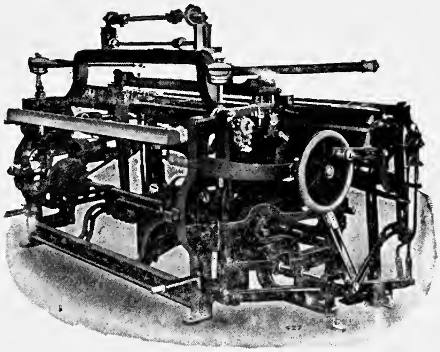


FIG. 52.—Blanket Loom (R. Hall & Sons).

desired effect this process dragged a considerable number of fibres out of the cloth. With the newer machines there is very little loss of fibre and weight, and a better nap is obtained with fewer passages through the machine.

For some markets blankets are dyed, scarlet being a common colour; in other cases the cloth is printed with variously coloured floral designs; animal figures are also printed upon the cloth for markets, the lion, tiger, elephant, etc., being represented in large sizes. The printing is usually done by hand by the aid of blocks, this being one of the few remaining cases in which the old-fashioned method of cloth printing still survives.

Sheetings are lighter in weight, and made from finer yarns of better quality than blankets, the weft ranging from 3's to 8's cotton counts and the twist up to 32's. The weave is generally two up and two down or sheeting twill, but the plain or calico twill is also used. Same type of loom, but of lighter construction than the one last illustrated is used for sheetings, and the cloth is sold both in the raised and non-raised condition.

Cleaning Cloths. (Fig. 53.)

These are an exception to the general rule in that they have both warp and weft composed of coarse waste yarns. The softness of the latter, together with their low price and open structure arising from the method of interweaving them, giving a fabric which by reason of bulk and absorbent properties is specially suitable for cleaning purposes. This cloth is also very easily cleaned for using again, and when used for cleaning oily machinery

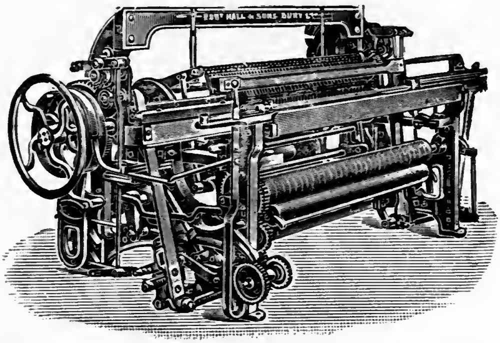


FIG. 53.—The Sponge Cloth Loom (R. Hall & Sons).

the absorbed oil can be reclaimed. Two styles of cleaning cloth are in use. In the first kind the warp and weft are interwoven in the plain or calico order by looms of ordinary construction, but the second kind, commonly known as sponge cloth, is woven by the gauze or leno principle of weaving, in which the warp threads are twisted partly round each other, with the result that increased strength is obtained without losing the required open structure. For ordinary gauze or leno weaving, specially constructed healds known as "doups" are employed; but the coarseness and strength of the warp yarn, together with the strain arising from the necessary deep shed, or division in the warp to be formed for the passage of the shuttle, causes rapid wear and destruction of such doup healds. Sponge cloths are therefore woven by specially constructed looms in which two rows of needles take the place of doups and healds, one row pointing upwards, and the other row pointing downwards, while the warp threads are alternately drawn through the needle eyes. The needles are secured in bars which are controlled by tappets and levers in such a manner that, besides rising and falling to form a shed, they can also be moved sideways for the crossing of the warp threads.

At each end of the piece a few picks of fine weft are usually put in and woven in plain order more closely than the coarser picks of the body. In these picks the needles are moved up and down in plain order only, and the speed of the take-up motion is automatically reduced. A few picks of coloured weft are also thrown in at the ends and a drop-box is provided at one end of the sley for this purpose.

Double Cloth Weave with Waste Cotton Weft.

It is sometimes the case that double-cloth weaves are constructed with either the weft or the warp of wadding or cotton-waste yarn, the use of weft in this connexion being much more prevalent than that of warp.

This practice adds both weight and bulk to the woven cloths, and it is possible to do it in double cloths without the waste yarn showing on either the face or the back of the cloth. Take a specific instance with the face and the back of cassimere twill with one face, one back in the warp, and one face, one back, one cotton waste yarn in the filling.

The cotton waste or wadding yarn is of course a bulky, moderately twisted and cheap yarn, and this is picked into the cloth, the face warp ends are lifted and the back warp ends are held down so that the weft waste yarn is put in the centre of the cloth without showing and without interlacing with either face or back warp ends. Weight and bulk are thus durably imparted to the cloth without deteriorating the appearance. In some cases of cotton-waste warp the waste yarns are raised over every backing pick and depressed over every face pick so as to be put into the centre of the cloth.

One reason for cheap thick yarns from cotton waste spun on the condenser principle being more used for weft than warp, is that warp yarns are subjected to more strain than the weft, and are liable to be rubbed by the healds and reeds and shuttle.

Tapestry carpet is a simple figured warp-pile fabric, containing loops of uncut pile-warp and all the surface of the fabric covered with the pile in a uniform manner. The pattern is formed by printing the design on the pile-warp and formed on the surface of the cloth by the pile. It is convenient to print a certain length of pile warp a desired colour, so that this colour is reproduced in the cloth for a certain distance, after which an alternative colour may obtain for a space.

In a tapestry cloth there may be a centre warp possibly of cotton-waste yarn which passes between the ground picks without interlacing after the manner obtaining with the cotton-waste warp yarn in a double or backed cloth.

Although the structure of a Brussels carpet is quite different from that of a tapestry, yet it is quite possible for some of the pile threads that are disposed in the body of the cloth to consist of cheap thick yarns, although the main body of the fabric may be of as good yarn as the face.

Waste in Weaving Sheds.

In a weaving mill the control of the waste to the best advantage is one of the most difficult duties of the overlookers and manager.

Although the waste of a spinning mill may be much greater in amount it is probably more easily checked and supervised.

It is fairly easy, for example, to check the amount of waste made in the blowing-room, or at the cards or combers.

Suppose, however, a certain number of skips of yarn are delivered at a weaving mill and pass into the winding room, each winder may be required to bring back or give up in some way the waste she makes; but the full bobbins are probably taken directly to the warper, and no one knows what the half-full bobbins contain in weight of yarn, so it is awkward to check. At the end of the week the overlooker may weigh his waste and compare with yarn given to winders, but percentages are not easy to check, partly on account of yarn on the bobbins.

Naturally at the six months' stock-taking it is possible to say how much yarn entered the winding and warping room, how much waste came out, how much yarn has left the room on the full beams, and an estimation can be made of weight on the bobbins. In this way the waste per cent can be estimated, and if too much the overlooker talks severely to the operatives and says they must bring less waste in.

They will do this, but it is common knowledge that in many cases it has been only because they have taken some of the waste home, and so the master now has a double loss.

It may be easy at stock-taking to find out that a considerable weight of yarn has entered the winding room that has never been accounted for, but it is not so easy to pick out the culprits and bring them to book.

Much the same remarks apply to the weavers in many cases, and especially in places in which the moral and religious characters of the operatives have not been developed and maintained.

Often the weavers simply fetch skips or boxes of weft, bring the waste back with the empty skip, are rebuked or fined if too much waste is brought in, with the result that next time some of the waste is taken home, and probably nothing is said to the weaver. All this kind of thing puts a premium on the unscrupulous weaver, and the thing is manifestly wrong in principle.

Winders are often paid so much per pound's weight of yarn and weavers so much per length of cloth or per "cut," and taking too much trouble with badly skewering and badly readying cops represents so much loss to them.

Improved methods of skewering the twist cops by winders, and pin cop weft by the weavers, combined with better systems of checking the twist given to winders and the weft given to weavers, have certainly resulted in the reduction of losses in winders', warpers', slashers' and weavers' waste; the winders' and weavers' especially. Counts and qualities of yarns should be checked, and each class of goods considered separately.

Cop-Skewering.

In the case of weft for weavers it is perhaps as well for the spinning mules to be fitted with full-cop stop-motions which stop the mule by preventing engagement of the taking-in friction when the plates of the copping motion have moved a certain distance and the cops have reached a definite fixed length. How can a weaver help making waste if the cops are too long for the shuttles? The shuttle pegs ought also to be capable of retaining the cops firmly after having been skewered, and the cops should be spun on mule spindles of the correct thickness and cop bottoms started at the right distance from the bolsters. It is not fair to have the shuttle pegs so blunt that they can with difficulty pierce the cop without stabbing. Neither must the opposite extreme of shuttle tongues too sharp be provided or they will often catch internal threads and lead to breakage in winding off. There is perhaps increased danger of this in cases where loose coils are run over the noses of the cops upon the bare spindle at the mule every time the fallers unlock.

In cases of very softly spun and softly built cops it may be best to build the cops on through tubes at the mule, although these through tubes cause unsteady spindles, are comparatively costly, and require more time in putting on the spindles, since tubing apparatus is in very common use for putting short tubes on the spindles. In the case of ordinary cop winding of twist yarns of medium counts and moderate price, winders are often recruited from girls and women, who from some reason or other have been unable to cope with the more arduous and often more highly paid duties of weavers, and this is a disadvantage often. At any rate in this one item of skewering cops with pasted cop bottoms as much skill is necessary as in anything else, if the minimum amount of waste is to be produced.

In the case of yarns of good quality and probably of comparatively fine counts, it is advisable not to employ winders whose hands have a distinct tendency to perspire, since this leads sometimes to corrosion of the spindles, after which it becomes difficult to quickly and satisfactorily skewer the cops. Naturally this point is worthy of attention, even in the case of lower-priced yarns, but more so in regard to the more costly sorts. Many of the points under discussion affect the skewering of cops, either in weaving or doubling mills, or apply even in the case of some commission or other reelers.

Shuttle tongues being split will often hold a cop firmly even when the aperture is a little too big, but in the case of winders' or reelers' skewers it is important that these be of the same shape and dimension as the spindles of the mule if waste is to be kept down to a minimum and good winding secured. For good skewering of cops practice is necessary, and it has been suggested in the case of large firms it might even pay to employ a skilful operative to teach the art of cop-skewering to the beginners and others less skilled in the work.

In the case of weft that is intended to be bleached or dyed in cop form the problem of made-up cop bottoms and waste in cop-skewering becomes even more acute, since any handling of the cops between spinner and weaver will be so much against the maintenance of good apertures in the cops. Cop bleaching or dyeing probably makes the use of tubes—as against starching—still more necessary. It has been contended that higher training in regard to cop-skewering would make weavers independent of requiring tubed cop bottoms even in the case of bleached or dyed cops, and at any rate the point is worthy of attention.

Winders, weavers, and reelers should avoid pulling lengths of yarn from the cops.

A great idea in skewering consists in keeping the point of the spindle, skewer or shuttle peg, as much as possible in the centre of the aperture, and prevent the tip from penetrating any threads on the walls of the apertures.

Demonstrations have been made which go to show that almost any kind of cops, however badly crushed, may be skewered by a skilful person.

Sometimes winders' waste is not collected for several days and this gives them more opportunity of wrongly disposing of it as compared with collection every day, especially if much grumbling is done for excessive waste.

In the case of doubling winding, there has been a good deal of waste made by cob-webbing or running off the ends when quick traverse drum winders are used.

It is possible also to overfill flanged bobbins and thus to cause extra waste. Sometimes the tubes for quick traverse winding do not exactly fit the cradle, thus leaving it possible for a tube to work a little on one side, or be placed on one side after piecing-up, with the inevitable result of cob-webbing. At the next process such run-off threads will probably break and lead to waste. Winders', weavers', reelers', and doublers' waste is really much more of a real loss to the master than is waste from a card, comber, or fly-frame, because it has borne all the cost of manufacturing nearly to the end; and yet may only command a low price if sold as waste, because it is difficult to break up in the earlier machines used in a waste-spinning mill, and is very fluffy and weak after such treatment.

In regard to waste made at the doubling or twisting frame a chief item consists in roller laps, and various devices are on the market for limiting or preventing these. The chief underlying principle of most of these devices consists in permitting a wire of some kind to disconnect any individual top roller when its thread is broken, and there is a danger of a roller lap. In some cases, however, devices are used which prevent a broken thread from touching adjacent ones or becoming daubed with grease from the lubricants used on the rings in the case of wet doubling.

Undoubtedly the use of a good doubling winding frame is the best method of preventing waste, single, and cork-screwing in connexion with the doubling trade.

The use of large bottle-shaped bobbins on gassing frames, as prepared on clearing frames, tends to reduce waste, by limiting thread breakages and piecings.

Improved Tubular Winding Machine.

This machine is for winding solid cops for weft and is a step forward towards an automatic loom.

As competition becomes keener and keener, manufacturers naturally look round to see in what way expenses can be reduced. Labour, as one of the most expensive items, comes in for a great deal of attention, and anything which can reduce manual work to any extent is of the greatest importance. The replacement of labour by capital is an economical law which must be duly attended to by all who hope to keep abreast of the times. With this purpose in view certain firms have for years paid attention to tubular or solid cop winding, and there is no doubt that this system is the most economical, and reduces the amount of labour in a great degree both as regards winding and weaving. Instead of the old method of winding on to a wooden pirn or paper tube to provide the material for the weaver's shuttle, this machine winds on to the bare spindle. The space

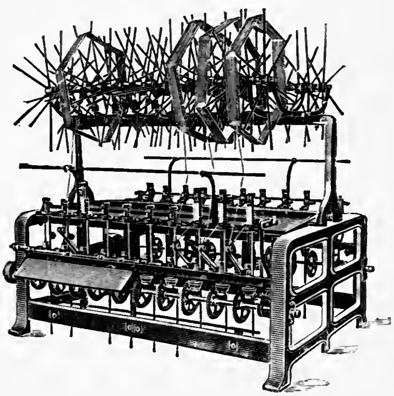
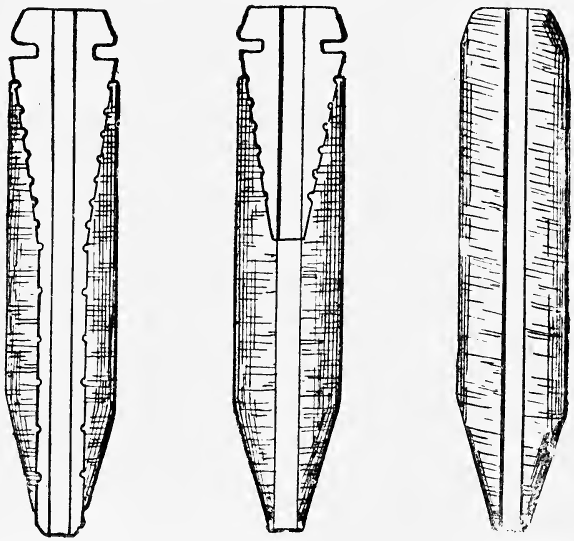


FIG. 54.—Improved Tubular Winding Machine for Solid Weft Cops (R. Hall & Sons).

which is taken up in the old system by the wooden pirn is consequently filled with yarn. In addition to this, the cops produced can be of a greater diameter without increasing the external dimensions of the shuttle, on account of the cop resting in the shuttle itself instead of being placed on a spindle or tongue. The quantity of yarn placed in the same size of shuttle by this new system is from two to five-fold that of the old system, according to the counts and previous conditions. What an economy this immediately effects is at once



Old System, With Wooden Pirn. New System, With Half Pirn. New System, Solid Cop.

FIG. 55.—(R. Hall & Sons).

apparent. The winder winds a longer length at one operation, and the weaver weaves from two to five times as much without changing the shuttle. Not only does the production become larger, but there is a saving in waste, because every time the weaver re-fills a shuttle a small length of weft is wasted. The main saving is in the stoppages of the loom being greatly reduced, the effective number of picks per day being greatly increased. It is also well known that the repairs for looms are much less when the stoppages are reduced. Another point which must not be overlooked is the producing of better selvedges. By the old system the tension of the weft becomes greater and greater as the wooden pirn gets empty. By the new system described the tension remains practically equal from beginning to end.

The machine is suitable for all counts of linen ; fine, coarse, and waste cottons ; woollen yarns, asbestos and ramie wefts, jute, hemp, etc. Thousands of spindles are at work in the production of quilts, honeycombs, sponge-cloths, tapestry and Brussels carpets, lappings, sailcloth and duck, damask towels and tablecloths, linens, cotton blankets, trouserings, sackings, hessians, hosepipes, etc., etc.

In fig. 55 we give proportionate drawings of the old and new systems, which show at a glance the greater quantity of yarn placed in a shuttle of equal size by the new system.

The machine may be used to wind solid cops to weave from the inside, or to wind on to half pirns to weave from the outside. It is arranged to wind from warping bobbins, slubber bobbins, large or small hanks or cops. Also to wind two threads at once.

CHAPTER VII.

VARIOUS NOTES.

In this section a number of features are dealt with which are more or less connected with the main subject of this book, but do not lend themselves to more specific classification.

The Counts of Cotton-Waste Yarns.

The counts of yarn from such machines as the can frame, chapon and cup or jumbo winder are always very coarse and hardly ever contain much twist, especially from the first and last of these three machines.

Such yarns are more like very coarse yarn spun on the roving frame, but with a more hairy appearance. It is quite a common practice instead of terming such yarns ·5's or 1's or 1½'s or 2's counts, to state the yards per ounce. For cotton blankets and cotton quiltings the very lowest numbers from ·5 up to 1¼ or so appear to be in less demand in the Bolton and other districts than formerly, owing to the almost complete extinction of heavy hand-loom weaving. A good proportion of lime-bleached waste is used for these very coarse yarns, say often from 60 to 70 per cent, with the rest of better stuff, such as clearer waste and strips.

The following table shows the comparison of ordinary cotton counts with the yards per ounce system from ·5's up to 10's counts, but it is chiefly in the lowest of these that the yards per ounce system has been much in vogue.

Apart from bleaching, the character of the waste affects the colour of the grey-spun yarn, so that droppings and sweepings, possibly mixed with dull, dirty raw cottons, such as some Indian, may be used in spinning such yarns.

Table of Counts.

Cotton counts ·5's =	840 × ·5	yds.	= 420	yds.	per	lb.
and	420 ÷ 16	,,	= 26¼	,,	,,	oz.
Cotton counts ¾ =	840 × ¾	,,	= 630	,,	,,	lb.
and	630 ÷ 16	,,	= 39·37	,,	,,	oz.
Cotton counts 1's =	840 × 1	,,	= 840	,,	,,	lb.
and	840 ÷ 16	,,	= 52½	,,	,,	oz.
Cotton counts 2's =	840 × 2	,,	= 1680	,,	,,	lb.
and	16 0 ÷ 16	,,	= 105	,,	,,	oz.
Cotton counts 3's =	840 × 3	,,	= 2520	,,	,,	lb.
and	2520 ÷ 16	,,	= 157½	,,	,,	oz.
Cotton counts 4's =	840 × 4	,,	= 3360	,,	,,	lb.
and	3360 ÷ 16	,,	= 210	,,	,,	oz.
Cotton counts 5's =	840 × 5	,,	= 4200	,,	,,	lb.
and	4200 ÷ 16	,,	= 262½	,,	,,	oz.
Cotton counts 6's =	840 × 6	,,	= 5040	,,	,,	lb.
and	5040 ÷ 16	,,	= 315	,,	,,	oz.
Cotton counts 7's =	840 × 7	,,	= 5880	,,	,,	lb.
and	5880 ÷ 16	,,	= 367½	,,	,,	oz.
Cotton counts 8's =	840 × 8	,,	= 6720	,,	,,	lb.
and	6720 ÷ 16	,,	= 420	,,	,,	oz.
Cotton counts 9's =	840 × 9	,,	= 7650	,,	,,	lb.
and	7650 ÷ 16	,,	= 472½	,,	,,	oz.
Cotton counts 10's =	840 × 10	,,	= 8400	,,	,,	lb.
and	8400 ÷ 16	,,	= 525	,,	,,	oz.

Approximate Prices of Cotton Waste.

Prices of cotton waste, even of the same denomination and from the same description of cotton, vary within limits according to the relative proportions of impurities on the one hand, or good fibre on the other hand, that may be left in the material.

An approximate idea of the relative prices of cotton waste may be obtained from the following summary, taking Egyptian raw cotton at 11d. or 1s. per pound average.

Raw Egyptian cotton	per lb.	. . .	11 or 12	pence.
Comber waste	,,	,, . . .	6	,,
Card strips	,,	,, . . .	6	,,
Card back fly	,,	,, . . .	1½	,,
Bobbin waste	,,	,, . . .	6	,,

Clearer waste cotton per lb. . . .	3	pence.
Scavenger waste ,, ,, . . .	5	,,
Stockings ,, ,, . . .	3	,,
Flat waste ,, ,, . . .	3	,,
Opener and scutcher droppings per score lb.	4	,,
Cardroom sweepings . . ,, ,,	12	,,
Mule-room ,, . . ,, ,,	4	,,
Flue dirt . . . . ,, ,,	2	,,

The price of waste does not appear to go up in any fixed proportion to the price of raw cotton, but from the above list a fair idea of average proportionate prices may be obtained. With American cotton at 7d., strips and bobbin waste might fetch 3½d. per lb.

Approximate Prices of Condenser Yarns.

It is a somewhat astonishing fact that condenser yarns in the higher numbers and qualities have been generally dearer than ordinary cotton yarns of decent qualities. One would naturally imagine that, the cotton being taken directly from card to mule without using fly-frames or draw-frames, and using no better class of raw material, the condenser yarn would be inevitably cheaper for any counts. In the higher ranges of condensed yarns, however, the prices per pound have often gone up excessively, so that 14's ordinary cotton yarn could be bought cheaper than 10's condenser yarn, while the price of 10's condenser has been disproportionately higher than 8's, and 8's than 6's.

Possibly this can be partly explained by the fact that the ring doffer has been the favourite type of condenser in England, and this is not very suitable for the finer ranges of counts. It is seldom that more than 36 threads have been made at one time on a ring-doffer card and this does not come out very fine. The double tape condenser lends itself better to the finer counts, not speaking of the possibilities of the treble and quadruple tape condensers. We are accustomed to associate condenser yarns with shoddy and cheapness, but at any rate the finer ranges of condenser yarns are really more valuable than equal counts of fully spun and twisted roller draughted cotton yarns for many purposes, and will produce much better effects in certain directions. For example, this is notably the case in regard to quite a number of woven fabrics in which the full character of the condensed yarn is of immense value. At the same time the open character of the condensed yarn lends itself readily to the influence of dyeing materials, a very large proportion of this class of yarn being dyed in one colour or another.

From these remarks it will be seen that many customers will be prepared to pay more for a good condensed yarn than for its equivalent in roller draughted yarns with parallel fibres. Very frequently German spun condenser yarns of good quality and in the finer ranges have been imported into England, this being one of the very few examples in which foreign spun cotton yarns have found their way into Lancashire.

Double carding adds to cost of condenser yarns.

Cotton-Seed Products.

The products from cotton seed are various and have recently much increased in quantity. Many years ago (1888) there was prepared the following table from the actual results of oil-mills.

Products from a Test of Seeds.

Linters	20	pounds.
Meats	1089	,,
Cake or meal, feeding stuff, fertilizer	800	,,
Hulls	891	,,
Crude oil	289	,,

Other details: summer yellow, winter yellow, cotton seed stearin, salad oil, summer white, lard, cottolene, miners' oil, soap, bran, fuel, ashes.

In 1896 it was stated that processes of manufacture had so improved that over 300 pounds (40 to 45 gallons) of oil could be obtained from each ton of seed. Also delinting machines have been introduced which remove a much larger amount of linters than given in above table.

We may now add in 1911 that the production of oil, lard, linters, and other valuable articles has been recently carried to a far greater and more profitable extent than in 1896, owing to various causes.

The Condenser Rubbers.

There are some persons who contend that the rubbers of the condenser put twist in the cotton, but this can scarcely be true as the action is not a continuous forward rotary one upon the cotton but purely a reciprocating one.

It is a more or less common practice to castor oil the rubbers, possibly two or three times per week under circumstances, but new rubbers may need castor oil a time or two per day, applied with rubbers working but with card run bare. The rubbers are always made of leather and obtain their name from their rubbing action on the cotton strands.

Stripping.

As in the case of stripping doors of carding engines there is a certain element of danger to the operatives working on waste cards. For example, it is within the author's knowledge that recently an operative had the lid of the fancy roller open and slipped on the floor made greasy with oiling the condenser, and in this way got his hand in the wire with consequent serious injury.

It is more or less the practice for the minder and piecer to look after the waste-spinning mule and a number of cards—say four, for which they break off and put laps on and transfer the long condenser bobbins to the mule creel. They may, however, not do any stripping and grinding.

As a rule the grinders on waste cards do not get quite as much wage per week as do strippers and grinders on ordinary cotton spinning. As a consequence the grinders will often leave the waste mills and get into the proper cotton mills when there is an opportunity. Some prefer the waste work.

There are examples of small waste-spinning concerns using low qualities and depending entirely upon adjacent mills for their supply and closing down whenever this supply fails them. Naturally the carriage cost of the worst kinds of droppings must not reach much or this feature alone would be prohibitive to its use.

One hour or so may be taken in stripping and grinding a card, this depending upon labour supply and other local circumstances.

Owing partly to the width of cotton-waste cards the rollers are heavy and a workman needs to be sufficiently strong and practised to receive each roller when thrown over from the opposite side of card by his fellow workman.

Grinders may work in pairs and look after their own grinding machines, or there may be a separate man for this latter duty.

For coarse counts the Scotch or cross-feeding system appears to have increased in use.

Cop bottoms, winders' and weavers' waste, and all kinds of hard waste may come to the waste mill in bags.

In some cases grinding on waste cards is done once per week, and the cyl of the finisher is stripped once a week but that of the breaker seldom or never stripped. Practice varies in these respects.

Banding. (Figs. 56 and 57.)

A very considerable weight of more or less damaged cops, (not cop bottoms or other ordinary hard waste) goes to rope and banding makers, and in many instances is returned to the same

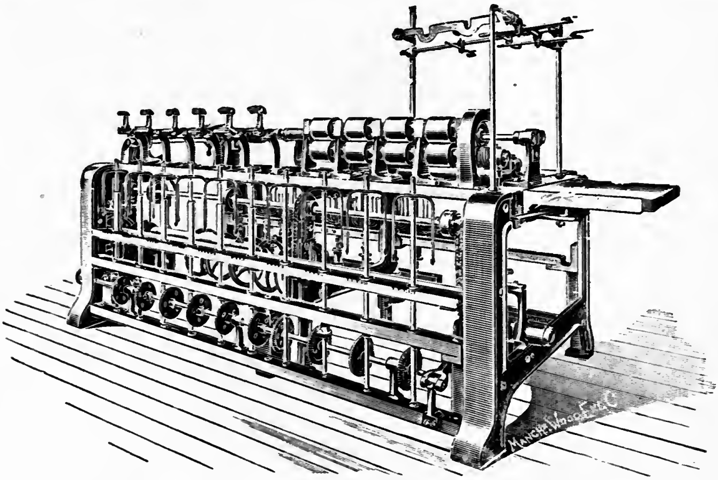


FIG. 56.—Banding Machine (Hetherington & Son).

mills by the rope-maker after manufacture in banding of one sort or another.

Some spinning concerns have installed machines by means of which they make their own banding from their own damaged cops.

Moderate unevenness in yarns, cops of snarly yarn, nicked cops, soft cops, cops with bad bottoms or other similar defects, are not perhaps so objectionable for making into banding as they are for the more usual purposes to which cotton yarn is put.

Overlooking and Kinds of Waste.

The coarseness of the counts at the mule, the limited number of spinning machines in use, and other circumstances often preclude the employment of a full-fledged mule overlooker, and as a rule the onus of keeping things in good order chiefly devolves upon the carder. The carder at times may find his position a very unenviable one, especially as often the manager or master will buy the waste and give instructions for its use without consulting the

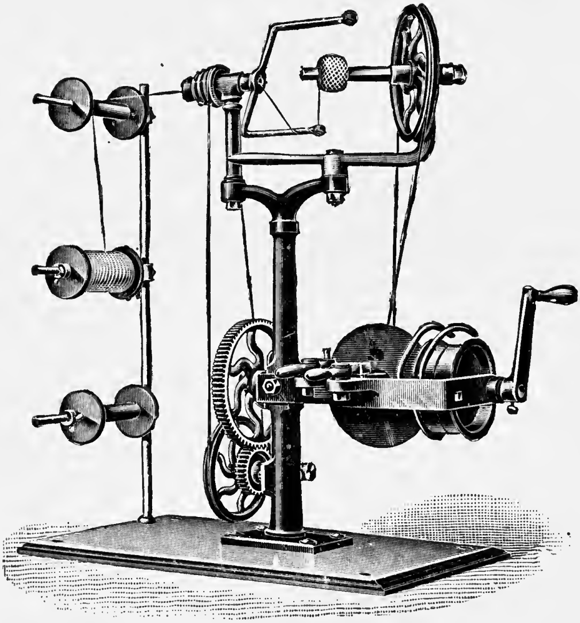


FIG. 57.—Balling Machine (Hetherington & Son)

carder, leaving the latter to get through to the best of his ability, although the character of the mixing is in its way quite as important as in ordinary cotton spinning.

Such are the variations in cotton waste that it is often highly desirable for consultations to take place between the manager or buyer of the waste and the carder, as in this way much unpleasantness may be avoided in the way of bad work, diminished production, and loss of wages to the spinners.

It is a regular thing for one kind of waste to be too expensive and too good for the quality of yarn required, and so it is necessary to blend the same judiciously with poorer and cheaper sorts of waste. Judgment and experience are necessary for this to be done to the best all-round advantage.

Too often the manager is almost solely guided by the all-powerful object of putting down a mixing which must only cost a certain price per pound.

It is possible for a mill with eight pairs of mules spinning about 8's average counts to have its production reduced from 33,500 lb. per week down to possibly 30,500 lb. by cutting down the price per pound of the mixing only very slightly. It is well for a manager to remember that ends keeping up at the mule may be very beneficial to the firm as well as to the spinners.

There are many waste mills which work overtime according to the state of trade, as the operatives' union rules are not applied as stringently to such mills as to ordinary cotton spinning mills.

Unreasonably poor mixings will lead to overtime to fetch production and wages up, too much of the stuff going back as waste instead of selling as weft at a profitable price, in addition to extra cost in cardroom wages, in coal and driving power.

Spindle banding is often made from spoiled cops and hence we show fig. 57.

Hard Ends.

It is necessary to exercise reasonable care in regard to the admixture of different lengths of fibre in the waste, as it is difficult to get the machinery to operate satisfactorily upon the different lengths of fibre.

In such cases what are termed hard ends may be expected in excessive proportion, and these will either break at the finisher or will be responsible for very many breakages at the mule.

In the ordinary waste spinning mule roller draught is not used and the draughting of the cotton is all done by "carriage draught," that is the carriage moving faster than the roller delivery. Hard ends will not yield to carriage draught properly and will either break entirely during spinning, or will then partially break and afterwards completely break during backing-off or winding-on.

The first duty of the officials and operatives is to make the material to spin, but if this be done by taking twist out and faller weight off, in order to make the hard ends to draw, then trouble may be expected with the customers in regard to soft yarn or soft cops. Apart from this there may be reduced production through increased twist, and smaller builder wheels with shorter lengths on cops owing to the latter being softer.

If the machines are set to break the long fibre to nothing, in the earlier machines there is an excessive amount of waste, a troublesome amount of lap-licking, with consequent uneven yarn, as there is little chance to provide a remedy by subsequent doubling.

Workmen.

It is not too much to say that in waste spinning there is quite as much advantage in a man being thoroughly used to his mules as in ordinary cotton spinning, so that frequently a sick minder will drop down in production to an inconveniently large extent.

Waste of sufficient quality, regular work and fair treatment will command good workmen—an undoubted advantage to any firm. At the same time good prices are more likely to be obtained for the yarn and customers retained,

With a poor mixing there may be extra loss in blow-room at the cards, and in using bad bobbins at the mules.

Fine Counts from Waste.

It is stated that in concerns set out to spin from cotton waste on the tape condenser system as high as 16's cotton counts may be produced from 9 hank condenser ends. In these cases good comber waste has been largely used, and no waste brought in that needed the soaping arrangement.

Such waste naturally needs only a moderate amount of opening and cleaning in the earlier machines. The preparation system lends itself best to making fine counts.

In some cases the spinning varies so much that a quarter hour or more may elapse with scarcely any threads breaking, and yet the same mules another time may have scores upon scores of threads broken in a similar time.

About 8's may be taken as the limits of counts to be spun from 4's condenser strands, and if say $8\frac{1}{2}$'s counts are attempted the spinning will usually be very bad and this also will be the case with 8's if the waste is not of fair quality.

Spinners and piecers on coarse counts of cotton-waste spinning have usually plenty of work in doffing and in changing the creel bobbins—let alone so much piecing-up.

For example on some of the lower counts doffing may occur eighteen or twenty times per day with cops reaching possibly $1\frac{3}{8}$ in. by $7\frac{1}{2}$ in. Four to five draws per minute with possibly 72 in. stretch are common enough speeds.

Cone-drum Driving for Mules.

There are many waste mules in which cone-driving is used instead of two-speed or three-speed driving for the carriage.

A pair of uniform cones (not concave and convex) are used in connexion with driving the spindles. By having the cone-belt to start on the slowest extremities of the cones when the carriage is starting outwards, and by having the cone belt to gradually move from one end of cones to the other during the length of the draw, a gradually increasing spindle speed is obtained, well adapted to the method of carriage draughting. There are some spinners who like this system of driving, although a disadvantage consists in the expense connected with the use of the belting.

Use of Stores.

The following paragraph will indicate one department in which there is often unnecessary waste, i.e. in relation to the use of stores and materials necessary for keeping the work of the factory in going order.

An outstanding item is the consumption of coal, as this is one of the most costly requirements of the average cotton mill, in spite of the progress of electrical driving and the threatened rivalry of gas-engine driving. The combination of satisfactory driving with economy in coal consumption should be the chief aim of all mill engineers and firemen. The exact character of the coal needed to suit any particular mill is sometimes to be decided by the individual case, since it happens that the limited boiler and driving power of one mill demands good quick steam-raising coal, while another mill can well afford to use a cheaper if slower-burning coal.

Apart from all this, an efficient, careful fireman will keep his fires well spread over the grate bars, regulate his dampers to admit the proper quantity of air, keep his fires clean, endeavour to maintain a uniform pressure of steam and therefore steady driving, and finally will use every endeavour to burn the smoke.

No doubt the present very extensive use of efficient mechanical stokers will aid in preventing waste in coal consumption, but incrustation should be limited in the boiler, flues should be kept clean, the economizers should be kept clean, while steam pipes, boilers and cylinders should be kept well covered to prevent heat loss from this source.

Woollen and Worsted Machines. Summary.

The following specifications from a leading machinist are introduced to show the general resemblance between these machines and those used for cotton waste :—

Carding and Spinning Machinery.

"For all kinds of woollen and worsted cards, with iron or wood cylinders and doffers; improved single and double stripper condensers; also double doffer condenser, with four heights of surface drums, for bringing off double number of threads; hopper feeds, with weighing apparatus for scribbler or first machine; also improved Scotch, bank and ball, or other feeds for intermediates or carders, self-acting willows, tenter-hook willow or fearnought grinding machines, etc., etc.

"Self-acting mules with rim at back or parallel to roller beams, supplied with wood or our patent metal carriage, with all the latest improvements.

"Carding machinery on the Belgian principle, consisting of scribbler, intermediate and finishing carder, with balling machine and bank feed, between scribbler and intermediate, and Scotch feed, between intermediate and finishing carder. Carder fitted with tape condenser to take from 50 to 120 good threads off a 60 in. machine.

"Carding machinery for blankets, carpet yarns, shoddy, hair, and other coarse fibres, with Blamire's or Scotch feeds, and fitted with double doffer condensers with ordinary or 'tandem' rubbers.

"Carding machinery for angola yarns, meltons, unions, mungo, etc., with single stripper or double stripper condensers, with ordinary or 'tandem' rubbers.

"Carding machinery for botany and merino wools, with four lickers-in, two cylinders, and two doffers, fitted with balling head or coiler.

"Carding machinery for crossbred and medium wools, with two lickers-in, breast, two cylinders, and two doffers, fitted with balling head or coiler.

"Carding machinery for camel hair, cashmere, mohair, vicuna, etc., with one licker-in, breast, two cylinders, and two doffers, fitted with balling head or coiler.

"Condensers for carding machinery of all descriptions. Single doffer, single rubber condensers, with ordinary or 'tandem' rubbers. Single doffer, double rubber condensers, with ordinary or 'tandem' rubbers, tape condensers to take from 50 to 120 good threads off a 60 in. machine. Double doffer, double rubber condensers, with ordinary or 'tandem' rubbers. Condensers of all descriptions fitted to existing carding machines.

"Bank feeds, balling machines, Blamire's feeds, and Scotch feeds fitted to existing carding machines.

"Self-acting mules for all kinds of woollen hair, shoddy, mungo-carpet yarns, blankets, angola yarns, Scotch yarns, tweeds, etc., cannot be surpassed for simplicity, durability, strength, or economical working, and supplied with the following :—

"Speeds.—This mule is made with one, two, or three speeds, as required.

"Spindle stop motion supplied if required.

"Changes of the cam shaft effected by a positive motion, and so arranged that no two motions are antagonistic and cannot be in gear at the same time.

"Improved twist motion, pushing-in motion, spindle retarding motion, slubbing delivery motion, etc."

Coal.

In regard to consumption of coal a comparison should be made in regard to total amount used and results compared, so that the true relative value of different descriptions of coal may be ascertained.

The consumption of oil is another important item, and waste may occur in this connexion in several ways, such as using oil that is too thin or too thick for particular bearings, the operatives allowing oil to run on bearings too carelessly as on the spindle bolsters and rollers of self-acting mules. Careless application of oil to rollers on any machine stains the yarn, and does damage besides wasting the oil.

It has become the very common practice to use mineral oils, and especially for the lighter bearings such as ring-frame and mule spindles. Castor oil, sperm oil and tallow are, however, in extensive use for some lubrication.

It is not contended that free use of good oil is necessarily waste, since light running of parts, durability of parts, consumption of coal and other items are affected by the question of satisfactory lubrication.

It is for the operatives and foremen to see that efficient lubrication is obtained without undue waste of expensive oil.

Belting and leather are two other important items in which undue cost and waste easily occur. The purchase of poor leather may easily prove a double loss in reducing production and soon compelling renewal.

City Guilds Examination Question, 1909.

There are two common methods of preparing waste cotton ready for the spinning process; describe these fully. Say which you consider gives the best results, and give reasons.

Answer.—There are various differences in the detailed treatment of cotton waste in the blow-room, but these may belong to either of the two methods presumably referred to in the question. In the same way the cotton waste may be transferred from breaker to finisher cards either by the Scotch feed or the Derby doubler

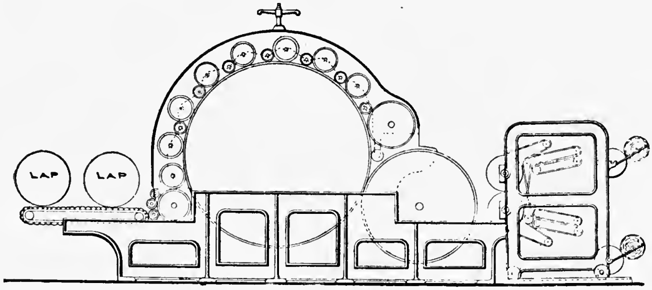


FIG. 58.—Finisher Card for Two Bobbins and Fed with Laps from Derby Doubler.

systems. The two distinctive systems, however, are first strongly and definitely marked at the delivery of the finisher card, at which point it is decided whether waste yarns are to be prepared on the (1) condenser system, or (2) the manifold coiler or preparation system.

In the condenser system the thick web of cotton waste is divided up into a number of individual strands, from 30 to 40 being a common number, although the writer recently saw a finisher condenser producing 120 strands. These 30 or 40 ends are rubbed into sufficiently round and strong strands and wound side by side upon a long flanged bobbin, which is placed directly into the creel of the waste mule, without any intermediate treatment.

In the coiler system the web from the finisher card may be divided into four equal parts, and each coiled inside a card can in the usual manner. These slivers are then passed through a slubber, drawn out, twisted and wound upon bobbins in the usual manner. These bobbins are then taken directly to the creel of the waste spinning mule. As to which gives best results, this depends upon requirements, the coiler system giving the strongest and probably the finest yarns owing to the use of drawing rollers in one machine.

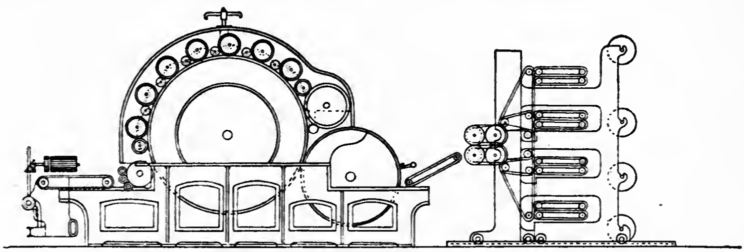


FIG. 59.—Finisher Card for Four Bobbins and Supplied with Cotton by the Scotch Feeder.

The condenser system gives the fullest threads, and is the more used of the two. Figs. 58 and 59 indicate two arrangements of Finisher card for cotton waste.

Vigogne Yarns.

At the time of writing a mill in Bury is being adapted to the production of Vigogne yarns. Vigogne means cotton spun to imitate wool, and is made in all sorts of colours and colour mixtures. Vigogne yarns are made not from waste, but from good American cotton, and mixtures of cotton and wool. This trade is not done at present in this country, but is done to some extent on the Continent and imported here. The only reason it is not done in this country is that Lancashire spinners have never been able to see change for a shilling in the business. Obviously German machinery and methods could have been introduced here if anybody had thought it worth while. Lancashire spinners have not been asleep. The business has not been done simply because they could not see any possible chance of profit in it. The Elton Cop Dyeing Company have certain new and novel methods and machinery in the spinning, bleaching and dyeing which they think will enable them to do this better and cheaper than it has been done hitherto.

Extracts from Recent Consular Reports.

"Cotton waste includes two very distinct classes; one a thread waste used for wiping and packing purposes by railway and navigation companies; the other a soft waste of various grades which is re-spun or otherwise mechanically treated. Hard thread waste is exported from Germany to the United States, while soft waste is exported from the United States to Europe in enormous and increasing quantities.

"The soft waste, of which Germany requires increasing quantities, is chiefly worked up into yarns, which are used in the manufacture of cotton or of half-woollen goods.

"English, French and American wastes are highly valued in the German market and are usually better than German wastes.

"The German market is ready to absorb every variety of soft waste and likes American waste because it almost all originates from American cotton.

"Market prices for cotton waste in Germany are regulated by the range on Middling Upland cotton in New York. Strips may command possibly 90 per cent of cotton price and comber waste or roving waste may command as good a price as raw cotton on account of the small loss in opening and cleaning."

"Many factories for using cotton waste have been established during recent years in Germany.

"Some of the uses for cotton waste in Germany are as wadding for upholstery purposes, and in the manufacture of smokeless powder.

"Cotton linters are much imported into Germany.

"Also cotton pickings composed of pieces of cotton which come off in sampling and in transportation, and become dirtier than the ordinary cotton and are separately sold at possibly 90 per cent or so of cotton price.

"German manufacturers have such little demand for cotton-tipped cigarettes that they often use ordinary loose cotton when required for that purpose.

"It is understood that in Russia there is a moderate demand for partly spun cotton, a ball of which is inserted in the mouthpiece to prevent tobacco dust from entering the mouth of the smoker, while at the same time the moisture is absorbed."

A good amount of cotton waste is imported into Lancashire from the United States, and the following have been given as prices quoted in September, 1909.

Combers 5d. to $5\frac{3}{4}$d. per pound; card-strips $3\frac{1}{2}$d. to $5\frac{1}{4}$d.; spinner's waste 5d. to $5\frac{1}{2}$d.; coloured card 3d. to $3\frac{3}{4}$d.; cop waste $3\frac{3}{4}$d. to 4d.; oily cards and soiled cards according to quality. The Manchester Ship Canal Company puts a toll of 3s. per ton on cotton waste entering that port, and there is also a quay porterage of 1s. 3d. per ton. It is estimated that France produces more cotton waste than she uses.

In 1900 the (in substance) following statements were made in respect of cotton waste :—

"In Manchester district yarns made from cotton waste are very much cut in price and are not very profitable".

"Probably half the waste made in England is exported to the Continent. Cotton waste comprises a clean soft mill refuse worked into wadding; mill sweepings and dirty oily soft mill refuse worked up into coarse yarns 4's or 6's by a special plant. Also hard waste made from different processes known as spinners' waste, reelers' waste, weavers' waste, including cop bottoms. This hard waste is broken up by a different plant from the soft waste. There is some hard waste which is made into engine waste or cleaning waste. Cotton waste is sometimes spun on ordinary spinning machinery, but more often upon a special plant."

"As far as we know the yarn from cotton waste is made up into yarns for such purposes as :—candle wick, sponge cloths, towel manufacture, bed quiltings, flannelettes, and for the backs of Kidderminster carpets. In very many cases only one portion of the manufactured article is from cotton-waste yarn, the other portion being from ordinary wool or cotton yarn."

"Districts on the Continent to which cotton waste is exported include Verviers (Belgium), Fermonde (Belgium), Rhenish Prussia (M. Gladbach), Chemnitz (Saxony)."

One list of waste was given as follows :—

"Droppings from openers and scutchers, flat strips, grid fly, brush strips, card-room sweepings, comber waste, bobbin waste, clearer waste, hard waste, fluker waste, carriage fly, spinning-room sweepings, oily waste. Such a variety of waste requires a variety of treatment."

"Most of the cotton waste imported from the U.S.A. goes to Hamburg and is sent from Hamburg to the German and Austrian cotton districts. Hungary sends its cotton waste largely to these places."

"Cleaning cloths absorb a good deal of the dirtiest waste. Sponge cloths also take a good deal."

Wastes in the Woollen Trade.

In what are termed the low woollen districts large quantities of rags are regularly used up again after being thoroughly torn up. Various terms are applied to such waste, such as flocks, shoddy, mungo, or extract. Noils or proper waste is usually better than re-manufactured stuff such as above specified.

Dusting, sorting, seaming, oiling and grinding are processes included in the treatment of such re-manufactured stuff as mungo and shoddy. Extract is a term applied to material for grinding up which is obtained from waste cotton and wool cloths from which the cotton portions have been extracted by what is termed the sulphuric acid process, or some equivalent.

In cotton it is usual to apply the term comber waste to the large percentage of waste extracted at this point, but in wool-combing the term "noil" is applied to the material rejected in preparing and combing of wool. Noils therefore come in a different category altogether from the wastes specified above, and these noils are often of quite good value. Such names as alpaca, mohair, crossbred, and botany are applied to various descriptions of noil resulting from wool-combing.

Absorbent Cotton.

Absorbent cotton is now in demand for a number of important purposes, being largely used as surgical lint in the medical profession, and also in compounds of cellulose and artificial silk. It is very important that such cotton be properly purified for such special purposes as surgical lint, but the organic matters natural to cotton do not offer much resistance to purification.

The essential requirement of hygienic cotton is a good degree of purity of cellulose and aseptic power. Care should be taken to avoid imperfections in the boiling-out operations and to secure a good expulsion of air from the fibres, so that the cellulose solutions shall be as free from air as can be reasonably obtained.

If not more than about 5 per cent of impurities require removal the preparation of absorbent cotton should be a comparatively simple matter, but care should be taken not to introduce other impurities in the boiling and bleaching operations. Boiling out may be done in a kier with alkali at 120 or more degrees C. temperature, boiling seven or eight hours possibly with caustic soda. There is little of a special nature about the bleaching operations.

In regard to gun-cotton, this may be prepared from clean pure cotton waste by steeping in a solution of sulphuric acid three parts and nitric acid one part, the latter forming the explosive constituent while the sulphuric acid absorbs the water. After steeping for several hours the superfluous acid should be removed by squeezing and washing out processes. It is of course quite possible to make either surgical lint or gun-cotton from raw cotton sufficiently opened and cleaned before treatment as above described.

Waste in Doubling.

The question of limiting the amount or percentage of waste made is in its own way quite as important as that of obtaining maximum productions and highest qualities of work. In the case of a doubling frame we have to remember that any waste loss is very expensive, because the yarn has gone through practically all the processes and has had the full cost of production put into it. At the same time the waste may be of less value per pound than soft waste from the card or comber, because it takes so much treatment in a cylinder breaking machine and thereby loses so much of its strength.

A prolific cause of waste on a doubling frame is the breakage of threads and their entanglement with adjacent threads.

In one case special means are adopted to prevent entanglement or licking of the threads due to snarling. This is done by giving a wide spacing to the lengths of threads extending from the nip of the rollers to the stump rail when the machine is stopped, and bringing the length nearer when the machine is working. By this means broken ends are caught up by one of the adjacent lengths of thread, and these become lapped round the top roller instead of being delivered amongst the spindles with resulting excessive waste and "doubles".

Waste in Wiping up Oil.

Writing on the subject of loss in lubricants an American authority recently said :—

"It was found that the oil soaked waste used in wiping up was sent to the boilers to be burned in one case.

"In wiping up around engines it has been found by experiment that a pound of dry waste will, after being used and squeezed out by hand, weigh 2 lb., or as the writer found out at one plant, there was a loss of one gallon of oil for every 10 lb. of dry waste used ; this in itself is quite an item. In most large plants it will pay to install some make of oil and waste-saving machine, by means of which the oil is extracted and filtered, and the waste washed, dried, and used over again.

"In the particular case of a large concern it was found that waste was being used at the rate of 28,000 lb. per annum for cleaning purposes. Most of this waste was used for wiping up around the machinery and engines on which a great deal of oil was used. All of it was sent to the boiler to be burned. As this waste was heavy with oil, it is safe to say that at the very least 2000 gallons of oil, together with the waste, were lost per annum."

Large quantities of cotton waste and sponge cloths are used in engineering workshops as well as in textile mills for the purpose of cleaning machinery. When dirtied and fully saturated with oil formerly this material was thrown away, but this day is nearly past. In some cases the cloths are cleaned without charge for the value of the oil. In others a slight charge is made.

A particular machine for cleaning oily cotton waste may be described as follows :—

The machine will hold from 50 to 60 lb. of waste. The oil and grease are first liquefied by steam and are then ejected from the waste by the action of centrifugal force. The oil can be collected and filtered, and then both oil and waste may be ready for using again. Such a machine can either be driven by turbine or belt. When a turbine is used the exhaust steam is led into the machine and serves to liquefy the oil. It is stated that the pressure inside the machine does not exceed 25 lb. to 30 lb. per square inch and a pressure gauge indicates the pressure, while a safety valve prevents excess of pressure.

Loose Cotton Bleaching.

The preparation of loose cotton for the purpose of subsequent use in the manufacture of absorbent cotton wadding for surgical purposes, of gun-cotton, smokeless powder, other explosives, artificial silk, cellulose, etc., is a particular branch of the bleaching business, and has received a good deal of attention, and various patents have been taken out in this connexion. The purification and bleaching called for in the preliminary preparation of loose cotton intended for such purposes as the above may be accomplished by either the "cold system" or the "warm system".

Waste in American Mills.

The following brief extracts from a good paper given in America are worthy of notice.

"It is worth while to study the relative losses in waste in regard to length and strength of fibre. Below are given some approximate figures relating to waste losses in certain Southern mills. In one case out of every eleven bales of cotton entering the mills, one bale was lost, this estimate being based on the working of many months, the mills making crashes and damasks.

"In the different departments it was found that nearly 5 per cent was lost in the blowing- or picker-room, 2 per cent in the card room, 1 per cent among the bobbins and fly-frames, and 1 per cent in the spinning-room.

"In another Southern mill it was stated there was an average loss of 13·11 per cent, this mill making heavy cloth for rubber belting and being very well governed.

"The waste fibre from above mill goes into cheap cloth such as engine cloth and cheap glove cloth. It is baled at the mill and sold at the rate of from one to six cents per pound according to grade.

"In another firm the waste is used altogether in the making of weft, and it has been found that after cleaning and getting the waste ready for use it has been worth on an average seven cents per pound."

Artificial Silk.

"The great bulk of cotton waste is certain to concern our cotton mills more in the future, and further developments in its use will lead to a supply of trained operatives.

"It is contended that all very large cotton mills and associations should have a connexion with artificial silk mills, which often offer a paying channel for cotton waste.

"Cotton is almost pure cellulose to commence with, and no fibre is equal to the cotton fibre for making cellulose, which is the basis of artificial silk, for which there is a large demand practically all over the world.

"It is stated that three leading processes are employed in the

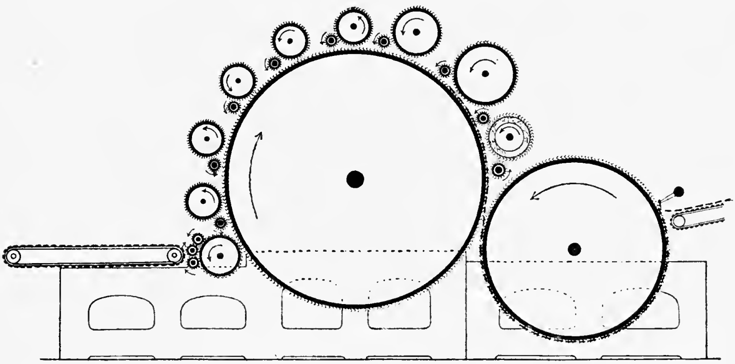


FIG. 60.—Roller Card Showing Direction of Rotation of Principal Organs.

manufacture of artificial silk, these being the chardonnel, or nitro-cellulose process; ginet or cupro-ammoniacal; and xanthate cellulose or viscose process.

"It has been stated in recent issues of the American silk journal that there are at present some thirty establishments throughout the world engaged in the manufacture of artificial silk approximately distributed in countries as follows: United States, 5; Germany, 7; France, 7; Belgium, 3; Italy, 2; England, 1; Spain, 1; Austria, 1; Russia, 1.

"Germany and England are stated to be producing the best artificial silk yarns.

"The German yarns are made by the viscose process. While the total American consumption of artificial silk is 1,450,000 lb., 880,000 lb. of this comes from France, Italy, and Germany.

"More than 30,000 persons are employed in the industry, and the production in 1909 was stated to be 10,000,000 lb.

"The distribution of the three processes of manufacture is given, nitro-cellulose 4,400,000 lb., cupro-ammoniacal 4,000,000 lb., viscose 1,600,000 lb.

"All grades of cotton, wood-pulp, and any other material capable of chemical conversion into cellulose are available as materials for the basis of the manufacture."

Baine's Loss Table, 1833.

"Cotton wool imported	303,656,837 lb.
Cotton wool used in manufacture . .	282,875,200 lb.
Yarn spun (counting 1½ oz. per lb. loss)	256,174,400 lb.

"This shows a loss of 9½ per cent on the weight of fibre going into the mills, which much resembles present practice for American cotton."

New Patent Machine.

The utilization of soft waste in the cotton trade is now very greatly studied, and various methods of treating the same have been studied, the recent high prices of raw cotton enhancing the value of waste very materially.

In a recent case the machine consists of two compartments opened to admit the air necessary for the treatment of the waste.

The waste is fed on a travelling belt and is given to a card covered licker-in, which in turn gives the waste to a combing roller having a dirt grid beneath it. The bulk of the heavier and larger impurities passes through the bars of this grid and at the same time the waste is combed to a certain extent. The combing roller may have a speed of 1200 revolutions per minute and a diameter of 8½ in. From this comber roller the waste is taken by card taking off roller having the very high speed of 3200 revolutions per minute, and the waste is driven upwards. The passage of the cotton waste is at this point greatly helped by a current of air passing through the grate bars.

Fire Risk with Cotton Waste.

In certain tests made abroad the following conclusions were formed :—

That cotton wadding soaked with oil varnish will carbonize spontaneously in the interior at ordinary temperatures and will then take fire on being opened out.

Waste cotton soaked with fatty oils takes fire or chars spontaneously in three to eight hours when heated to 82° C. with exclusion of external air. Clean cotton, soaked with twice its own weight of fatty oils and heated to 100° C., with a moderate admission of air from the outside, becomes hot inside in about an hour to an extent depending upon the kind of oil employed, and often going as far as spontaneous combustion. Cotton that has been soaked with its own weight of rape oil or cotton-seed oil, and heated to 25° C., with exclusion of external air, generates such a small amount of heat by auto-oxidation, that the risk of spontaneous ignition from this cause appears to be remote.

No danger of spontaneous combustion has been recorded among the enormous quantities of wool stored in the London Docks from cargoes from the Cape and Australia, although packed in heavy bales and still in the grease. On the other hand the opinion seems to prevail that either raw cotton or cotton in the earlier stages of the mill will tend to ignite spontaneously, and cases of mill fires have been attributed to this cause.

Shoddy has a high fire risk owing to suspicion from its containing cotton waste or other vegetable fibre on the one hand, or from softening oil on the other hand.

Danger of Flannelette.

Mr. Thompson reported as follows :—

" The difference between ordinary calico or cloth and flannelette is that the latter has a nap which is produced upon it by raising one or both surfaces by passing it over revolving rollers provided with steel dents or teeth, which raise upon the surface a nap which forms a better non-conducting material for heat than the original cloth, and which therefore gives a greater feeling of warmth to the person using it than the unraised cloth.

" Experiments were made with various kinds of flannelette—new and after wearing—to test the amount of fire danger.

" Conclusions : 'When a flame is applied to the surface of a flannelette the nap ignites and spreads for a few inches only from the point at which the flame was applied, and then becomes extinguished, the fabrics being cold in all these tests.

" 'After drying and warming the fabrics there was a greater tendency for the flame to run over the material, doing damage in proportion as the flannelette was old and torn, but hardly any if the material was of a good class.'

"It would be advisable for children's dresses to be made of woollen or a mixture of wool and cotton, or of flannelette which has been treated to render it non-inflammable.

"There is, however, probably no more burning danger with any specific material after it has been raised than if the same were not raised or converted into flannelette."

Candlewick.

The term candlewick yarn is not now necessarily confined to yarn used for candlewick, but is often used to indicate cotton waste yarns of very coarse counts which are probably so coarse that they are numbered by the number of yards which make one ounce instead of on the standard cotton basis of so many hanks per pound, which is not very convenient for counts below 1's cotton.

Bump yarn is another special term applied to very coarse condenser yarn, the term probably arising from the rebound or concussion in the loom when these yarns are used for wefts and they are beaten up by the reed.

Carpet Cops.

As elsewhere fully described such machines as the "chapon" and the "can" spinning frames, build up the coarse condenser yarns into cops having the distinctive feature of being without bottom cones. These are sometimes termed "carpet cops" because of their use in weaving some sorts of carpets and cheap quilts.

Naturally such a cop is far larger than any ordinary cotton weft cop, and indeed is often larger than an ordinary cotton twist cop. The most distinctive feature of all is that a cop of this description when placed in the shuttle of the loom is woven off or drawn off from the base of the cop and the inside thereof and no shuttle tongue or peg is used. The cop is often held in the shuttle by an elastic strap or band of some kind, although thin and almost flat metal bands are sometimes used and are held in position by small flat springs. Carpet cops are probably more often referred to in the case of cops used for wefts for rugs, carpets and quilts using cotton waste or condenser yarns.

Occasionally cops of cotton waste yarns may be as much as $2\frac{1}{2}$ in. diameter and 11 in. long and even of larger dimensions.

When mule spun cops of very coarse condenser yarns are used in the loom as weft it is often necessary to provide special shuttle pegs to prevent the cops from breaking and knocking-off; some of these shuttle pegs are corkscrewed, and others are fluted or corrugated for this purpose.

Condensed Yarn.

Some condensed yarn is sometimes spoken of as vigogne or imitation vigogne yarn, possibly because of its early use in France or Belgium to imitate yarns spun from the wool of the vicugna.

Sometimes condensed cotton yarn is described as imitation yarn owing to its use in cheap goods which imitate woollen ones.

The condenser system of carding and spinning somewhat resembles those in use for woollen yarns, and hence the occasional use of the term wool-spun.

In proper condensed yarns the fibres of cotton waste are not put through any draughting rollers, and the fibres are not placed in parallel order and there are many projecting ends of fibres on the yarns.

In "drawn" yarns prepared by ordinary cotton-spinning processes the fibres are laid in parallel order and overlap each other and there is a multi-draughting process.

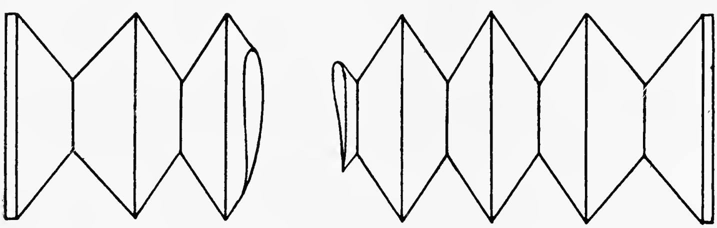


Fig. 61.—Dividing Roller for Condenser Cards—with Ring-doffer.

Objectionable Wastes.

In some weaving districts a good deal of trouble has been given to the sanitary authorities by the amount of waste found in the sewers and other places, due to the throwing away of waste by weavers or winders.

Apart from this there is very little objectionable waste from either cotton spinning or cotton weaving mills such as may be caused by wool-scouring mills, cotton yarn bleaching, cotton yarn dyeing, and from the manufacture of fertilizer, glue, and other substances. These factory wastes often run into streams and rivers, and greatly pollute the same.

In Lancashire, however, stringent means are adopted for limiting this in regard to many waterways. It has been found that almost all of these wastes can be purified at a reasonable cost and in some cases the sewage contains sufficient valuable matter to pay for the cost of purification.

The pollution of streams and destruction of natural water resources by the running in of such liquid wastes is certainly very often a serious evil.

Woollen Mill Wastes.

A slight comparison may be made between the wastes of a cotton mill and those of a woollen mill.

Among the various kinds of waste from a woollen mill may be specified the following: burr waste, card waste, hard waste, rags, flocks, sweeping.

Burr waste represents the waste knocked out of the wool in cases of very burry material by the burr picker, or in cases of less burry material possibly by the action of a burr cylinder, as attached to the breaker cards at the point where the material is about to enter the first breaker of the first set of cards. A long box is adjusted near the feeding mechanism, in line with the burr cylinder, and burrs and other impurities are thrown into the box, from which they are removed at regular intervals through the day. Some of the burr waste may be of very little value, whereas other burr waste may be re-worked by first carbonizing the waste, dusting and re-working it in connexion with wool into low grades of yarn.

Burr waste, after cleaning it from its foreign and undesirable matter, is made up of a combination of short and long fibre united in a body about one another. Disentanglement may be effected by the steel toothed cylinders of a Garnett machine.

Card waste is the refuse of wool remaining in, and adhering to, the teeth of the card clothing of the set of carding engines, and daily removed from the clothing by stripping the cylinder and rollers of the card, probably by means of hand cards.

Hard waste may be produced in the spinning, dressing, and weaving departments of the mill. In the spinning, hard ends are the result of breakages, which require the attendant to make a yard or two of waste spun-yarn before the end is re-pieced.

In spooling, hard waste is made when the operative pulls off several yards of yarn when a broken end has to be pieced.

In the weaving, hard waste is caused by the accumulation of weft on the bobbins, which instead of going in the cloth was left on the bobbins, probably because the remaining yard or two was not long enough to reach the width of the fabric. Also warp threads break and require re-tying with a little waste due thereto.

Rags, as produced in the mill, are the clippings from the ends of fabrics which are trimmed for the market, samples, etc.

They may be re-manufactured by passing them first through a rag-picker and in turn through a Garnett machine or a shoddy card.

Flocks are of two kinds, such as produced from the shear, and flocks produced by gigging or napping the goods. The latter have to be cleaned of any hard substance before going to the flock cutter.

Sweepings are the refuse of the wool of the mill, but may contain an amount of good fibre. They are treated to a dusting process which liberates the dust and dirt, and may afterwards be treated somewhat like flocks.

Indian Raw Cotton.

Short stapled cotton, such as poor American or Indian, with or without an admixture of cotton waste, is often used in the production of thick cheap yarns spun on the ordinary cotton-spinning principle with roller draughting and possibly a reduction of drawing frame and fly frame use. Such yarns may be spun either on the mule or the ring frame, and are much used in the manufacture of the cheaper sorts of floor coverings or carpets after doubling into 3, 4, 5 or 6 cords; 6's or 8's single yarn is common for this purpose, and such yarn is often used as the warp.

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