COTTON COMBING MACHINES

THOMAS THORNLEY

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HEILMANN

(INVENTOR OF THE COTTON COMBING MACHINE)

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BY

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WITH FRONTISPIECE AND 121 ILLUSTRATIONS AND DIAGRAMS

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PREFACE.

THERE can be no doubt that the Heilmann Comber has exercised a most important influence upon the spinning of fine cotton yarns, and high-class yarns of lower numbers, during the fifty years of its existence.

It would appear that Heilmann, of Mühlhausen, had so perfected his comber as to make it a practical success, a short time before the great London Exhibition of 1851, and it there attracted a considerable amount of attention on the part of spinners and machine makers. Many of these gentlemen were so favourably impressed with Heilmann's Comber that, amongst them, an important syndicate was formed, and the patent rights of the comber were purchased by this syndicate.

For many years the eminent firm of Messrs. Hetherington, of Manchester, exercised the sole privilege of making the cotton comber, and by this firm it was brought to a high degree of perfection.

At the expiration of the patent rights the eminent cotton machine making firms of Messrs. Dobson & Barlow, of Bolton, and Messrs. Platt Brothers, of Oldham, also took up the manufacture of the Heilmann Cotton Comber, and both these firms have vastly aided in perfecting its constructional details. Messrs. Asa Lees & Co., of Oldham, have also quite recently begun to manufacture the Heilmann Single Nip Comber, along with the Sliver and Ribbon Lap Machines.

In its leading and essential features the Heilmann Cotton Comber has been really very little altered since its introduction, as may be seen by an inspection of the early form of this comber given at the commencement of Chapter II.

Innumerable attempts, however, have been made during the last fifty years both to supersede the Heilmann Comber by others of very different construction, and also to effect very radical alterations in this comber.

Several of the best known and most important of these later combing machines are illustrated and described in the last chapter of this treatise, but at the time of writing it is questionable whether a single cotton comber is working in England except single and duplex Heilmann Combers.

On the Continent, however, and in America a good many such combers have been successfully worked, and our own English machine makers have experimented with them, but have not yet seen their way to take up their manufacture, although this may soon come to pass.

While nearly all the cotton spinning machines of to-day were invented and have been perfected by Englishmen, it is noteworthy that Heilmann was a native of Alsace, and it is probably still more noteworthy that almost all the other cotton combers since invented were originated and perfected also on the Continent.

It does not appear that Heilmann himself—of whom a pencil sketch is given in the frontispiece—lived long enough to benefit much by his great invention, while its development involved a great deal of labour and expense.

It has been contended that cotton combers were likely to go out of use on account of the great perfection of modern cotton carding. The author, however, is quite opposed to such an idea, and, on the contrary, holds the opinion that cotton combing will, in the near future, receive far wider adoption than at any time previously.

The comber does work which it is quite impossible for any carding engine to do. As the world grows richer there is a greater demand for high-class goods, and combing gives such strength, finish and appearance to cotton yarns that an increase in its adoption appears more than likely to the author.

Coming now to the present treatise, it has been the aim of the author to provide his readers with the most complete and practical treatise ever published on the subject of cotton combing.

First of all, there is a chapter dealing with the allied processes of the sliver lap machine, ribbon lap machine, and drawframe.

Then is given a chapter dealing with the details of the Heilmann Comber in an elementary manner. Afterwards follow chapters on cams, detaching, resetting, erection, calculations, various discussions, and more recent combers.

The Heilmann Comber, as befits its paramount importance, has received by far the most attention. The comber is a most intricate machine, so that this book is only the outcome of many years' study and application on the part of the author, and it is hoped it will prove of great service to masters, managers, overlookers, carders, advanced students, and others engaged in the cotton trade both at home and abroad.

Very many of the ideas put forth in the following pages are so original and novel that it is only reasonable to imagine that there will be differences of opinion amongst practical men as regards some of them.

The author has to acknowledge the kind assistance of several machine makers, whose names are specified in connection with the description of their machines.

In this connection also special and grateful acknowledgment is made of the services rendered by Messrs. Frederick Hardman and John Gregoriades.

THOMAS THORNLEY.

Bolton, *February*, 1902.

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CHAPTER I.

THE SLIVER LAP MACHINE, RIBBON LAP MACHINE, AND DRAWFRAME.

When the Heilmann comber is used it is necessary to employ apparatus for converting the slivers from the carding engine into narrow laps suitable for the comber. This is done on the sliver lap machine, in which from fourteen to twenty sliver cans are placed in position, so that the sliver from each of them can be conducted upwards through an aperture in the back guide plate. Then the various slivers pass side by side over spoon levers, through three pairs of drawing rollers, and between one or two pairs of calender rollers.

The cotton issues from these latter in the form of a narrow sheet or ribbon, which is coiled round a wooden core or bobbin ready for transference to the creel of the comber.

Before reaching the sliver lap machine, or Derby doubler, the slivers are usually put through one head of drawing in order to make the fibres somewhat parallel and the slivers uniform. This facilitates the work of the comber very materially. Instead of this special drawframe, some firms have begun to use the ribbon machine, as described hereafter.

It is generally considered that the sliver lap machine is an indispensable adjunct to the Heilmann comber. Any one who is familiar with the old Derby doubler, as formerly used so very extensively in connection with double carding, can very readily understand the sliver lap machine. The latter possesses leather-covered drawing rollers, which were not used in the Derby doubler—at any rate, to the writer's knowledge, and he formerly had the opportunity of handling and watching quite a number of these machines. Although drawing rollers are used on the sliver lap machines, there is usually only a very small draft in them—as a matter of fact, scarcely enough to warrant their use. In some makes of these lap machines the back sliver table is maintained of the triangular shape which was always used in the Derby doubler, while in other cases only a rectangular back plate is used. Such a plate is permissible on account of the small number of slivers passed through the machine together as compared with the Derby doubler. Often the writer has witnessed about sixty slivers working together on the older machine, as compared with about fourteen to twenty commonly used on the sliver lap machines. The essential use of the older machine was to convert slivers from the breaker card into laps for the finisher card, and in like manner the essential use of the sliver lap machine is to convert the card slivers into narrow laps for the comber. This, of course, is necessary whether the ribbon machine is used or not. The name of the machine will indicate its use, as it is fed with slivers of cotton and delivers laps.

In Fig. 1 we show the sliver lap machine as made by Messrs. Dobson & Barlow, with a few particulars relating thereto.

Dobson's Improved Sliver Lap Machine.

This machine unites the slivers from the carding engine, and forms them into a lap for the comber or for the combined draw and ribbon lap machine when the latter is used.

From fourteen to twenty cans are usually put up at this machine, and the laps made are from 7½ in. to 10½ in. wide when taken direct to the comber. But when a ribbon lapper is used they are one inch narrower to allow for spreading in the drawing.

In order to produce uniform laps a stop motion is applied to each sliver, which instantly stops the machine when an end breaks.

The slivers pass through guides and between three lines of rollers, having a small amount of draft. They then pass between calender rollers, which slightly press the fibres and form them into a fleece to be wound upon a bobbin driven by revolving plates.

When the ribbon lapper is not used the slivers are taken from the card and put through one process of ordinary drawing, after which they go to the sliver lap machine to be made into a lap for the comber. In this case four lines of rollers are recommended.

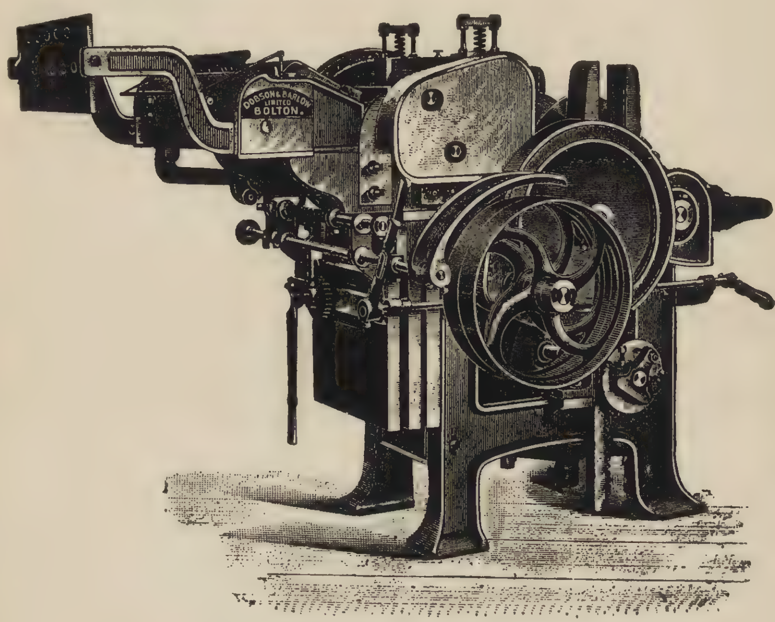


FIG. 1.

Notes.

Power.—½ i.h.p.

Production.—450 to 500 lb. per day.

Speed.—Driving pulley, 16 in. by 2½ in.; 200 revolutions per minute.

Floor Space.—8 ft. by 4 ft. 6 in. = 2·44 m. by 1·37 m.

Weight.—Gross, 20 cwt.; net, 16 cwt.

Cubic Measurement.—65 ft.

To determine hand of machine, face the feed end and note on which side the driving pulleys are to be placed.

Course of Material.

Fig. 2 is designed to show the course of the cotton through this machine, as made by Messrs. Dobson & Barlow. Fourteen to twenty cans of sliver, A—either from the card, or from a special head of drawing, as the case may be—are placed behind or under the machine. The slivers, B, are drawn upwards from the cans, A, by the action of the drawing rollers, G.

Each sliver passes through a small round aperture in the guide plate, C, which latter can be adjusted to put a little more or less drag on the slivers. Leaving the guide plate, C, each

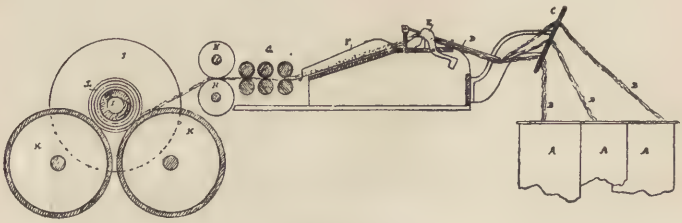


Fig. 2.

sliver passes under a small round bar held by the arms, D, and then over a spoon lever at E, which forms part of the automatic stop motion for stopping the machine when a sliver breaks or a can runs empty at the back.

The purpose of the small round bar between C and D is to keep the slivers down on the spoons better, therefore securing quicker action of the stop motion. In passing, the author may say he has known a similar idea to be used successfully on the drawframes in place of the single-preventer rollers.

At F the slivers pass down a specially shaped guide plate or bridge piece, on which each sliver is kept apart from the others, and in a groove or channel to itself. The slivers are in this manner converged and kept to a comparatively level sheet, without overlapping each other, at the point where they enter the drawing rollers, G, side by side. It is not the purpose of this machine to make the slivers thinner, but to lay the slivers side by side, and to form a lap sheet out of them ; and therefore the draft in the rollers, G, seldom much exceeds about $1\frac{3}{4}$, and it is doubtful whether a larger draft would be of advantage, as it would interfere with the production by leading to more waste and more stoppages.

The top calender roller, H, may be held down, either by small spiral springs or by short weighted levers, the former being the neater method, while both methods offer facilities for adjustment of the amount of weight. The weight on each end of the roller may be from 80 to 140 lb.

After leaving the calender rollers the cotton is wound in the form of a lap, L, upon the wooden bobbin or roller, I. The bobbin or lap of cotton is rotated by frictional contact with the large fluted iron rollers, K, K. The edges of the lap are kept good by the large circular, smooth iron plates, J, which are screwed tightly up to the ends of the wooden bobbin, and therefore revolve with the bobbin and prevent the lap ends from swelling out. The bobbins when empty are 4 in. diameter, and when quite full may be upwards of 12 in. diameter. The width may be from $7\frac{1}{2}$ in. to $10\frac{1}{2}$ in.

Lap-forming Apparatus.

Figs. 3, 4 and 5 are intended to convey a full idea of the apparatus for forming and hardening the lap.

The screwed spindle, C, and its companion parts are used to keep the various parts belonging to the lap in position during the formation of the lap, and are shaped so as to facilitate doffing.

As on a scutcher, the increasing diameter of the lap forces the centre of the spindle and lap roller upwards, this lifting, however, being resisted by the brake motion. The spindle at either end is encircled by the top of one of the vertical racks, and the upward motion of the racks, D, cannot take place freely because of the difficulty of rotating the brake shaft, F, owing to the resistance offered to the brake pulley, G, by the brake, I.

In Fig. 5 the spindle and bobbin are shown separately.

FIG. 5.

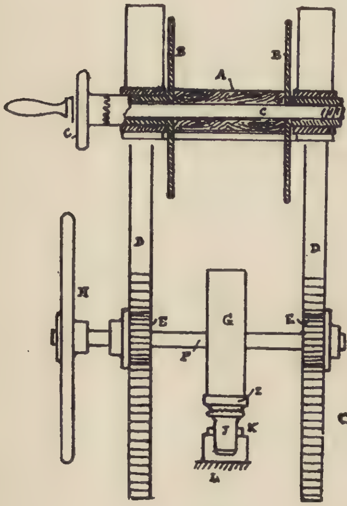


FIG. 3.

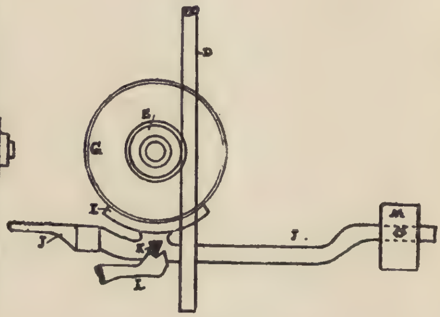


FIG. 4.

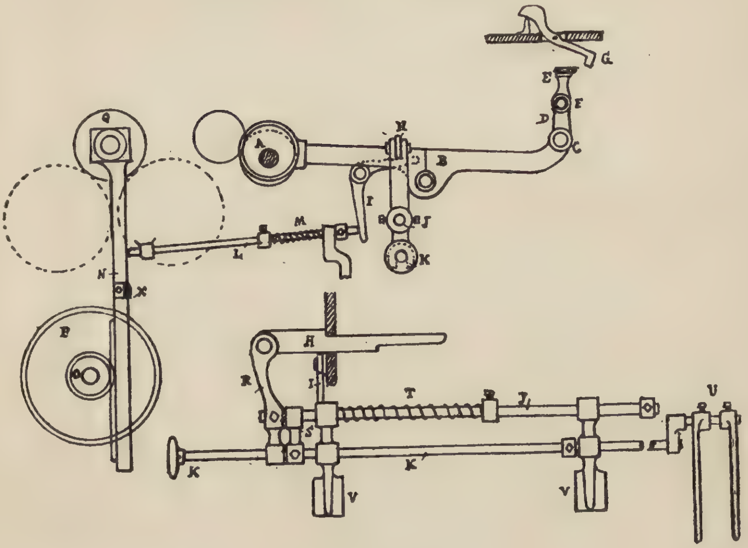
A Bobbin.
B Circular Lap Plates.
C Spindle which sustains A and B in position.
D Vertical Racks.
E Rack Pinions.
F Rack Pinion or Brake Shaft.
G Brake Pulley.
H Hand Wheel for Brake.
I Brake covered with Leather.
J Brake Lever.
K Fulcrum for Brake Lever.
L Rest for Fulcrum, K.
M Adjustable Brake Weight.

KNOCKING-OFF MOTIONS.

There are two knocking-off or automatic stop motions applied to this machine, *viz.*, the full lap motion and the back spoon motion.

These two motions are shown in Figs. 6 and 7, and most of the parts are common to both motions.

ACTION OF FULL BOBBIN MOTION.



FIGS. 6 and 7.

Index of Parts.

A Eccentric for oscillating the Lever, B.
B Eccentric Arm or Knocking-off Lever.
C Connection of B to
D, E, F Rocking Knife-bar parts.
E is the Knife Bar.
F the Fulcrum Bar.
G Spoon Lever.
H Double Catch Finger for Stop Rod.
I Bell-crank Knocking-off Lever.
J Knocking-off Rod.
K Stop Rod.
L Knocking-off Finger for full Lap.
M Spring to keep L in position.
N Vertical Rack.
O Brake Pinion.
P Brake Pulley.
Q Lap Bobbin.
R Finger Bracket fast to J, but loose on K.
S Finger Bracket fast to K, but loose on J.
T Knocking-off Spring.
U Strap Fork.
X Knocking-off Snug.

The vertical rack, N, is moved upwards as the lap increases in diameter. According to the size of lap required the knocking-off snug, X, is set-screwed in position on the vertical rack.

When the vertical rack has been raised a definite height—according to the diameter of lap required—the snug, X, comes against the end of the rod or finger, L, thus overcoming the resistance of the spiral spring, M, and pressing the other end of the finger, L, against the bottom arm of the bell-crank lever, I. This causes the other or upper arm of I to lift up at the catch finger, H, and release it from the framing. The strong spring, T, then immediately slides the top rod, J, forcibly in the direction of the belt fork, V, and the upper rod, J, takes along with it the lower rod, K, and in this way the belt is moved from fast to loose pulley.

Spoon Stop Motion.

When the slivers are passing properly over the spoons, G, the knife bar, E, oscillates below the spoons freely, and all the parts of the stop motion are inoperative excepting that the eccentric, A, is constantly oscillating the double fulcrum bar or lever, B, and the knife lever, D, E, F. Upon the failure of a sliver from any cause the lower extremity of the spoon lever, G, falls in the way of the knife bar, E, and prevents it from oscillating. The result is that the double fulcrum lever, B, opens out at B, owing to the eccentric, A, still acting on the front half of this side lever, B. Yielding to the action of the eccentric causes the front half of side lever, B, to lift up and release the catch bar or finger, H, from the framing, when the frame is knocked off in exactly the same way as described for the full lap stop motion.

Hetherington's Sliver Lap Machine.

Fig. 8 shows a side view of this machine. It is made with three pairs of drawing rollers, followed by two pairs of calender rollers for consolidating the lap, which can be made $7\frac{1}{2}$ in., $8\frac{3}{4}$ in., or $10\frac{1}{2}$ in. wide, as may be desired, with 14, 18, or 20 ends up, as may be required. Each end is provided with an automatic stop motion which brings the machine to a standstill before the broken end enters the rollers. It is on the same principle as that applied to the drawing frame. A full lap stop motion or measuring motion is also applied, so that the size and weight of the laps can be regulated at will. The $7\frac{1}{2}$ in. laps usually weigh 10 dwt. to the yard, and the $8\frac{3}{4}$ in. laps 11·5 dwt. to the yard. The draft in this machine should not be more than two.

Pulleys 12 in. by $2\frac{1}{2}$ in., running usually at 200 revolutions per minute, at which speed the machine will produce approximately 2,000 yards per hour.

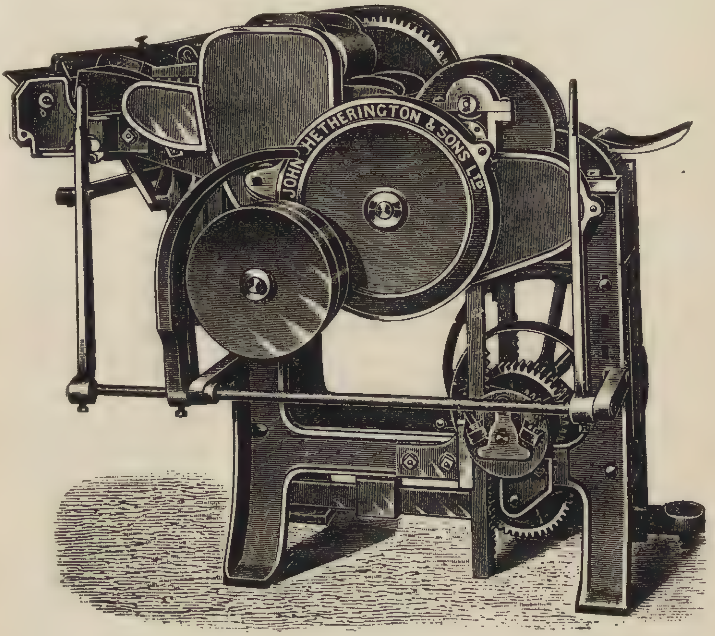


FIG. 8.

Floor space, including cans, 7 ft. 6 in. by 4 ft. 6 in. (= 2 m. 385 × 1 m. 37).

Approximate gross weight ($7\frac{1}{2}$ in. lap), 23 cwt. (= 1,170 kilos.).
Net weight ,, 20 cwt. (= 1,016 kilos.).

There are supplied extra with each machine one top roller and two extra change wheels. This firm strongly recommend the metallic rollers in this machine.

THE RIBBON MACHINE.

There are two or three rival methods of preparing laps for the Heilmann comber, each involving the employment of two or three special machines. The latest method is by the use of the ribbon machine, although it is probably some twenty years since the first of these machines was experimented with in England. A well-known and practical carder and comber overlooker of Bolton has assured the writer that he was the first to give this machine a fair trial in an English mill, and the very same machine—put up twenty years ago—is still working, and giving every satisfaction.

We are bound to say that, considering the length of time this machine has been before the public, it does not appear to have made such very great headway.

When the ribbon machine is adopted the slivers are taken straight from the card, and are converted into narrow laps on the sliver lap machine, or Derby doubler. Several of these laps—usually six—are placed on the wooden lap rollers of the ribbon machine, and are then operated upon separately by four pairs of drawing rollers. Emerging from these rollers, the thin fleece or web from each lap is run over a highly polished curved plate, and deposited upon the flat polished front table. Upon this table the six webs or ribbons of cotton are superposed upon each other like the laps in the creel of a scutcher, so that a doubling action is secured. On a scutcher there is, of course, a travelling lattice employed to carry the sheets of cotton forward, but this would be inconvenient on the ribbon machine, and in place thereof there are several pairs of calender rollers drawing and passing the ribbons forward.

The thin superposed ribbons form one thicker ribbon, which is wound into lap form by mechanism, which is practically the same in principle as the lap forming part of a scutcher. The calender rollers are weighted by adjustable weights or by springs, so as to consolidate the sheet of cotton.

Instead of the iron lap roller used on a scutcher or opener, the ribbon of cotton is wound upon a wooden bobbin of a width suitable for the creel of the comber.

The best way to study this machine is to take it as a drawframe which operates upon small ribbons or laps instead of upon slivers.

Like the drawframe, this machine makes the fibres parallel, and it makes the ribbons of cotton uniform, while the drawframe makes slivers uniform. The ribbon machine acts on ribbons, and the drawframe on slivers.

But there is another great advantage claimed for the ribbon machine in addition to the two above specified. It takes out the individuality of the slivers which compose the lap made on the sliver lap machine, and amalgamates the fibres so as to make a ribbon or narrow lap which is more uniform in thickness all across the width than is possible to be got from the other and older methods.

This method of making laps by the use of the ribbon machine is often called the new method, although, as has been shown, the method is twenty years old.

The use of the adjective "new" serves, however, to distinguish between this and the older methods, and is therefore quite justified. In just the same way the term "new Curtis mule" is appropriately applied to the mule of that firm, in which all the changes are made by rods, levers and springs, although nobody needs telling that the mule has been now working for several years. The term is used to distinguish between this mule and the older and better-known mule of this firm, in which the cam shaft is employed to make the changes.

There can be no doubt that the third and special object aimed at by the ribbon machine is a good one, and it is the opinion of the writer that it is to a considerable extent attained. Anything which tends to make the grip of the nippers of the comber upon the cotton fibres more perfect is undoubtedly a good thing, if not spoiled by disadvantages which more than counterbalance the benefits. It is, however, the opinion of many practical men that in this case the vices of the machine are greater than the virtues, while others are just of the opposite opinion. So far as the writer can judge, the ribbon machine has received a larger amount of adoption abroad than in England.

In the writer's opinion, it is a great defect in this machine that the thin ribbons have to be passed in such a peculiar manner round the curved web conductors on their way from the drawing rollers to the front table. At this time the ribbons or fleeces of cotton are so thin, and the fibres are so parallel, that the ribbons are easily diverted from their proper course, and waste and irregular laps are formed. This evil is intensified by the apparent want of a good front stop motion to stop the machine when a ribbon is not falling on the front table or plate properly. On a drawframe there is, of course, a front stop motion as well as a back one, but on a ribbon machine it appears to be a difficult matter to apply such a motion. It appears to the writer a case in which the delicate and wonderful powers of electricity might be profitably applied, as on some makes of drawframes.

On the other hand, it might be possible to make some modifications in the construction and arrangement of the machine, such as adding a draw box before the lap head, on the principle of that on a comber. In this way the draft in the usual rollers could be reduced to, say, about three, and then this could be doubled into six by a draft of two in the draw box. This would leave the ribbons much thicker and stronger on the front tables and on the curved web conductor, as well as easing the work of the rollers. The evil under discussion is also made worse by the quick rate at which the cotton is delivered from the front rollers.

A name which is often applied to this machine is "The drawframe and lap machine combined".

This is rather too long a term to be continually repeating, either in writing, teaching, or in actual mill practice; but it denotes the uses of the machine very well. As we have previously explained, it really is a combination of some of the principles and parts of a lap machine with the rollers of a drawframe. It is a drawframe arranged to act on narrow laps or ribbons instead of on slivers. When the ribbon machine is not used it is necessary to use a special and extra drawframe

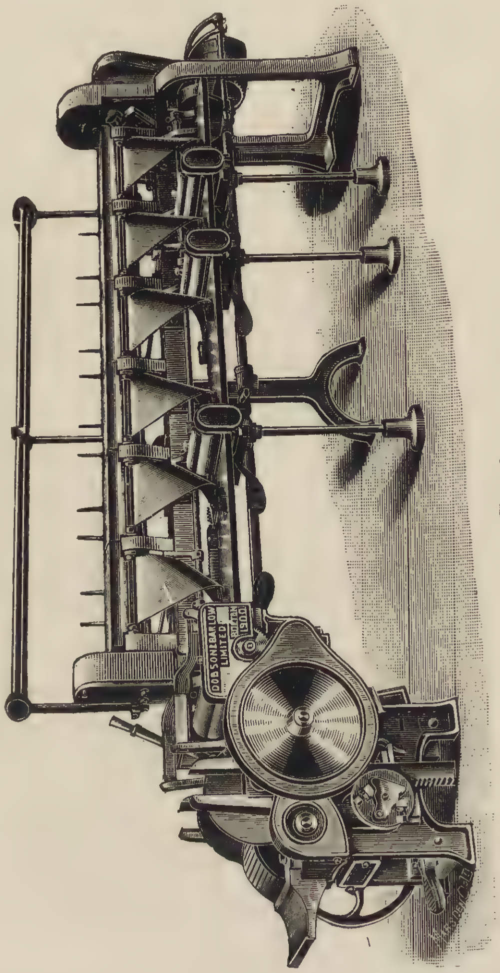


Fig. 9.

between the card and the comber, since it is an indispensable principle that the fibres and slivers should be operated on by drawing rollers if efficient combing is to be secured.

Dobson's Drawframe and Lap Machine Combined.

This machine is shown in Fig. 9, and dispenses with the first drawframe and prepares the laps for the comber after they have passed through a sliver lap machine.

Six laps are put up at a time and drawn through four lines of top and bottom rollers in the form of a ribbon.

Curved plates guide the ribbons evenly on the top of each other. They are then compressed and formed into one lap ready for the comber.

Laps formed on this machine are uniform in thickness, and contain an equally distributed amount of cotton, thus rendering the combing process easy.

There is less waste made at the comber, the fibres are not liable to be broken, and an increased production is obtained.

Notes.

Power.—1 i.h.p.

Production.—450 to 500 lb. per day, according to class of cotton.

Speed.—Driving pulley, 14 inches diameter by 3 inches wide; 262 revolutions per minute.

Floor Space.—14 ft. 2 in. by 4 ft. = 4·32 m. by 1·22 m.

Weight.—Gross, 51 cwt.; net, 41 cwt.

Cubic Measurement.—143 ft.

To determine hand of machine, see sketch below.

Feed. Feed.

The firm supply, free of charge, with each machine one ordinary top roller, or two loose shells when loose boss top rollers are used, and the following changes, including those on the machine, three draft wheels.

Course of Cotton.

The course of the cotton through this machine is illustrated in Figs. 10 and 11.

Fig. 10 is a transverse section through the rollers, while Fig. 11 is a longitudinal view in part section from the front of the machine.

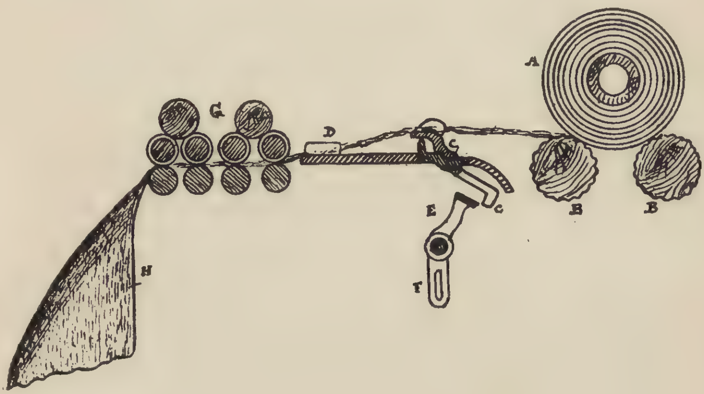


Fig. 10.

Index of Parts to Figs. 10 *and* 11.

A Lap from the Sliver Lap Machine.
B Fluted Wooden Lap Roller.
C Broad Lap Lever for Stop Motion.
D Adjustable Guide Finger.
E, F Oscillating Stop Motion, Knife Lever or Bar.
G Drawing Rollers and Top Clearers.
H Curved Web-conductor Plates.
I Calender Rollers.
J Calender Rollers.
K Small Loose Guide Roller.
L The Lap.
M Fluted Iron Lap Rollers.
N Circular Smooth Plates for Lap Edges.

Action of Parts.

This machine receives the cotton in the form of laps, and delivers them in the same form but 1 inch wider.

Six laps from the sliver lap machine are placed at A, on the wooden fluted lap rollers, B, B. The sheet of cotton from each lap is slowly unwound by frictional contact with rollers, B, B, and is drawn forward by the back pair of drawing rollers. On its way to the rollers, G, it passes over a balanced plate lever, C, which is part of the back stop motion and acts exactly like the spoon levers of the drawframe stop motion. The guides, D, can be readily opened or closed to contract and hold in the lap to whatever extent may be required.

The lap sheet all through this machine exhibits a strong

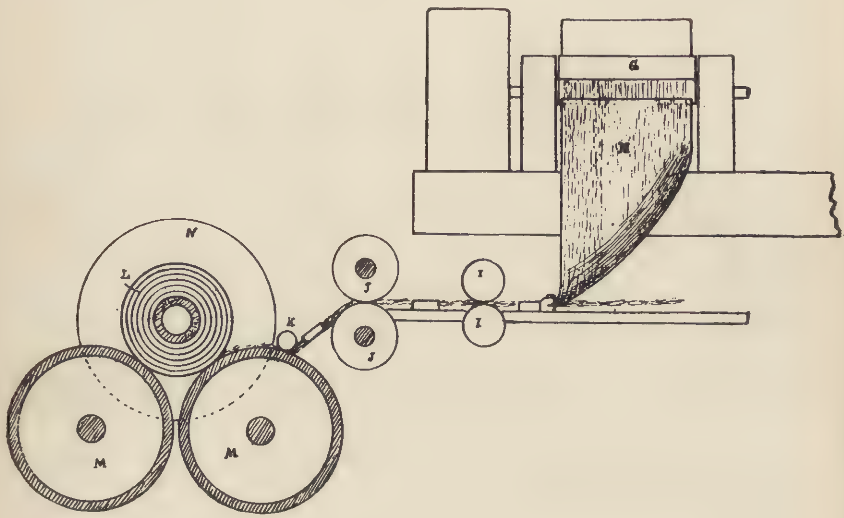


FIG. 11.

tendency to widen or spread out, and there are also guide fingers to prevent excessive spreading between the drawing rollers and at two or three positions on the front table. It will be noticed there are four pairs of drawing rollers at G, as on a drawframe, and the roller draft may be about six.

Emerging from the rollers, G, each fine sheet of cotton passes over a curved web plate, H, to the front table.

Along the front table the various thin sheets of cotton are superimposed upon each other and passed through the various calender rollers, I, J, along to the lap at L.

The ribbon machine is essentially a drawframe, except that it doubles and draws narrow laps or ribbons of cotton instead of slivers.

It will be noticed that in the ribbon machine doubling is done after drawing, whereas the reverse is true of the drawframe.

Hetherington's Improved Ribbon Lap Machine.

The sliver lap machine is used to prepare laps for this machine, which in turn prepares them for the comber. It is usually made for six laps, which are put up behind and drawn at their full width. On leaving the rollers the thin web formed by each lap runs over a highly polished curved plate, shown in Fig. 12, and the six webs are superposed on the table, along which they are drawn by frequent pairs of press rollers to the lap head, consisting of two pairs of heavily weighted press rollers to consolidate the lap and of the lap drums. The drawing process straightens the fibres, the draft usually approaching six, and the superposing of the six webs gives laps of absolutely even section, so that all the fibres are firmly held by the comber nipper, the two causes combining to reduce the comber waste to a minimum. The laps from the preceding machine are usually made one inch narrower than those to be made by the ribbon lap machine to allow for the spreading of the cotton in passing the draw rollers of the latter.

Stop motions are applied to each lap, so that if one runs off the machine comes to a standstill. A full lap stop or measuring motion is also applied, so that the size of the laps can be regulated at will and all the laps made alike.

Hetheringtons' strongly recommend metallic rollers in these machines. If ordinary rollers are used the top rollers should have loose ends.

The stands are made on the same principle as those on the drawing frames ; that is, each slide can be set separately, and is furnished with an easily renewable brass step.

The curved web conductors are usually of polished cast-iron, but they also cover them with sheet brass, which admits of a

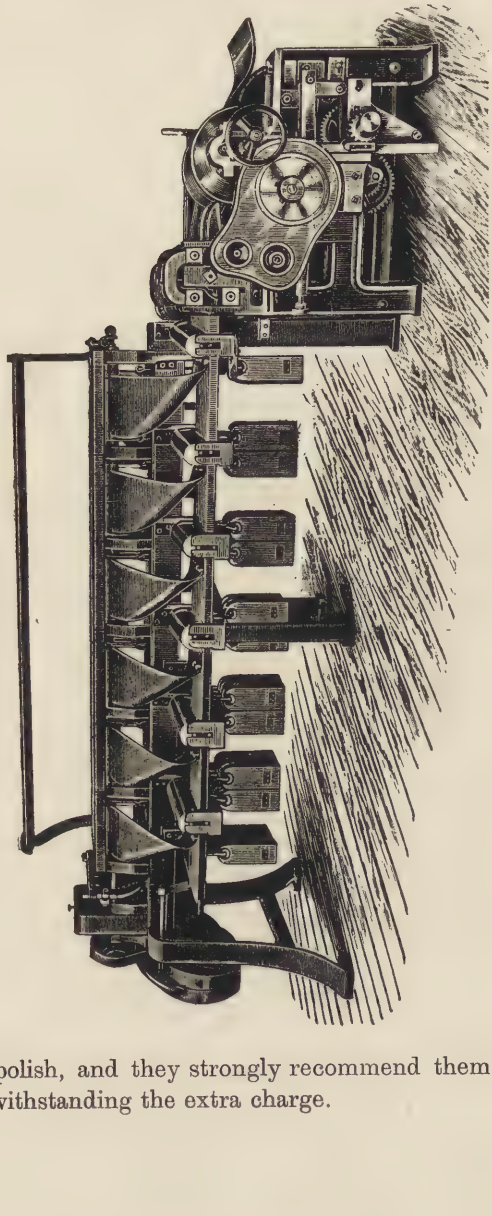


Fig. 12.

higher polish, and they strongly recommend them to be made so, notwithstanding the extra charge.

Fig. 12 shows the machine in perspective, and a plan is shown in the chapter on calculations, giving the details of the gearing, size of pulleys, speeds, etc.

The theoretical production may be obtained from the following formula :—

$$\frac{\text{Speed of the pulleys} \times \text{weight of yard of lap in grains.}}{80}$$

The result will be pounds in ten hours, and should be reduced by about 10 per cent. to obtain the actual production, the allowance being for stoppage and taking off the laps.

The weight of the laps varies from 10 to 14 dwt. per yard, according to the width and the quality of combing required. They may be made $7\frac{1}{2}$, $8\frac{3}{4}$, or $10\frac{1}{2}$ in. wide.

The total draft in the machine is :—

$$\frac{56}{30} \times \frac{70}{\text{change wheel}} \times \frac{100}{25} \times \frac{68}{72} \times \frac{20}{40} \times \frac{14}{21} \times \frac{21}{50} \times \frac{12 \text{ in.}}{2{\cdot}75 \text{ in.}} = \frac{301{\cdot}7}{\text{change wheel}}.$$

The draft in the fluted rollers is $\frac{280}{\text{change wheel}}$ if both back and front rollers are the same diameter.

Weight of a machine of six heads and for $10\frac{1}{2}$ in. laps :—

Gross (machine alone), 48 cwt. 3 qr. (2,475 kilos.).

(Roller weights), 8 cwt. 2 qr. (534 kilos.).

Net (machine alone), 33 cwt. (1,675 kilos.).

(Roller weights), 8 cwt. (465 kilos.).

Cubic feet with weights, 118.

Floor space for six heads, 14 ft. 4 in. by 3 ft. 11 in.

Driving pulley, 16 in. diameter. Speed, 300 revolutions per minute.

It may be added as regards the backstop motion in a few cases a roller is advantageously employed to hold the cotton better down on balanced rail, in imitation of single-preventer rollers now so commonly applied to drawframes.

In the majority of cases, however, this back roller does not appear to be used.

On some machines there are guide or calender rollers for each head, while on others these rollers are only used to about half the heads.

Curved Web Conductors.

As regards the curved web conductors or guides for the ribbons on the front table, these, as before stated, are often of highly polished somewhat heavy cast-iron. If required these, however, can be covered with sheet brass, which admits of a higher polish and is perhaps less affected by changes of temperature and humidity. Although somewhat expensive, this brass covering appears to be a commendable practice, as—with the possible exception of at the drawing rollers—there is no part of the frame where the cotton is more liable to go wrong and make waste and bad work than in passing round these curved web conductors. In some cases they are made very much thinner than the cast-iron ones and of sheet steel, which admits of and readily retains a very high polish. In a few cases we believe these curved guides have been electro-plated in order to impart an extra polish and smoothness to them.

Hand of Machine.

A ribbon lap machine is said to be of the right hand when in standing before the curved guide plates the driving pulleys are on the right hand, and the delivery or lap end on the left hand. It is said to be of the left hand, when standing in this position the pulleys are on the left hand, and the lap forming attachment on the right hand.

Drawing Rollers.

As regards the drawing rollers, practically everything which applies to the rollers of a drawframe applies just the same to those of the ribbon machine. These two machines are the only two machines where it is customary to apply four pairs of drawing rollers, and the driving of the rollers may be the same in each case. In some cases metallic drawing rollers have been successfully applied to this machine, and are highly recommended for this purpose by some machine makers, although there is a difference of opinion as to their respective merits and demerits. The roller stands of a ribbon machine are usually made with each side capable of independent adjustment, and having renewable brass steps. As on the drawframe, various descriptions of patent clearers have been more or less successfully adopted for cleaning the leather-covered rollers of the ribbon machine.

Spreading of Cotton.

A very important point which has to be reckoned with by those who have practically to do with ribbon machines is the tendency that the ribbons of cotton exhibit for spreading on their way through the drawing rollers and on the front table. To meet this difficulty it has been found necessary to make the laps for the creel of the ribbon machine one inch narrower than those which the ribbon machine produces from the comber. In addition to this procedure, it is necessary to hold the edges of the ribbons in by special guides placed between the drawing rollers and others placed at intervals on the front table. Some of these guides have to be set to impinge somewhat considerably against the edges of the ribbons of cotton. Some portion of this tendency to spread is due to the compression of the cotton by the drawing rollers and the calender rollers, and some of it is due to the fact that the six thin ribbons which issue independently from the rollers, and are superposed on each other to form the one necessary thicker ribbon, are not placed on each other in an exactly level manner, but often have the edges of one thin lap extending beyond the edges of the others, thereby increasing width of the lap.

Calender Rollers.

It is important in order to secure effective working of the various calender rollers to take proper steps for keeping them well cleaned and oiled and in perfect alignment. It is the writer's experience that these rollers are sometimes allowed to get a bit fast in the bearings, and to have the clearers of these rollers not properly fixed in position. Sometimes when the cotton has refused to carry down the curved guide plates, through the calender rollers and along the front table in a satisfactory manner, an excellent improvement has been produced by rubbing all these parts well with French chalk, or even with common whitening.

Loose Ends to Rollers.

When metallic rollers are not employed it appears to be the more common practice to have the end pivots of the leather rollers working in loose ends or shells, which effectively protect these bearings of the rollers from dirt and fibre, and yet afford an easy and ready and efficient method of oiling. It is the writer's experience that for drawframes and ribbon machines these loose ends are very good things, and appear to constitute one of the most important improvements in leather-covered rollers since the invention of loose boss or shell rollers by Evan Leigh. For drawframes opinions are divided as to whether the loose boss rollers or the loose ends are the better.

Front Table.

It is the writer's experience that it is quite possible to get a little out of the proper horizontal position, and when it does so it may quite upset the good working of the calender rollers. Besides tending to make the rollers bind in the bearings, it may tend also to put the bevels out of proper gear, by which the calenders are driven from the long driving shaft.

Lap End.

As before stated, the sheet of cotton is formed into a lap by being wound on a strong smooth-wooded bobbin of, perhaps, four inches diameter. Through this the spindle, which keeps the bobbin in position, is passed and screwed firmly into its own position by a special nut and screw arrangement. It may not be amiss to remind practical readers that a little attention to oiling and cleaning of this nut and screw would probably be beneficial in some cases. In order to improve the selvedges of the laps it is now customary to screw smoothly turned circular plates up to the edges of the lap bobbins, so that the plates revolve with the bobbin and quite prevent any tendency on the part of the lap selvedges to spread out. The same idea is also now utilised on the sliver lap machine. When the lap is sufficiently full the spindle is withdrawn from the bobbin, and the latter with its cotton is taken to the creel of the combing machine. The bobbin, in effect, for the laps of the sliver and ribbon lap machines, takes the place of the lap rod used for opener and scutcher laps. If the bobbins are too narrow the circular plates cannot fit with sufficient tightness against the bobbin, and the latter is loose on the spindle, except for the pressure exerted by the brake ; bad selvedges follow such a defect. If the bobbins are too wide the lap edges are also liable to be spoiled, and there is a tendency for the edges of the ribbon of cotton to go down with the bottom lap drums. Calculations on the ribbon machine will be found in the chapter on calculations.

It is noteworthy that the ribbon machine is recommended for use along with the new Monfort and Gegauff combers.

A general view of Hetherington's Derby doubler is given in Fig. 13 to show its close resemblance to the sliver lap machine, but it must be understood that it does not belong to the comber system of machines.

Derby Doublers.

Hetheringtons' have patterns for the following :—

Derby doubler, to make laps 10 inches to 13 inches wide, with V table for 22 cans, and patent stop motion to each sliver or can.

Dimensions (12 in. lap, 22 cans), 9 ft. by 6 ft. wide.

45 cwt. gross ; 40 cwt. net, approximate.

Derby doubler, to make laps 17 inches to 19 inches wide, with V table for 36 cans, and patent stop motion for each sliver or can.

Dimensions (19 in. lap, 36 cans), 12 ft. long by 6 ft. 6 in. wide across cans.

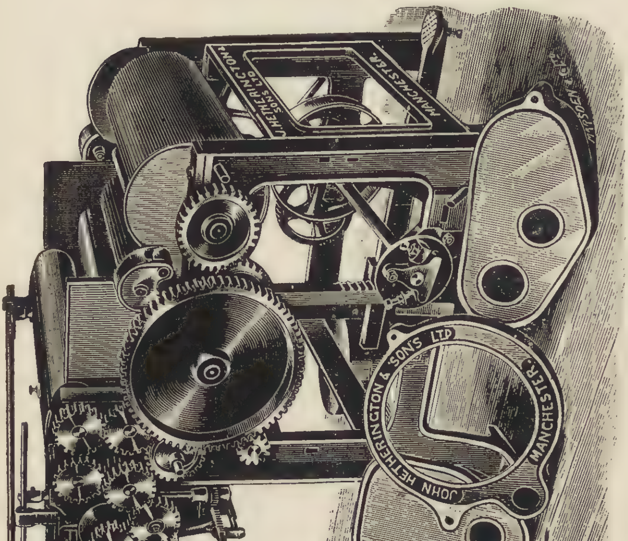


FIG. 13.

50 cwt. gross ; 42 cwt. net, approximate.

Derby doubler, to make laps 34 inches to 37 inches wide, with V table for 60 cans, and patent stop motion to each sliver or can.

Dimensions (34 in. lap, 60 cans), 14 ft. long by 7 ft. 8 in. wide across cans.

58 cwt. gross; 48 cwt. net, approximate.

The size most generally adopted is from 17 inches to 19 inches wide, and V table for 36 cans.

Driving pulleys, 15 in. diameter, 3 in. wide, making 120 revolutions per minute.

THE DRAWFRAME.

A very cursory examination of the film or web of cotton as it leaves the doffer of a carding engine will show that the fibres of cotton are disposed therein in a very irregular manner, and are far from being parallel to each other.

Whatever may be the arrangement of the fibres when they reach the doffer, it may be taken that the condensing actions which take place (1) between the cylinder and doffer, (2) between the doffer and the doffer comb, will tend greatly to the giving of an irregular disposition of the fibres in the finished card sliver.

As a matter of fact, it is highly probable that the doffer comb would be quite unable to perform its work of efficiently stripping the doffer were the fibres composing the web arranged in parallel order to each other.

It should be noted, however, that the surface speed of the calender rollers is generally a trifle greater than that of the doffer, thus giving a slight draft between the two, while at the same time there is a convergence of the fibres towards the trumpet hole of the calenders, and these two factors both slightly tend to lay the fibres side by side.

When everything has been considered the actual fact remains that the fibres composing the card sliver are in a very crossed condition when they leave the machine.

It will be demonstrated later that such a disposition of the fibres is quite unsuitable for the laps fed to a Heilmann comber if the best results are to be got from this machine.

If the fibres are fed through the nippers of the comber in a crossed or entangled condition it is certain that a great quantity of good fibre will be taken out as waste by the cylinder needles laying hold of them when they are not gripped between the nippers.

Further than this, it is also necessary to have the laps fed to the comber as uniform as possible in the width, and an excellent method of obtaining this uniformity is to first have the individual slivers which form the lap as uniform as possible.

It is well known that the use of the drawframe secures the two principal advantages pointed out above, and this in a very ready and economical manner. Hence the drawframe has almost always been in use between the card and the comber to the extent of having just one passage of the cotton through it and just one set of doublings.

From one point of view, therefore, it is quite clear that in a book treating with "cotton combers and allied processes" the drawframe should be given a prominent position since it is essentially one of the allied processes.

The drawframe is, however, dealt with in a very complete manner in other treatises both by the author and also by others.

Further, it constitutes one of the necessary machines for all mills concerned in ordinary cotton spinning—where the comber is not used; and is therefore not special alone to the combing system or to mills concerned in fine spinning.

For these reasons it will be only dealt with very briefly in these pages.

In the drawframe, by means of doubling several slivers together and reducing these to the dimensions of one, a sliver is delivered from the machine which is more uniform than those fed to the machine.

The drafting or drawing-out action of the drawing rollers also tends to make the fibres parallel.

When the ribbon machine is not used the order of machines after the card in single combing is as follows: special drawing frame, sliver lap machine, comber.

If the ribbon machine is used the order is: sliver lap machine, ribbon lap machine, comber. In double combing the cotton is taken through the same sort of machines in the same order a second time over. We shall content ourselves with giving here a general view of the machine and a section through it, as made by Messrs. Dobson, along with a few particulars.

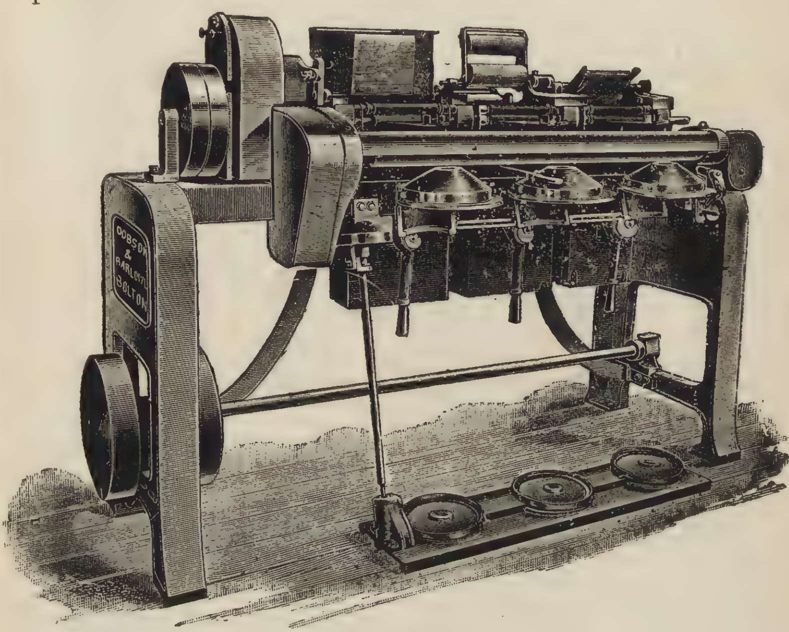


FIG. 13 (*a*).

DRAWING FRAMES.

The following particulars about these machines refer more especially to Dobsons' frames, who have kindly lent blocks for illustration.

Dobsons' make these machines with back spoon motion for stopping the machine when an end breaks or cans run empty.

Double action front stop motion to prevent roller laps and stop the machine when the sliver is too heavy or too light. This motion also prevents lumps, flat waste, or uneven sliver entering the cans.

Motion to stop the machine when the cans are full, or for any given length of sliver.

Weight-relieving motion to take the weight off rollers when the machine is stopped, and thus prevent flat places on leather-covered rollers.

Improved back roller motion for preventing single.

Cast-iron flats for stationary or revolving cloth, or with patent top clearers.

Middle and back traversing motions.

Top rollers with loose bushes—a great improvement upon top rollers with loose bosses, both from point of oiling and friction.

Bottom rollers case-hardened all over, or in the necks only.

Notes.

Power.—1 i.h.p. per 12 deliveries.

Production.—70 to 180 lb. per finishing delivery per 10 hours.

Driving Pulley.—18 in. by 3 in.

To determine hand of frame, fill in the following diagram :—

Mark on this sketch position of coilers and driving pulleys.

Dobsons' supply, free of charge, one ordinary top roller, or one loose shell when loose boss top rollers are used, to every three deliveries, and the following changes, including those on the machine, three draft wheels to each head.

WEIGHTS AND CUBIC MEASUREMENT.

	Without Weights.		Roller and other Weights, if supplied.		Cubic Measurement.	
					Without Weights.	Weights only.
	Gross Cwt.	Net Cwt.	Gross Cwt.	Net Cwt.	Feet.	Feet.
3 heads of 3 deliveries each	54	38	14	13	193	11
3 ,, 4 ,, ,,	68½	52½	17½	16½	230	12
3 ,, 5 ,, ,,	80	62	22½	21	266	14
3 ,, 6 ,, ,,	88	70	27	25½	297	17
3 ,, 7 ,, ,,	98	76	31	30	339	20

COMPARATIVE SPEEDS.

Intermediate pulley on driving shaft, 16 in. diameter by 4 in. wide.

Front roller pulley, driven by above pulley, 12 in. diameter by 2 in. wide.

Driving Shaft. Revs. per Min.	Front Roller. Revs. per Min.	Driving Shaft. Revs. per Min.	Front Roller. Revs. per Min.	Driving Shaft. Revs. per Min.	Front Roller. Revs. per Min.
150	200	205	273⅓	260	346⅔
155	206⅔	210	280	265	353⅓
160	213⅓	215	286⅔	270	360
165	220	220	293⅓	275	366⅔
170	226⅔	225	300	280	373⅓
175	233⅓	230	306⅔	285	380
180	240	235	313⅓	290	386⅔
185	246⅔	240	320	295	393⅓
190	253⅓	245	326⅔	300	400
195	260	250	333⅓		
200	266⅔	255	340		

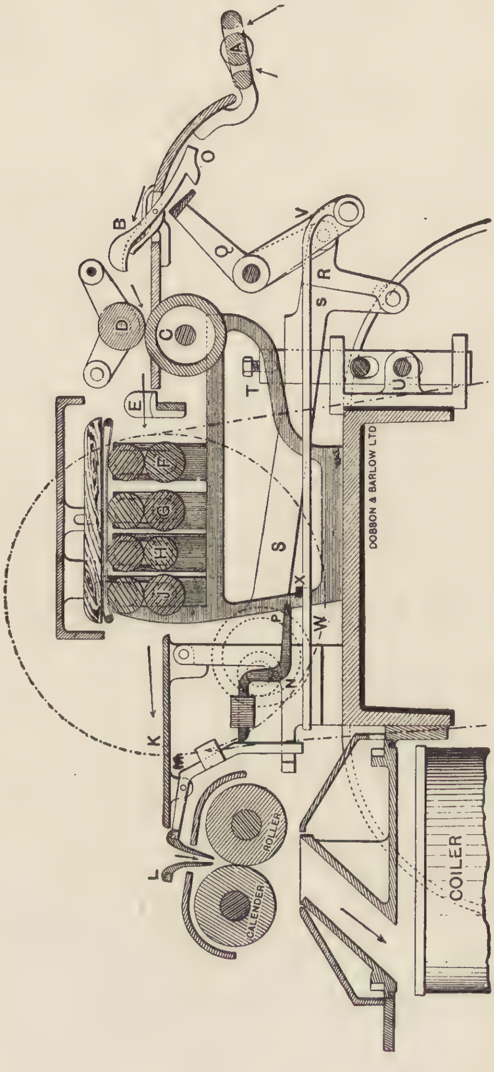


Fig. 13 (*b*).

References to Section of Drawframe.

A Sliver Plate.
B Spoon.
C, D Back Roller Motion.
E Sliver Guide.
F Back Roller.
G Third Roller.
H Second Roller.
J Front Roller.
K Front Stop Motion Top.
L Brass Funnel for Front Stop Motion.
M Eye Glass for Front Stop Motion.
N Stop Motion Foot.
P Eccentric.
Q Knife for Spoon Motion.
R Eccentric Arm Elbow.
S Eccentric Arm.
T Knocking-off Catch for Stop Motion.
U Bracket for Catch for Stop Motion.
V Rocking Shaft Lever.
W Feeler Bar.
X Catch on Feeler Bar.

Usual Weights for Drawing Frame Rollers.

	Front.	2nd.	3rd.	Back.
Indian and American Cotton . .	20 lb.	20 lb.	20 lb.	20 lb.
Egyptian Cotton	18 ,,	18 ,,	18 ,,	18 ,,
Sea Islands Cotton	16 ,,	16 ,,	16 ,,	16 ,,

The following is a description of Platt's drawing frame, as shown at the Paris Exhibition :—

This machine contains three heads of two deliveries each, and is fitted with traverse motion, tumbler stop motions at back, stop motion between front rollers and calenders, and stop motion when cans are full. The bottom driving shaft is surrounded by a wrought-iron tube from end to end to prevent accidents to the attendant.

The front and second lines of bottom fluted rollers are case-hardened end to end, the third and fourth lines have necks and squares only hardened. The three heads are arranged in different ways, to show the various kinds of top clearers, traverse motions and roller weighting arrangements, *viz.*, top rollers end weighted with dead weights (8 in. bosses), middle weighted with lever weights ($5\frac{1}{4}$ in. bosses), and middle weighted with dead weights ($5\frac{1}{4}$ in. bosses), loose boss top rollers to two front lines, and loose weighting bush to third and fourth lines of top rollers for one head, the other heads have two lines of loose boss top rollers, the remainder being common top rollers, Ermen's patent revolving self-stripping clearer flats, iron flats for revolving cloths, also iron flats for stationary cloths. Instead of the usual pivoted tumblers, one head is fitted with knife edge tumblers which traverse along with the back guide. Dugdale & Howarth's patent single preventer is fitted to one head. Weight-relieving motion is fitted to the heads with dead weights for the convenience of small attendants, and to make it easy to lift the pressure from the top rollers at a week end or holiday time. In addition to the ordinary traverse motions, one head is fitted with Tatham's patent duplex traverse motion, an arrangement by which the cotton passing between the bottom and top rollers is always equidistant on each boss from the point of pressure.

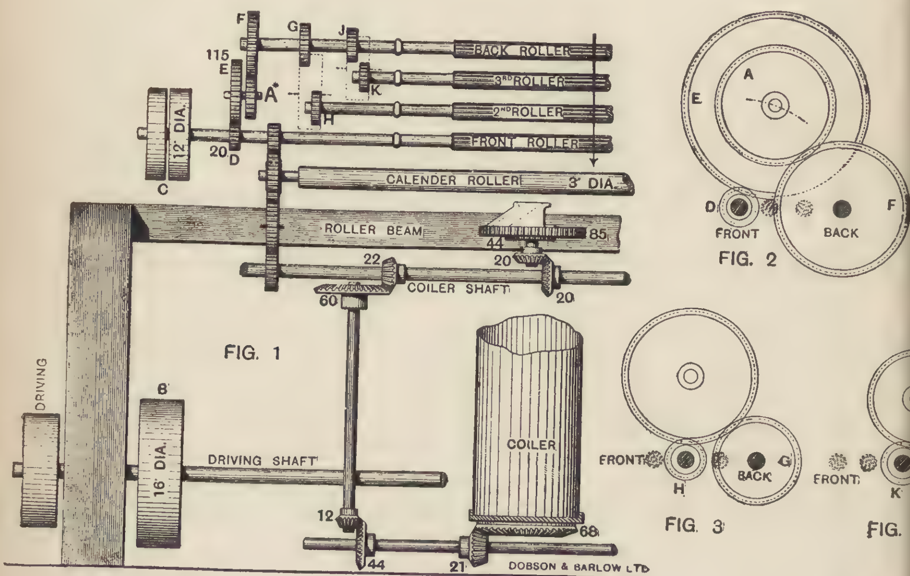


Fig. 13 (*bb*).

CHAPTER II.

GENERAL DESCRIPTION OF THE HEILMANN COMBER.

THE principal machine for description and illustration in this treatise is the Heilmann comber.

First of all, a brief reference may be made to the inventor, followed by a brief verbal description of the operation of combing on this machine. A pencil sketch of Heilmann is given in the frontispiece, and an early form of Heilmann's comber is shown in Fig. 13 (*c*).

The combing machine, in some respects, bears to the spinning trade a position analogous to that of the Jacquard machine to the weaving trade. The comber enables us to produce very fine yarns, and the Jacquard loom is the machine upon which are woven the most fancy and costly fabrics. Jacquard was the son of a hard-working couple in Lyons. Heilmann—who invented the combing machine—was born in 1796 at Mulhouse, which is the principal seat of the Alsace cotton manufacture. Prior to devoting his attention to the invention of the combing machine, Heilmann brought out several very ingenious and successful inventions in connection with the spinning and weaving industries. He was led to give himself up to the subject of the comber primarily by the cotton spinners of Alsace offering a prize of 5,000 francs for an improved combing machine. It was not the need of money that attracted him, but his inborn mechanical genius. Before success attended his efforts several years passed over; his wife's fortune was swallowed up; he was reduced to poverty, and ruined in health, and died shortly after his machine had been successfully adopted. It is said that £30,000 was paid by Lancashire spinners for its use, £30,000 by the wool spinners, and a Leeds firm paid £20,000 for the privilege of applying it to flax. The Heilmann cotton comber has been in use for nearly fifty years, and remains to this day substantially the same machine, although considerable improvements have been effected in details. The action of the

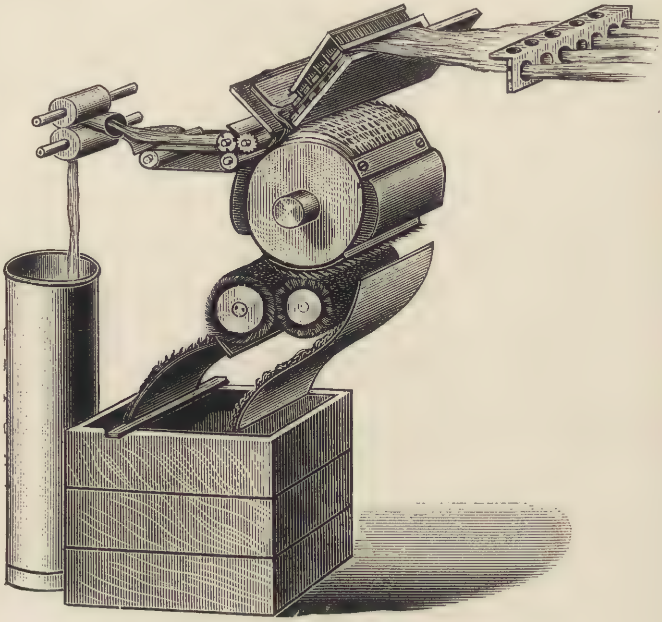


FIG. 13 (*c*).

parts upon the cotton fibres is more delicate and beautiful than is the case in any other machine. The fibres are first held at the rear ends, while their forward ends are combed by steel combs. Afterwards another comb moves into the path of the fibres, and their rear ends are drawn through the teeth of this comb, each fibre being thus combed at both ends. As before said, all fibres below a certain length are rejected, and all impurities are extracted. In the comber the lap from the sliver lap machine—or in the newer system from the ribbon lap machine—is placed upon corrugated wooden rollers in the creel, whose revolution unfolds the lap and passes down a convex polished plate. It is then passed in an intermittent manner through a pair of feed rollers, which feed it in short lengths to the nippers. These consist of upper and lower jaws, which first close and hold the fibres whilst they are combed, and then open to allow the fibres to pass through. While the fibres are held by the cushion plate and nipper a circular comb—having several rows of graduated needle bars—is passed through the front ends of the fibres. These needles remove short fibres and impurities. Upon the same periphery as the needles is a fluted segment, which comes into the path of the fibres immediately after the needles have passed. Simultaneously, and while revolving at the same surface speed, a leather-covered detaching roller is lowered into contact with the fluted segment, and the combed cotton is thereby carried forward and brought into contact with a portion of the sliver that has previously passed. Whilst these motions have been taking place the nippers — which were closed during the passage of the needles through the fibres—have now opened in order to allow the small portion of newly combed cotton to pass forward. At the same time the top comb has descended into the path of fibres so as to comb their rear ends. There is a fluted detaching roller and another similar roller which work along with the leather-covered detaching roller in order to pass the small portions of combed cotton successfully forward. By this ingenious "piecing" arrangement the fibres come out in front of the machine in the shape of a round sliver, which is coiled into an ordinary card can. The short and neppy fibre and impurities are taken from the cylinder by a stripping brush and transferred to a doffer, and the doffer is stripped by a slowly working doffer comb. Combers are made with either six or eight heads.

A general view of Platt's comber is given in Fig. 13 (*d*).

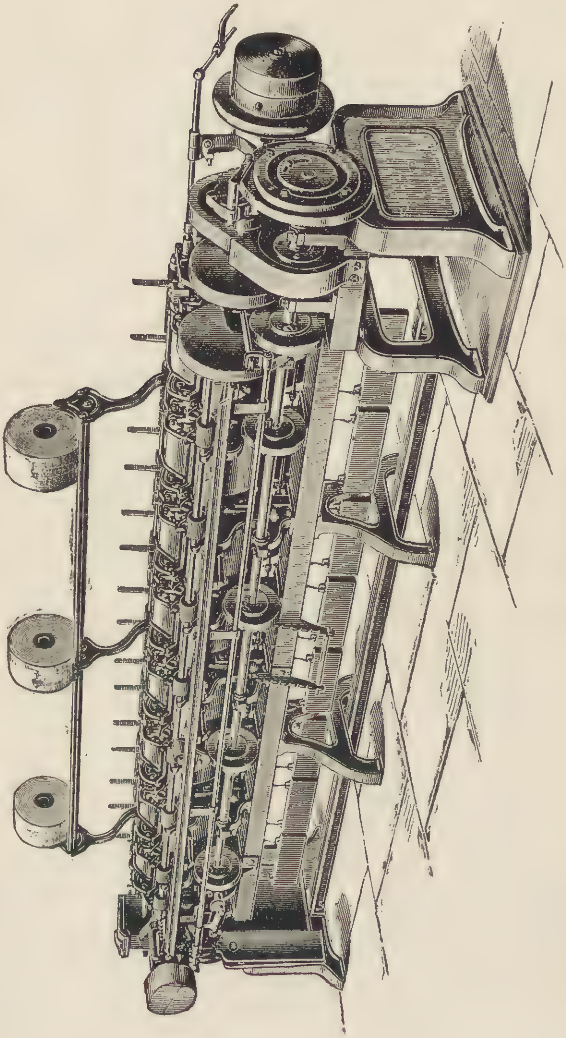


Fig. 13 (d).

Explanation of Terms.

Driving Shaft.—This is very short and contains fast and loose pulleys of about 10 in. or 12 in. diameter, the fly-wheel, a small wheel to drive the cylinder, and a second small wheel to drive the revolving brush.

Cylinder.—This is the principal part of the comber and contains the needle segments, the fluted segments, and the making-up pieces. It is the centre of the working parts of the machine, and determines the setting and timing of all the other acting parts.

Index Wheel.—This is fastened to the end of the cylinder shaft and receives its motion from the short driving shaft. It always has 80 teeth, divided into 20 parts of 4 teeth each, and is fitted with an indicator finger. The index wheel greatly facilitates the adjustment of the time for action of the various parts that act on the cotton.

Long Steel Detaching Roller.—This extends the full length of the comber in practically one piece. It has the two top short detaching rollers resting on it, and imparts rotary motion to those two rollers by frictional contact.

Leather Detaching Roller.—This roller has both a rotary motion and a bodily motion through space. After each short tuft of cotton has been combed the leather roller fetches the fibres away from the nippers and carries them to the steel detaching rollers. The leather roller does this with the assistance of the fluted segment of the cylinder.

Piecing Roller.—This is a term sometimes given to the short top steel detaching roller. This roller receives the fibres from the leather roller, and acts with the long steel roller so as to deliver the cotton into the collecting tins.

Needle Segment.—In the single-nip comber this segment is composed of 17 rows of needles, graduated in fineness from between 20 and 30 needles per inch for the front row up to between 80 and 90 needles per inch in the back rows. The coarsest needles attack the cotton first. The term "half-lap" is sometimes applied to the needle segment. The actual combing of the cotton and extraction of short fibre and nep, etc., are performed by these needles.

Fluted Segment.—This is fixed on the cylinder shaft, on the opposite side to the needle segment, and covers about the same space. Its duty is to act along with the detaching rollers in carrying the combed fibres of cotton forward.

Making-up Pieces.—These are smooth, convex plates, fastened to the cylinder between the needle segment and the fluted segment. It is impracticable to allow the cylinder needles to attack the cotton just as the fluted segment finishes, or *vice versâ*, partly because a little time is needed to allow of the nippers, top comb, detaching rollers, etc., changing positions: hence the use of the making-up pieces. One of the two making-up pieces covers the set screws by which the cylinder barrel or stock is screwed to the cylinder shaft for each head.

Nippers.—These hold the cotton firmly while the cylinder needles pass through it. There are two nippers, namely, the upper and lower nipper. The lower one is termed the cushion plate, because it is usual to apply to it a cushion of leather or rubber, so that the fibres can be gripped firmly without being damaged. Dobsons' now apply the cushion to the upper nipper. The nippers are shut to hold the cotton during combing, and opened to allow of detaching after combing has taken place.

Top Comb.—The special use of this is to comb out the tail ends of the fibres. The cylinder needles cannot comb the extreme rear ends of the fibres, because the latter are held by the nippers. The leather detaching roller and the fluted segment pull the tail ends of the fibres through the top comb, which has about 63 needles per inch. Short fibre and various impurities cannot get through the top comb, and are taken round by the cylinder needles at the next nip.

Wooden Lap Rollers.—The laps are placed on these behind the machine, and an intermittent motion is imparted to them by bevel wheels from the steel feed rollers.

Feed Rollers.—The steel or iron feed rollers are about $\frac{3}{4}$ in. diameter, and have an intermittent motion imparted to them by which they project the cotton forward through the nippers at the rate of approximately $\frac{1}{4}$ in. per nip. The feed peg and star wheel are employed to give the intermittent rotary motion to the bottom feed roller, and the top feed roller is driven by frictional contact with the bottom one. Sometimes a porcupine roller is used instead of the ordinary fluted feed roller.

Collecting or Sliver Tin.—This receives the combed web from the detaching rollers and sustains it in its passage to the front table calender rollers, and condenses it to a sliver.

Calender Rollers.—There is one pair of these to each head. Unlike the detaching rollers and feed rollers, they have a continuous forward rotary motion, and deliver the cotton sliver to the front table.

Front Table.—The combed slivers are passed along this table and placed side by side, so that all the six or eight slivers pass together through the rollers of the draw box.

Draw Box.—This receives the six or eight slivers from the front table, and draws them out or attenuates them to almost the dimensions of one. There are usually three pairs of rollers, with a total draft somewhat below the total number of doublings. Occasionally four pairs of rollers are applied to the draw box.

Coiler and Can Motion.—This is placed at the opposite end of the comber from the driving pulleys. It is practically identical in every respect with the can motion of a card. The upright shaft inside the coiler frame receives its motion from the cylinder shaft.

Cam Shaft.—This is fully as important on a comber as on a self-acting mule. It controls most of the reciprocating motions of the machine as follows : (1) It has a cam which controls the opening and shutting of the nippers ; (2) Another cam controls the movement through space of the two top detaching rollers. Some of the most recent combers contain more than one cam to perform this work ; (3) The cam shaft contains on Dobson's a cam which operates the quadrant ; (4) On the same machine is a cam which opens and closes the roller box. On other makes of machines there are cams for operating the notch wheel. It may be noted that the top comb is operated from cams on the cylinder shaft quite independently of the cam shaft.

Quadrant and Clutch Box. — This apparatus is used on Dobson's combers only in order to suitably impart the reciprocating rotary motion of the three detaching rollers.

Notch Wheel.—This is used on Hetherington's and Platt's combers to do the same work as the quadrant and clutch box on Dobson's. It is the older method, and was formerly also applied by Dobsons'.

Revolving Brush.—The object of this is to clean the waste from the needles of the cylinder.

Doffer.—This receives the waste from the circular brush, and then the waste is stripped from the doffer by the doffer comb and dropped into suitable receptacles.

Waste Shaft.—This is a slowly revolving shaft, sometimes used to wrap the waste up in muff-like form to keep it more together between waste-gathering times.

Stop Motions.—It is sometimes the practice to apply on the front table spoons for the slivers to pass over as on a drawframe, the spoons forming part of an automatic knocking-off motion, quite similar in principle to that on a drawframe.

Full Can Motions.—These motions are often applied, and serve the purpose of automatically stopping the comber when a can is sufficiently full of sliver.

Roller Beam.—This is made exceptionally strong and rigid, and connects the two ends of the comber, along with the bottom rail.

Stands.—The stands are fast to the roller beam, and serve to support nearly all the working parts of the machine, such as the feed rollers, nippers, top combs, detaching rollers, waste-collecting mechanism, nipper shaft, detaching roller shaft, cylinder, etc.

Nipper Stands.—These are more especially supports for the adjusting screws of the nippers.

Mica Plates.—Occasionally these are fitted into the back plates, so that the needles of the cylinder can be examined without being dangerously exposed. Mica plates are expensive and easily broken.

Duplex Comber.—This is a recent invention in which the cylinder is fitted with two sets of needles, two fluted segments, and four making-up pieces. The object is to secure two nips, and all attendant motions to act twice instead of once for each revolution of the cylinder. In this way production is increased, but many people consider the quality of combing to be inferior.

Nips per Minute.—120 nips per minute for the duplex, and about 85 for a single nip comber, are considered fairly good practice, but are sometimes exceeded.

Amount of Waste.—About 18 per cent. is a very common percentage of waste to extract from good Egyptian cottons for good combed yarns of 100's or so. Practice varies, however, in this respect, and both less and higher percentages are often taken out.

Internal Wheel.—This is used along with the notch wheel for rotating the detaching rollers in those combers which do not use the quadrant and clutch box.

Passage of Cotton through Comber.

In Fig. 14 is shown a section of Dobson's single-nip comber, and in Fig. 15 a section of their duplex comber.

Referring to Figs. 14 and 15, the laps are placed on the fluted wooden rollers as marked. The ribbon of cotton from each lap passes down the convex guide plate to the feed rollers, F, F, and is fed through them in an intermittent manner at about $\frac{1}{4}$ in. per nip. While the feed rollers, F, F, are feeding the cotton, the nippers, G, H, are open, and the detaching rollers, D, D, E, with the fluted segment, C, are taking the last combed portion of the cotton forward.

Then the nippers close, and hold the cotton that has just been projected forward, while the cylinder needles, B, pass through the fibres.

During this combing operation the feed rollers, F, F, and the detaching rollers, D, D, E, are not revolving.

The waste is taken out by the cylinder needles, and is carried to the back by the cylindrical brush and doffer shown in Figs. 14 and 15.

The index of parts will explain the names of the other lettered details in each case.

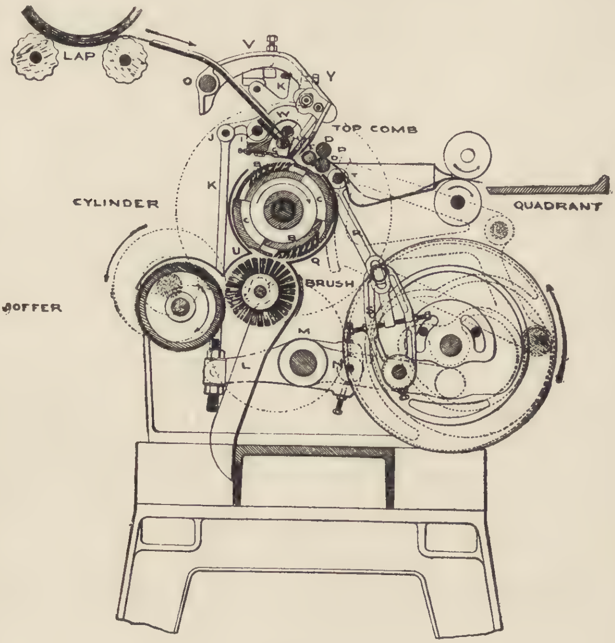


FIG. 14.

Index of Parts.

A Cylinder Shaft.
B, B Half-lap.
C, C Fluted Segment.
D, D Fluted Detaching Rollers.
E Leather Detaching Roller.
F, F Feed Rollers.
G Cushion Plate.
H Nipper Knife.
I Nipper Arm Fulcrum.
K Upright Connecting Rod for Nipper Arm.
L Nipper Shaft Lever.
M Nipper Shaft.
N Lever for Nipper Cam.
O Top Comb Centre.
P Loose Clutch Wheel.
Q Cylinder Casing.
R Long Lifter.
S Ring for Long Lifter.
T Long Lifter Shaft.
U Brush Casing.
V Top Comb Setting Screw.
W Nipper Frame Centre.
X Quadrant Bowl or Runner.
Y Nipper Setting Screw.

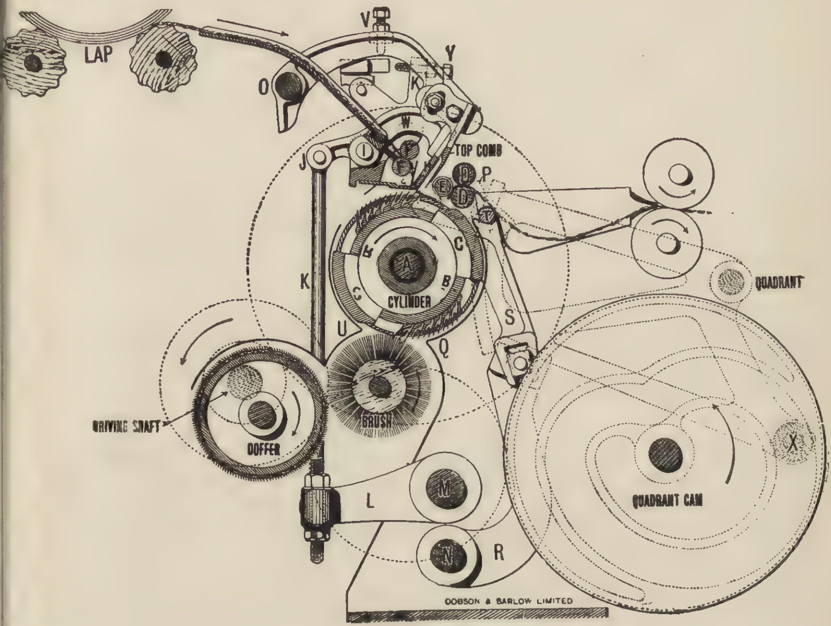


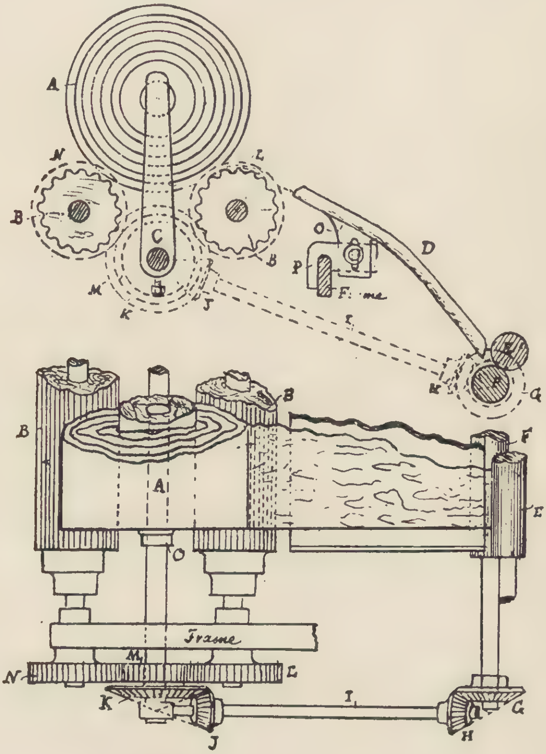
FIG. 15.

Index of Parts.

A Cylinder Shaft.
B, B Half-lap.
C, C Fluted Segment.
D, D Fluted Detaching Rollers.
E Leather Detaching Roller.
F, F Feed Rollers.
G Cushion Plate.
H Nipper Knife.
I Nipper Arm Fulcrum.
K Upright Connecting Rod for Nipper Arm.
L Nipper Shaft Lever.
M Nipper Shaft.
N Lifter Shaft.
O Top Comb Centre.
P Loose Clutch Wheel.
Q Cylinder Casing.
R Horn Lifting Lever.
S Long Lifter.
T Long Lifter Shaft.
U Brush Casing.
V Top Comb Setting Screw.
W Nipper Frame Centre.
X Quadrant Bowl or Runner.
Y Nipper Setting Screw.

FEED MECHANISM.

Referring to Figs. 16 and 17, the lap, A, is shown resting upon the two wooden fluted lap rollers, B, and is kept in proper position lengthways by the adjustable fingers, C. The cotton



FIGS. 16 and 17.

from the lap is passed slowly down the convex guide plate, D, and then between the small fluted iron feed rollers, E, F.

The iron feed rollers, E, F, are driven by mechanism of a peculiar character, which we shall describe in connection with the next figures. Their motion, however, is always very slow and of an intermittent character.

The small feed rollers, E, F, drive the larger wooden fluted lap rollers, B, by the wheels shown (Fig. 17). The small bevel, G, of 21 teeth on the coiler end of the bottom feed roller gives motion to the short cross shaft, I, by means of the bevel, H, of 20 teeth. On the other end of the short shaft, I, is bevel, J, which gives motion to the bevel, K, running loose on the shaft, C, of the upright fingers which keep the laps in position lengthways.

The bevel, K, is compounded with the small wheel, M, which gears into and simultaneously drives the two wheels, L, N, each of which is fast on the end of one of the fluted wooden lap rollers, B. The guide plate, D, is connected adjustably to the slotted bracket, P, and the latter fits firmly upon the framing, as shown. This fixing enables the guide plate, D, to keep firmly in position, while permitting of its being lifted out in a moment for any contingency that may arise.

Driving of Iron Feed Rollers.

Figs. 18 and 19 are designed to show the manner in which the feed rollers derive their intermittent motion. A is the index wheel secured to the cylinder shaft. The plate, B, is adjustably bolted to the face of the index wheel at the circular slot shown, and carries the feed peg or stud. As seen in Fig. 18, there is a peculiarly shaped star wheel at C, having five somewhat deep notches in lieu of teeth. Every time the plate, B, carries the feed peg round — which is once for every nip—the peg moves the star wheel, C, round one-fifth part of a revolution. The five concave surfaces of the star wheel are used to prevent oscillation of the parts except just at the proper periods. This is effected by the concave surfaces fitting in turn against the convex surface of the circular plate, Y. The feed change wheel, D, is carried on same boss as the star wheel, C, and therefore partakes of the same motion.

This feed wheel gears into and drives the feed roller wheel, E, fast on the bottom feed roller, F. The top feed rollers are driven by frictional contact with the bottom one and are held down by spiral springs. At each intermittent motion of the feed rollers something like $\frac{1}{4}$ in. of cotton is passed through them. Whatever motion is given to the iron feed rollers is transmitted by them to the wooden lap rollers, and the calculated relative surface speeds of these rollers should give the surface speed of the wooden lap rollers to be slightly in excess of that of the iron feed rollers in order to allow for stoppage of the lap on the lap rollers. To assist in the lap being pulled uniformly down to the iron feed rollers the latter should be set quite parallel, and the rollers at all the heads at the same angle.

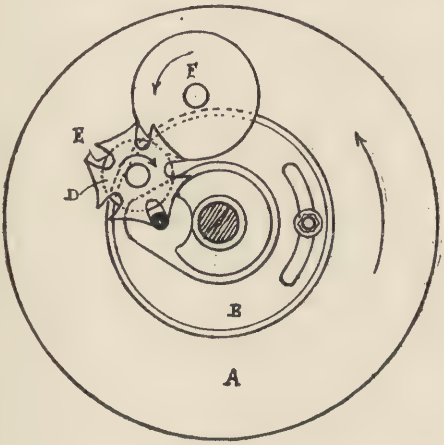


FIG. 18.

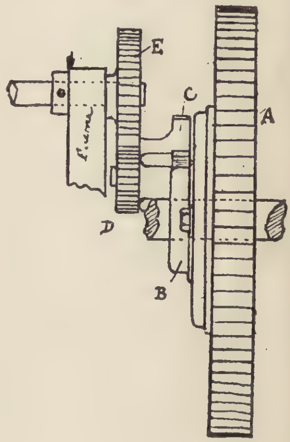


FIG. 19.

Taking the cylinder at 80 nips per minute, with a 16-feed change wheel, a 38-feed roller wheel, and a feed roller of $\frac{3}{4}$ in. diameter, the amount fed per minute would be as below :—

$$\frac{80 \times 1 \times 16 \times 3 \times 22}{5 \times 38 \times 4 \times 7} = 15{\cdot}88 \text{ in.},$$

and the amount per nip would be

$$\frac{15{\cdot}88}{80} = {\cdot}198 \text{ in., or practically } {\cdot}2 \text{ in.}$$

The amount fed per nip is probably the more important thing to find, and may be determined more directly as follows :—

$$\frac{1 \times 16 \times 3 \times 22}{5 \times 38 \times 4 \times 7} = \cdot 198 \text{ in., as before.}$$

Weighting of Feed Rollers.

While the bottom feed roller, D, is in practically one piece for the full length of the machine, and is driven positively by the small star wheel, the feed peg and their companion parts, the top feed roller, C, only extends the length of one head, and consequently there is one top feed roller for each head. Each top feed roller, C, is held down at each end by a spiral spring,

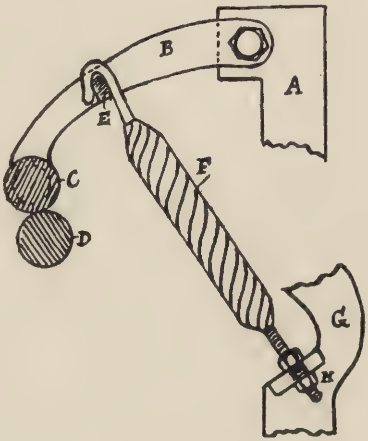


Fig. 20.

F, so as to ensure proper frictional contact and rotation of the top feed roller with the bottom one. The spring, F, is hooked on a stud, E, in the finger or lever, B, one end of which is fulcrumed in the stand, A, while the other end presses down on the boss of the roller, C. The stand, A, is the same one in which is also sustained the long shaft of the top combs. The spring, F, can be adjusted in tension by the nuts, H, which connect the spring to the bracket, G. Each bracket, G, sustains another spring much similar to G, fixed on the other side, but being connected to the nippers.

This method of weighting the top feed roller facilitates the removal of the top feed rollers in the case of roller laps and similar derangements.

THE NIPPERS.

The construction and action of the nippers are shown in Figs. 21, 22, 23 and 24.

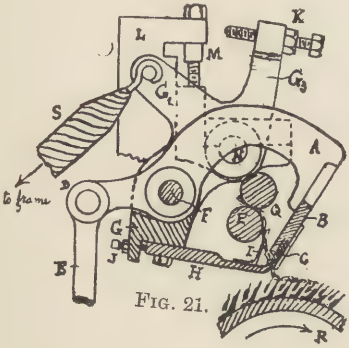


FIG. 21.

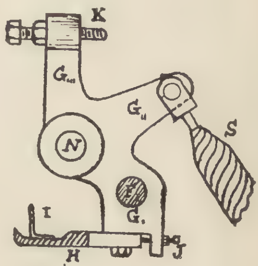


FIG. 22.

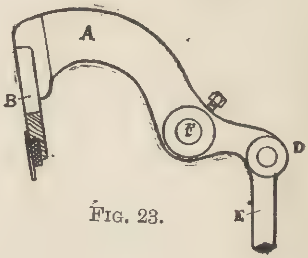


FIG. 23.

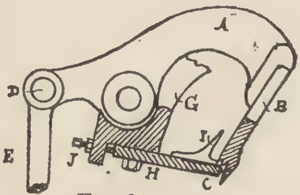


FIG. 24.

Fig. 21 shows the nippers closed, with the circular needles passing through the fibres, and the feed rollers and nippers holding the cotton.

Fig. 24 shows the nippers closed, but other parts left out for the sake of illustrating the nippers themselves more clearly without their connected mechanism.

For the same reason the top nipper is shown alone in Fig. 23, and the bottom one is shown alone in Fig. 22.

Referring to Figs. 21, 22, 23 and 24, the following is an index of the parts :—

Reference Letters.

A, F, D Top Nipper Arm or Lever.
B Top Nipper Blade bolted to A, and having a downwardly projecting lip screwed to it to hold the leather in.
C In Fig. 21 is a Leather Cushion in top Nipper.
C In Fig. 23 is a Leather Cushion in Bottom Nipper.
D Connection of Rod, E, to top Nipper Arm, A, F, D.
E Upright Screwed Back Rods, which give motion to Nippers.
F Swing Fulcrum for Nippers.
G Swing Frame, to which Cushion Plate, H, is secured.
$G_{,,}$ $G_{,,,}$ $G_{,,,,}$ Three arms of Bottom Nipper.
H Bottom Nipper or Cushion Plate.
I Finger attached to each end of Cushion Plate to prevent the Cotton from spreading out.
J Adjusting Screw for Cushion Plate or bottom Nipper.
K Screws for adjusting upward motion of Cushion Plate.
L Part of Nipper Stand.
M Vertical Screw for adjusting Nippers from Needles of Cylinder.
N Fixed or real Fulcrum for both Nippers, but especially for the Cushion Plate or bottom Nipper.
P Bottom Feed Roller.
Q Top Feed Roller.
R Cylinder Needles.
S Nipper Spring.

PURPOSE OF NIPPERS.

The essential use of the nippers consists in holding the cotton fibres well within the range of action of the several rows of combs or steel needles, fastened on the periphery of the revolving cylinder.

The nippers grip the rear extremities of the fibres while the cylinder needles pass through the front portions of the fibres. The nippers have no power to grip the front extremities of the fibres while their rear ends are being combed—this being a defect inherent to the Heilmann and most, if not all, other makes of cotton combers. It is most essential that the nippers should hold the fibres firmly without cutting them, and to assist in this work it is the practice in most combers to fit in a cushion of leather to the bottom nipper: hence the term cushion plate, as applied to the bottom nipper. In Dobson's comber this cushion is now fitted into the top nipper. In either case the fibres are held between the cushion of leather on the one nipper and the comparatively sharp edge of the other nipper.

Action of Nippers.

There would be little difficulty in arranging the nippers to hold the cotton properly, but it is also necessary to open them after combing to allow of fresh fibres being projected through them while the combed fibres are withdrawn.

It is also considered advisable to move the nippers away from the periphery of the cylinder during the operations of feeding and detaching, so that the action of the nippers is somewhat complicated.

In connection with Figs. 21, 22, 23 and 24, a few words may be profitably expended in endeavouring to explain the operation of the nippers.

As shown in Fig. 21, the nipper motion really emanates from the cam placed on the cam shaft.

By means of the cam and the proper levers, during each revolution of the cylinder the upright rods, E, at the back of the comber are made to have an upward and downward movement, or two such motions in a duplex comber.

This vertical motion of the rods, E, may be approximately $\frac{7}{8}$ in. in a double nip comber, and $1\frac{1}{8}$ in. in a single nip machine, the nippers when fully open having a space between them of about $\frac{3}{8}$ in. for the duplex, and perhaps $\frac{9}{16}$ in. for the single nip. The lesser amount of opening of the nippers and lesser movement of the vertical rods in the duplex comber are rendered necessary by the less amount of time allowed for each nip.

Closing of Nippers.

We will suppose the nippers are fully open, but everything is ready for their closing. The vertical rods, E, are then moved upwards by their connection to the cam shaft. For the moment the lever, A, F, D, works on the rod, F, for a fulcrum, and F remains fixed in space, while having a very slight rotation. This continues until the top nipper, B, comes against the bottom nipper, I, and presses firmly thereon, with the fibres held between the two nippers. The nippers are now closed, but are not near enough to the cylinder needles, so that the upward motion of vertical rods, E, continues, and the *top nipper*, B, *pushes the bottom nipper*, I, *downwards*, so as to bring the fibres well within the range of action of the cylinder needles.

The nippers are held firmly in contact with each other by the springs, S, whose resistance the top nipper has to overcome in forcing the bottom nipper down. During this combined downward motion of the two nippers, the rod, F, has a slight bodily motion through space, and is sustained by the fulcrum, N.

Opening of Nippers.

During nipping and combing the nippers cam is acting with its full or round part on the proper stud, so that the vertical rods hold the nippers down to the cylinder needles, while the springs, S, keep the cushion plate pressing against the top nipper in a firm but elastic manner.

After combing is finished the vertical rods, E, are moved downwards, and the consequence is that the top nipper is again brought upwards, working round the swing fulcrum or rod, F.

Impelled by the springs, S—of which there are two to each head—the bottom nipper, I, follows for a slight distance, but is prevented from going too far by the stop screw, K, coming against the nipper stand, M.

The movement of the bottom nipper is only sufficient to bring it quite clear from the fluted segment of the cylinder, and to enable the work of detaching to take place properly. The top nipper therefore leaves the bottom one sufficiently to give a space of from $\frac{3}{8}$ in. to upwards of $\frac{5}{8}$ in. between the nippers to allow of a free passage for the fibres of cotton.

Swing Frame.

As the motion of the nippers is somewhat confusing to students, a few words may be expended with special reference to the swing frame. If the lever, A, F, D, had its fulcrum, F, always fixed in space, it would be much easier to comprehend the action of the nippers, but, as stated previously, when the top nipper is moving up and down without being in contact with the bottom nipper, the fulcrum or rod, F, is fixed in space, while during the combined movement of the two nippers, the rod or fulcrum, F, has a slight bodily movement through space.

To understand this better special reference may be made to Fig. 22.

It will be understood that the spring, S, is always endeavouring to rotate the various arms or fingers shown upon the fixed fulcrum, N. When the nippers are open the force of the spring, S, is expended in keeping the stop screw, K, pressing against the nipper stand.

If Fig. 22 be studied, it will be understood that the movement of finger, G_3, will be accompanied by the movement of the nipper, H, I, attached to the finger, G_1. The motion of all the three fingers, G_1, G_2, G_3, will be really circular, but of very limited amount.

When the top nipper, B, comes upon the bottom nipper, H, I, naturally these three arms or fingers, G_1, G_2, G_3, are forced thereby in the opposite direction. It will be noted that in Figs. 22 and 23 the cushion of leather is shown fixed in the top nipper, being held in position by a bar or plate screwed to the main portion of the nipper.

In Fig. 24 the cushion is fixed in the bottom nipper. Even when the cushion is fixed in the top nipper it is quite common to term the bottom nipper the cushion plate.

Cushion Plate Guides.

There is always a tendency for the cotton to spread out in passing through the machine. In Figs. 24 (*a*) and 24 (*b*) are shown guide fingers which prevent this, and are made by Messrs. Hetherington.

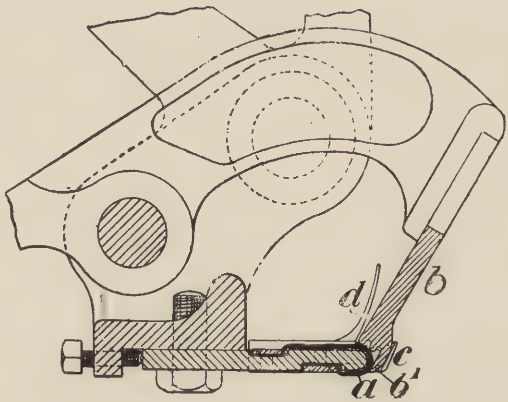


FIG. 24 (*a*).

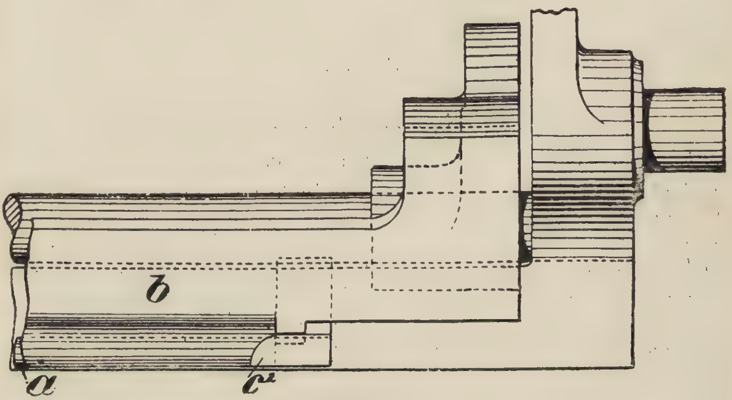


FIG. 24 (*b*).

a Cushion Plate.
b Top Nipper.
b^1 Top Nipper Finger.
c Projecting Lip of Top Nipper.
d Guide Finger to prevent Cotton spreading.

DETACHING AND ATTACHING.

The various organs which are concerned in the manipulation of the cotton fibres during detaching and attaching are shown in position in Fig. 25, which shows the operations of detaching in a nearly completed state.

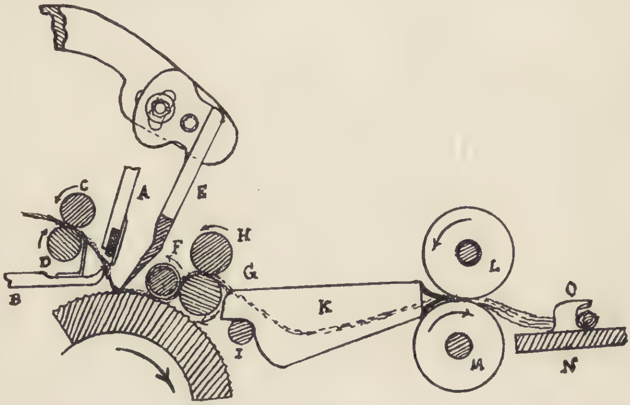


FIG. 25.

Reference Letters.

A Top Nipper.
B Bottom Nipper.
C Top Feed Roller.
D Bottom Feed Roller.
E Top Comb.
F Leather-covered Detaching Roller.
G Long or Bottom Steel Roller.
H Short or Top Steel Roller.
I Supporting Rod for Collecting Tin.
K Collecting Tin or Sliver Tin.
L Top Calender Roller.
M Bottom Calender Roller.
N Front Table.
O Sliver Guide Finger.

ACTION OF PARTS.

During the operations of detaching and attaching it will be noticed from Fig. 25 that the active parts are in position and operation as follows :—

(*a*) The feed rollers, C, D, are projecting fresh and uncombed cotton through the nippers, A, B, to the extent of perhaps $\frac{1}{4}$ in. in length of fibre for every nip.

This implies also that a good proportion of fibres, which have been previously partially combed, are being projected about $\frac{1}{4}$ in. farther through the nippers prior to being again combed.

(*b*) The leather-covered detaching roller, F, is resting upon the fluted segment of the cylinder and being rotated jointly by contact with the long steel roller, G, and the fluted segment.

(*c*) The nippers, A, B, are open during these actions to permit of feeding and detaching taking place quite freely.

(*d*) The top comb has descended amongst the fibres, so that the fibres have to be pulled through the needles of this comb by the detaching mechanism, and in this way the combing of the rear extremities of the fibres is ensured. It must be understood that the top comb needles are not allowed to touch the fluted segment in any case.

(*e*) The united action of the three small detaching rollers, F, G, H, and the fluted segment of the cylinder is causing the combed sliver to be delivered slackly into the collecting tin, as shown at K, from whence it is being drawn through the calender rollers, L, M, in a slow, continuous manner.

Notes.

It may be noted that between the feed rollers and the nippers the cotton is always left in a continuous sheet, but underneath the leather-covered roller there is either no cotton at all, or only a few straggling fibres, during the operation of combing.

At this time an almost complete separation of the combed and uncombed cotton has been brought about by the forward motion of the detaching rollers taking the cotton from the nippers, which latter close before the forward motion has finished.

The closing of the nippers in this manner before the forward motion finishes ensures a more perfect separation of the combed from the uncombed cotton. During the time of combing the detaching rollers do not revolve at all, so that although the combed end of cotton has almost disappeared through the rollers actual disappearance does not take place, since when the rollers next begin to revolve they make their backward motion and return the combed end of the cotton again ready for the piecing-up action.

In the return motion the combed end of the cotton naturally follows the bottom long steel detaching roller and the fluted segment of the cylinder, so as to hang down from the former, ready for the overlapping of the freshly combed portion of cotton by the leather roller.

It is possible to have such faulty motion of the detaching rollers as to either (*a*) deliver so much cotton as to pass the combed rear extremity of cotton to a dangerously near extent through the rollers ; (*b*) or to return so much cotton on the backward motion as to tear the cotton in the sliver tin ; (*c*) or to leave enough of the combed extremity of the cotton hanging down the inside of the long steel roller as to be caught and acted upon by the cylinder needles.

Delivery Parts of Comber.

The parts through or along which the cotton passes after the actual operations of combing and piecing-up of the cotton are performed are clearly shown in Fig. 26.

At D are the detaching rollers, and the manner in which ribbon or web of cotton is collected from them and condensed into a thin sliver is shown at C. Sometimes the collecting tins at C have their funnels or tubular apertures at the corner of the tin nearest the draw box, instead of being in the centre, as shown in sketch.

Each sliver is delivered into its collecting tin, C, by the detaching rollers, D, in an intermittent manner, but is drawn forward from the tin in a slow, continuous manner by a pair of calender rollers, B, I. The result is that each sliver is slack in its tin just after the delivery motion of the detaching rollers, and becomes tight, or almost so, just as the return motion of the delivery rollers is finishing. It must be understood that during the return motion of the detaching rollers the cotton is pulled out of the tins at one end by the calender rollers and at the other end by the detaching rollers. Obviously care is necessary to prevent each thin fleece of cotton from being torn in this manner, and the efficient regulation of the thin fleeces of cotton in this manner is one of the duties of the machine maker in the first instance and of the comber master in the second instance.

By turning the comber manually with the detaching rollers on the return motion an idea may be obtained as to whether the edges of the lap are torn in this manner, but care should be taken not to let the rollers commence to redeliver the cotton before examination of the tension of the fleece.

It may be noted here that the collecting tins should fit well up to the long steel detaching roller, and generally each one is numbered and fitted in its own place and should not be transferred to a different position.

The bottom calender rollers, I, are all keyed upon the shaft E, which extends the length of the frame, and is driven by the bevels, G, H, etc., in the manner shown in Fig. 31 (p. 63).

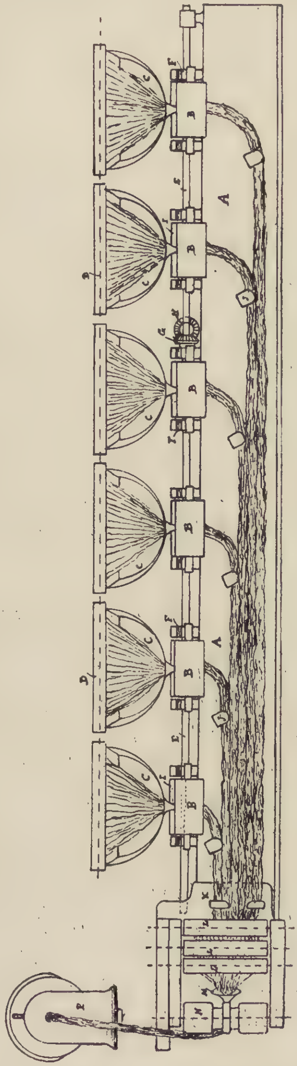


FIG. 26.

A is the long polished front table along which the slivers are drawn after issuing from the calender rollers. S is the support for the front table, A, and is part of one of the stands which carry practically all the operating parts of the comber, and are themselves supported by the very strong roller beam.

At F are stands in which the top calender rollers can be placed temporarily for piecing-up and other purposes.

The slivers are drawn along the polished front table, A, by the rollers, L, of the draw box, and are guided into position by the guides, J, K.

It will be noticed that the slivers pass, join each other, and are passed side by side through the drawing rollers, L. There may be a draft of perhaps five or so in the draw box, so that the doubling and drawing actions which take place on the front table and in the draw box greatly conduce to the production of a more uniform sliver from the comber than would be otherwise possible.

Emerging from the draw box, the sliver of combed cotton is again condensed and is drawn through the trumpet hole at M by the block rollers, N, from whence it passes upwards to the coiler top, P, and into a can exactly as on a carding engine.

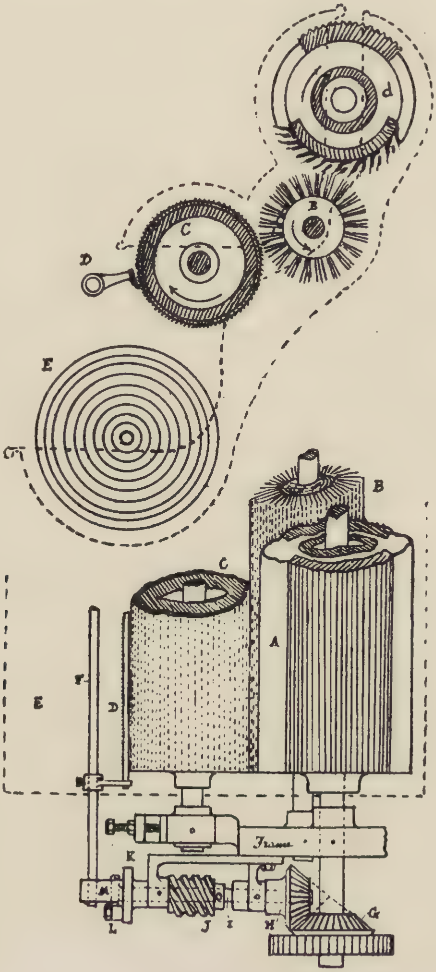
Waste Part of Heilmann Comber.

Figs. 27 and 28 are designed specially to illustrate the disposition of the waste taken out by a Heilmann comber. A is the cylinder, with the needles shown at the bottom, under the action of the brush, B.

The "needle segment" or "half-lap" of the cylinder brings the waste round to the bottom, when it is swept off the needles by the somewhat quickly revolving brush, B, the parts revolving in the directions shown by the arrows.

The strong teeth of the doffer being inclined against the direction of rotation of the brush, B, the waste is deposited on the doffer and is stripped therefrom by the rapid oscillation of the doffer comb, D.

In Fig. 27 the waste is shown being wound round a very slowly revolving shaft in the form of a narrow lap or muff, E.



FIGS. 27 and 28.

This slowly revolving shaft is of somewhat recent adoption and is not used on all combers. In its place there are often simply oblong cans or tin boxes into which the waste falls. The shaft takes up less space and leaves the floor behind the comber freer than the tins. The waste is removed at suitable intervals. The tins do not need cleaning as often as the shaft.

Fig. 28 is a plan of the waste parts, showing the gearing by which the doffer and doffer comb are driven. This gearing is at the coiler end of the comber.

The bevel wheel, G, of 25 teeth, on the cylinder shaft drives the bevel, H, also of 25 teeth, on the short cross shaft, I. The single worm, J, gears into and drives a wheel of 32 teeth in the doffer shaft. The same short shaft carries the crank, K, in which the crank pin, L, is fitted, the latter being connected by a suitable link to the finger, M, fitted on the shaft, F, of the doffer comb, D.

Providing the cylinder made 80 nips per minute, the doffer comb, D, would thus make 80 double strokes per minute, and the doffer, C, would make—

$$\frac{80 \times 1}{32} = 2{\cdot}5 \text{ revolutions per minute.}$$

Weighting of Leather-covered Detaching Rollers.

The usual method of weighting the leather-covered detaching roller of a Heilmann comber is shown in Fig. 29.

The full lines show the parts with the weight on the rollers, while the dotted lines show the position with the weight taken off the roller and resting upon a specially shaped rail at H.

A recent invention relates to cotton combing machines, and the object is to provide a spring weighting attachment for the leather-covered detaching roller. The motion of the leather-covered roller in these cotton combing machines is in four different directions, the roller moving forward, backward, upward and downward with every motion of the machine, and this roller is usually weighted with dead weights supported by means of hooks and chains. These weights are usually quite heavy, weighing about 32 lb., or 16 lb. for each end of a roller, and when the roller has been taken out for any purpose, which frequently occurs in the operation of the machine, the operator of the machine, usually a woman, has to lift these weights off and replace them, which is a rather difficult operation ; and it is one of the objects of this invention to dispense with these

A is the Lifter Finger which conveys bodily motion to the Detaching Roller.
B Shaft to which the Fingers, A, are attached.
C Adjustable Piece against which the brass end of the Detaching Roller is pressed.
D Adjusting Screw for Leather-covered Roller.
E Brass Covering or Step for end of Leather Roller.
F Long Steel Detaching Roller.
G Weight Hook for Leather-covered Roller.
I Connecting Chain.
K Hook Coupling Chain, I′, and Weight, L.

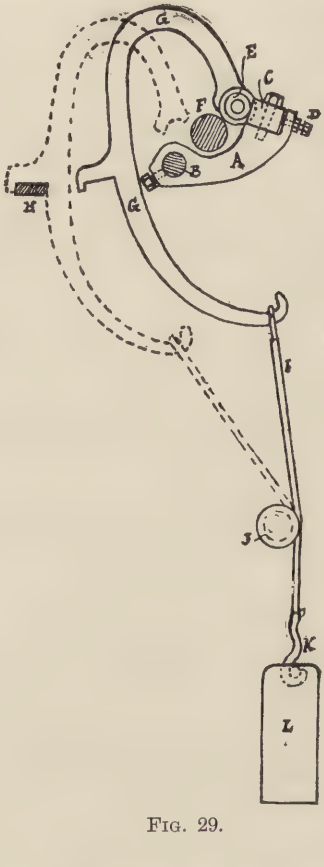


FIG. 29.

weights, and the consequent necessity of attaching and detaching them during the operation of the machine.

This is obtained by arranging a curved spring to move with the roll, and thrown into and out of action by the aid of a cam, which makes a very easy operation for the attendant to manage. In combers taking wide laps as much as 20 lb. is suspended from each end of the leather-covered rollers. Certain comber masters of the author's acquaintance tried a crude form of spring weighting twenty-five years ago. In Fig. 86 (*a*) (p. 294) is shown another style of spring weighting.

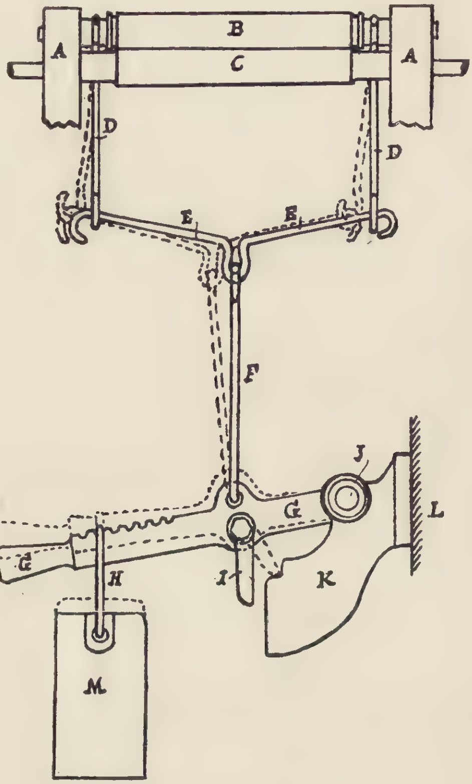


FIG. 30.

A	Stands for the Rollers.
B	Top Drawing Roller.
C	Bottom Drawing Roller.
D, D	Weight Hooks.
E	Double Hook connecting the two Hooks, D, D.
F	Bottom Weight Hook.
G	Weighted Lever.
H	Hook connecting Weight, M, and Lever, G.
I	Finger for relieving weight from Rollers.
J	Fulcrum for Lever, G.
K	Bracket for supporting the arrangement.
L	Strong Beam of Frame to which K is bolted.

Weighting of Draw-box Rollers (Fig. 30).

It is the usual plan to weight the top rollers in the draw box with dead weights suspended from each end of the rollers. There may be say a comparatively long narrow weight of 15 lb. suspended from each end of the front top roller, while the back and middle top rollers may be connected together by bridge pieces or saddles, from each of which is suspended a 20 lb. weight. This gives a total weight of 30 lb. on the front roller and of 40 lb. divided between middle and back. If metallic rollers are used in the draw box—as is sometimes the case—then the weights might be practically half of the above.

Fig. 30 shows a recently devised method of weighting the rollers of the draw box by the lever system.

The full lines show the parts with the weight on the rollers, while the dotted lines indicate the manner of hooking the weight lever, G, upon the ledge, K, so as to temporarily take the weight off the leather rollers.

This lever weighting of the rollers is more convenient than the dead weighting for relieving the weight quickly and for varying the amount of weight on the rollers, but is more liable to get out of order.

Dobson's Driving of Calender Roller.

Referring to Fig. 31, R is a small worm on the cam shaft, driving the worm wheel, Q, fixed to the small inclined shaft, T.

On the top of this shaft, T, is a small bevel wheel, H, driving a similar bevel wheel on the bottom calender roller shaft. A is the long front table.

The cotton leaves the detaching rollers, D, D, passes along the collecting tin, C, through the calenders, B, and round the guides, J, on the front table, A.

F is a stand to support top calenders when lifted up for piecing-up and similar purposes.

Hetherington's Top Comb.

As stated, the top comb is a most useful appliance on a Heilmann comber—much more so than many practical men appear to recognise. In the first place, it holds back the impurities and the crossed fibres, so that they cannot pass forward with the good cotton during the operation of detaching.

In the second place, it is placed in the path of the good fibres, so that at least the rear ends of such fibres are pulled through it during detaching.

In Fig. 32 is given a special sketch of the top comb and its various parts, which should aid any one materially in comprehending its construction and action.

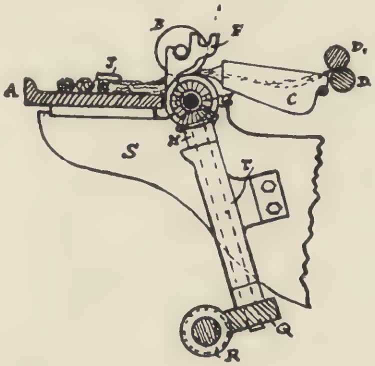


Fig. 31.

This particular sketch illustrates the top comb, more especially as made by Messrs. Hetherington, but there is little difference between the top comb parts of one firm and that of another.

In each case it must be remembered that the top comb is operated by a cam or cams on the cylinder shaft, whereas the cams for all other parts, such as the nippers, quadrant notch wheel, clutch box and lifters, are all fixed on the cam shaft.

In Fig. 32 the cushion plate is shown in position along with the feed rollers, the detaching rollers, and the nipper stand and front horizontal setting screw for the nippers.

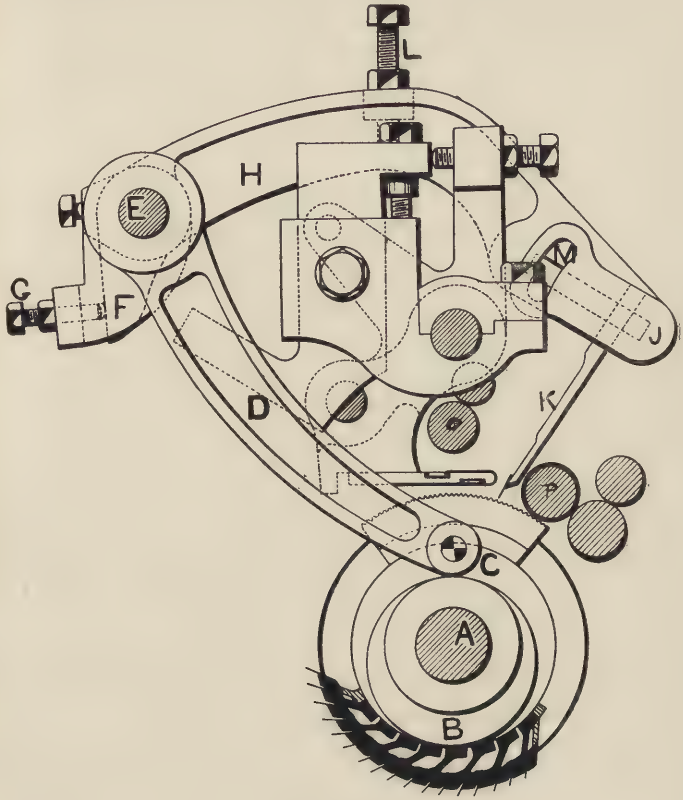


FIG. 32.

A Cylinder Shaft.
B Cam Set-screwed to A.
C Bowl or Runner carried by Cam Lever, D.
D Cam Lever or Bottom Arm of Top Comb.
E Top Comb Lever Shaft to which D is fastened.
F Thumb Bit for Top Comb Lever.
G Setting Screw in F for Top Comb Lever and forming part of Top Comb Arm, H.
H Upper Lever or Arm of Top Comb.
J, K Top Comb.
L Setting Screw on H for setting distance of Comb from Cylinder.
M Radial Slot for adjusting angle of Top Comb.
O Bottom Feed Roller.
P Leather - covered Detaching Roller.

Action of Parts.

The top comb is really in active operation during detaching, at which time it is in its lowest position and nearest the cylinder. The top comb is shown in this working position in Fig. 32, and at this time also the fluted segment of the cylinder is under the comb, and the leather-covered detaching roller is on the fluted segment, as also shown in Fig. 32.

To allow the top comb to be in its lowest position the cam, B, C, has the runner or bowl, C, resting on thin part of the cam as shown.

As the cylinder, A, continues to revolve, the full part, B, of the cam will come under C, and lift up at the arm or lever, B, thus slightly turning the shaft, E. The shaft, E, carries a set screw, G, for each end of each top comb on the machine. This set screw, G, comes against a thumb-piece, F, cast with the arm, H, and in this way lifts arm, H, and comb, J, K, slightly upwards. The combs drop by their own weight. In the chapter on resetting, the top comb is considered more fully.

To conclude this chapter a general view of Dobson's comber is given, with the maker's remarks thereon, the machine being shown in Fig. 33.

Dobson's Improved Combing Machines.

Heilmann's Principle.

Referring to their latest combers, the firm say :—

"In designing these machines the greatest care has been exercised in regard to accuracy of detail and the timing and setting of the various motions. The parts connected therewith are all machine tooled, and, wherever possible, constructed to template.

"To ensure rigidity, and as a precaution against tortional effect, we apply double cams to work the quadrant. The nipper cams are duplicated and work at either end of the machine in perfect unison with each other. The lifter cams are also duplicated, and are arranged so that one cam serves two heads : thus a machine of six heads is provided with three cams.

"The gearing headstock is built upon a solid cast-iron base plate, and has two frame ends supporting a planed table upon which the gearing is firmly secured, the whole forming a rigid and substantial structure.

"The base of the machine has also been widened.

"The lifter shaft, with levers, etc., for lowering and lifting the top detaching rollers is now done away with and replaced by the cams acting direct upon the rollers: thus all backlash is entirely obviated.

"The circular comb brushes are fitted with an oscillating motion to facilitate the cleaning of the comb.

"The cylinders are built upon round stocks to ensure concentricity.

"The stripping brush is driven by variable gearing to compensate for any wear of bristles.

"The machines are made with six or eight heads for laps from $7\frac{1}{2}$ in. to $10\frac{1}{2}$ in. wide, and when run at 80 or 90 nips per minute their action is smooth and steady. They are arranged to comb cotton $\frac{7}{8}$ in. staple to silk of $2\frac{1}{2}$ in. staple."

Patent Duplex Combing Machines.

Bourcart's Patents Adapted and Improved.

"The cylinder of this machine has two sets of combs and two fluted segments, which, with the necessary appliances for accelerating the feed, nip and detaching motions, enables the machine to be run at a greatly increased speed and to produce a correspondingly increased amount of combed sliver. Upwards of 50 per cent. more production can be obtained off this machine, whilst the quality of the sliver is maintained.

"In other respects this duplex comber is fitted up with all the improvements enumerated above."

Notes.

Power.—Ordinary, 6 heads, $\frac{5}{8}$ i.h.p.; 8 heads, $\frac{3}{4}$ i.h.p.
Duplex, 6 heads, $\frac{3}{4}$ i.h.p.; 8 heads, $\frac{7}{8}$ i.h.p.

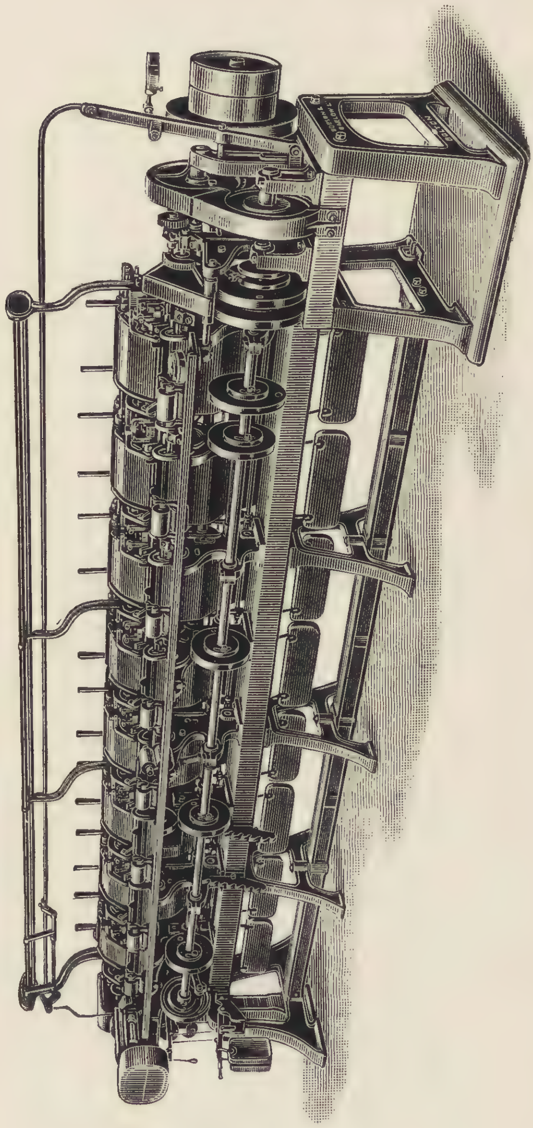


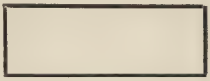
FIG. 33.

Pulleys.—Ordinary comber, 12 in. by 3 in.
Duplex comber, 12 in. by 3 in.
Speeds.—Ordinary comber, 305 revolutions, 80 nips.
Duplex comber, 229 revolutions, 120 nips.

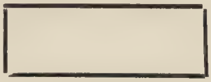
WEIGHTS AND CUBIC MEASUREMENTS.

	Without Weights.		Roller Weights.		Cubic Measurement.	
	Gross.	Net.	Gross.	Net.	Without Weights.	Weights Only.
	Cwt.	Cwt.	Cwt.	Cwt.	Feet.	Feet.
6 heads, 8½ in. lap—Ordinary	40	31	2	2	169	...
6 ,, 8½ ,, —Duplex	42	33	2	2	169	...
8 ,, 8½ ,, —Ordinary	48	38	3	2½	200	2½
8 ,, 8½ ,, —Duplex	49	39	3	2½	202	2½
6 ,, 10½ ,, —Ordinary	46	37	2½	2½	182	2
6 ,, 10½ ,, —Duplex	47	37½	2½	2½	185	2
8 ,, 10½ ,, —Ordinary	51	39	3	3	213	3
8 ,, 10½ ,, —Duplex	53	40	3	3	216	3

To determine the hand of a machine, see sketch below :—



Feed.



Feed.

The firm supply, free of charge, with each comber one top draw box roller, one top detaching roller, and the following changes, including those on the machine, three feed wheels.

SPACE OCCUPIED.

	7½ in. and 8½ in. Laps.	9 in. Laps.	10½ in. Laps.	Width.
8 Heads	15 ft. 6½ in. = 4·737 m. long.	15 ft. 10½ in. = 4·838 m. long.	16 ft. 10½ in. = 5·143 m. long.	3 ft. 4 in. = 1·02 m.
6 ,,	12 ft. 8½ in. = 3·873 m. long.	12 ft. 11½ in. = 3·950 m. long.	13 ft. 8½ in. = 4·178 m. long.	3 ft. 4 in. = 1·02 m.

PRODUCTION OF ORDINARY COMBER PER HEAD IN 10 HOURS.

No. of Nips per Min.	Weight of Lap per Yard.	Width of Lap.	Waste per cent.	Lb. per Head of Combed Sliver.	Kinds of Cotton Worked.
80	8 dwt.	7½ in.	20	6·37	Sea Islands.
80	9 ,,	8½ ,,	20	7·22	do.
80	11 ,,	10½ ,,	20	8·92	do.
80	9 ,,	7½ ,,	18	7·5	Egyptian or American.
80	10½ ,,	8½ ,,	18	9·0	do.
80	13 ,,	10½ ,,	18	11·15	do.

The above productions are based upon a speed of 80 nips per minute, but there are machines running up to 95 nips per minute for Egyptian cotton.

PRODUCTION OF DUPLEX COMBER PER HEAD IN 10 HOURS.

No. of Nips per Min.	Weight of Lap per Yard.	Width of Lap.	Waste per cent.	Lb. per Head of Combed Sliver.	Kinds of Cotton Worked.
120	8 dwt.	7½ in.	20	9·23	Sea Islands.
120	9 ,,	8½ ,,	20	10·47	do.
120	11 ,,	10½ ,,	20	12·93	do.
120	9 ,,	7½ ,,	18	10·88	Egyptian or American.
120	10½ ,,	8½ ,,	18	13·04	do.
120	13 ,,	10½ ,,	18	16·12	do.

These productions are based upon a speed of 120 nips per minute and for good qualities of work produced. We have combers working heavier laps than specified for medium qualities of work. This means the production will be greater than given above.

PLATT'S GEARING PLAN.

It is deemed advisable to introduce the gearing plan of Platt's Heilmann comber here, as it may help students to better understand the explanations already given in this chapter.

A full consideration of the gearing is, however, left over until the chapter on calculations.

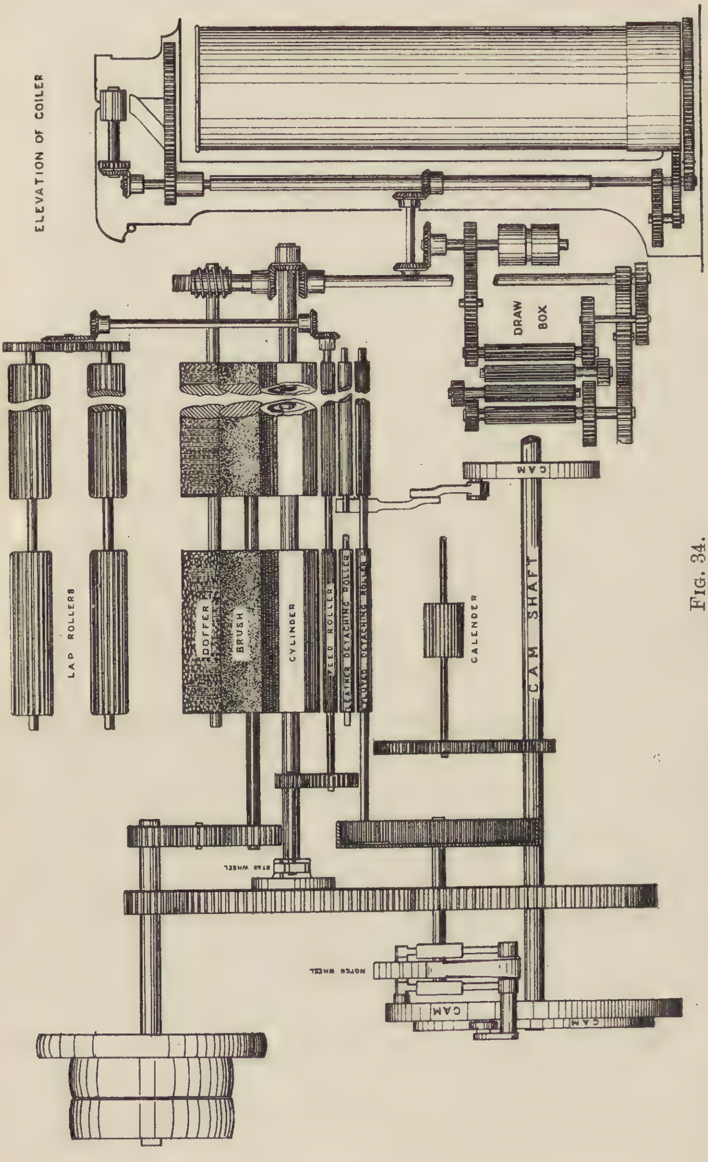

ELEVATION OF COILER
DRAW BOX
LAP ROLLERS
DOFFER
BRUSH
CYLINDER
FEED ROLLER
LEATHER DETACHING ROLLER
CALENDER
CAM SHAFT
CAM
CAM
CAM
STAR WHEEL
NOTCH WHEEL

Fig. 34.

Before concluding the present chapter one or two other matters of practical importance may be just referred to.

In the practical working of sliver lap machines, ribbon lap machines and combers, the author would like to say that every care should be exercised to obviate the necessity of belts and shafts running over these machines.

The cotton is at this stage in a very loose state, and is liable to be affected by the working of such parts in too close proximity, and belts especially sometimes throw dirt on the cotton machines.

It may be said that a sort of half-combed effect is often produced with Egyptian cotton in various ways. One method is to take out only a very low percentage of waste at the comber. A second method is to run up at one or other of the machines one carded and one combed end together.

In the same way laps of different sorts may be mixed at the comber, and slivers in various proportions at the draw-frames.

In some cases a somewhat similar effect is sought to be produced by taking out a very high percentage of waste at the card, and not using the comber at all.

It may be added that a well-known member of the firm of Messrs. Hetherington is at the present time engaged in bringing out an improved comber which differs very much from the usual Heilmann. The thing, however, is too much in its infancy to be dealt with in this book, so that it is dismissed with a brief reference at the end.

CHAPTER III.

THE CAM SHAFT.

THE cam shaft of a comber has received a great deal of attention at the hands of inventors during recent years.

Until a few years ago it was considered quite sufficient to have one cam for the nippers and one for the detaching rollers placed at the end of the machine.

Then a great improvement as regards rigidity and certainty of action was effected by running the cam shaft for half the length of the frame, and placing these cams in the middle of the frame instead of at the ends. In the very latest combers this idea has been carried out to an even much greater extent. The cam shaft in these cases is made to run the full length of the comber, and the number of cams has been so multiplied that there is now—

(1) A double cam for the quadrant as against a single one formerly.

(2) A nipper cam at each end of the comber.

(3) A detaching roller cam for each two heads of the machine.

(4) A greatly strengthened cam for the clutch box.

A view of one of the latest and most improved cam shafts is given in Fig. 35 from the front of the machine.

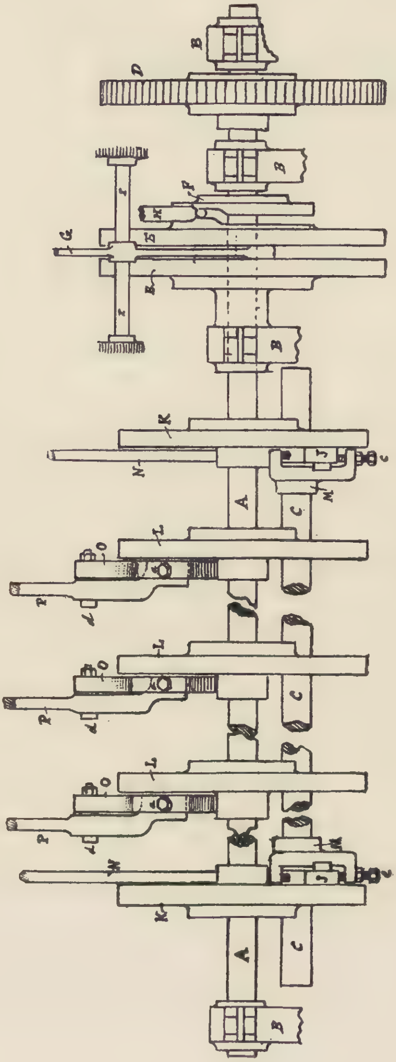


FIG. 35.

Reference Letters.

A Cam Shaft.
B Four Bearings for the Cam Shaft.
C Carrier Shaft or Fulcrum for Nipper Levers.
D 80's Cam Shaft Wheel driven from Index Wheel.
E Double Cam for Quadrant.
F Double Cam for Clutch Box.
G Quadrant Arm.
H Lever for Clutch Box.
I Fulcrum Shaft for Quadrant.

J Lever and Bowl Finger connected to Nipper Cam, K.
K Nipper Cam.
M Slotted Setting Bracket Screwed to Cam Shaft, A.
c_1c Setting Screws by which Nipper Shaft, C, can be adjusted.

(These parts are given twice on cam shaft.)

L Detaching Roller Cam.
O Double Setting Bracket carrying Bowl or Runner for Cam 4.
P Lifter Arm carrying Top Detaching Rollers.
a Setting Screw for Lifters.
d Fulcrum Bolt connecting O with P.

(These parts are repeated three times over on the cam shaft in Fig. 35, while on an eight-head comber they would be repeated four times over.)

Nipper Cam.

A side view of the nipper cam is given in Fig. 36, the parts being lettered the same as in Fig. 35. The direction of rotation of the cam is given, and with the cam in this position acting on the bowl or runner at J, the nippers would be in the act of closing. They remain closed during all the time the runner is on the full part of the cam.

In this sketch it is clearly shown that the bowl finger or lever is loosely connected to the nipper shaft at C, while it is connected to the bowl at J.

By means of the screws, C, the double bracket, M, is raised or lowered as required, this being accompanied by the slight turning of shaft, C, and consequently by alteration of the nippers.

Detaching Roller Cam.

In Fig. 37 is given a separate side view of detaching roller cam, the reference letters also in this case being the same as given in Fig. 35.

The direction of rotation is indicated by the arrow, and the thin part of the cam is shown acting on the runner at J. In this position the leather rollers would be touching the fluted segment of the cylinder and detaching delivery, and piecing-up of the cotton would be taking place. By means of the screw, C, the stud of the bowl, J, is secured to the double bracket, O.

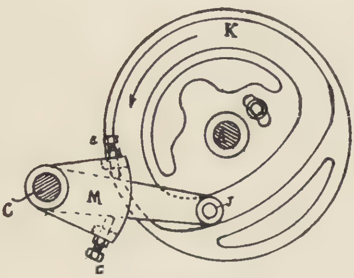


Fig. 36.

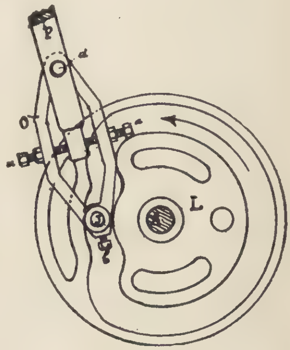


Fig. 37.

By means of the screws, A, A, the setting of the lifter bracket, P, can be altered, this being followed by a corresponding variation in the lifters and detaching rollers.

It must be distinctly understood that when the bowl or runner, J, was in the position indicated in Fig. 37, the bowl or runner, J, in Fig. 36 would be in the position shown (Fig. 36). That is to say, when the detaching cam bowl was in the centre of the thin part of the cam, the upper cam bowl would be nearly entering the full part of its groove.

Another point of interest is that the thin part of the detaching roller cam, L (Fig. 37), is the one which holds the detaching rollers in action on the cotton, whereas it is the full part of the nipper cam, K (Fig. 36), which holds the nippers in nipping action. In each case of course the portions of the cams between the full and thin parts of the cams represent the movement of the parts from active to inactive position and *vice versâ*.

Mechanism for Rotating the Detaching Rollers.

The detaching roller cams referred to in Fig. 35 are devoted entirely to the purpose of imparting to the two top detaching rollers a slight bodily motion backwards and forwards through space.

The cams shown in Figs. 38 and 39 are devoted to imparting to the long bottom steel roller a backwards and forwards motion of a rotary character. To do this work there are principally two rival methods : (1) the large notch wheel and cam sytem ; (2) the quadrant and clutch box system. The second method is illustrated in Figs. 38 and 39.

In this case there are two double cams fixed on the cam shaft, one of which is devoted to opening and closing the roller box, while the other oscillates the quadrant.

F:g. 38 is a side view of the arrangement, while Fig. 39 is a plan.

Reference Letters to Figs. 38 *and* 39.

A	The Long Steel Detaching Roller.	J	Groove for Quadrant Bowl.
B	The Clutch Box.	K, K	Cam for moving Quadrant.
C	Fork for Clutch Box and Fork end of Lever, D, F, C.	L, L	Cam for moving Clutch Box Lever.
D, F, C	Lever for opening and shutting Clutch Box.	M	Clutch Box Wheel.
D	Bowl End of Clutch Box Lever.	N	Short Top Steel Detaching Roller.
E	Cam Shaft.	O	Leather - covered Detaching Roller.
F	Fulcrum of Clutch Box Lever.	P	Lifters for Short Detaching Rollers.
G	Quadrant or Part Wheel.	Q	Spring to keep Clutch Box better engaged.
H	Fulcrum for Quadrant.		
I	Bowl for Clutch Box Lever.		

Object and Action of Parts.

The object of these parts is to give a suitable rotation to the

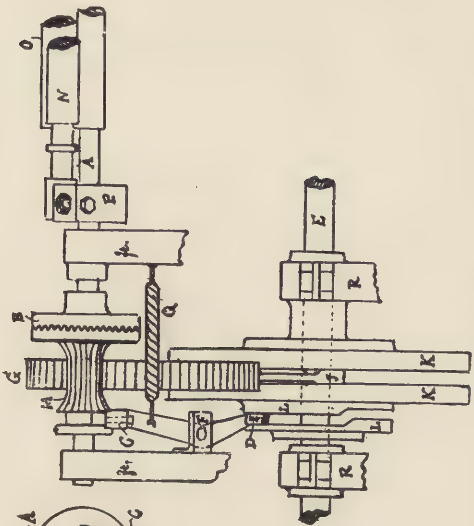


Fig. 39.

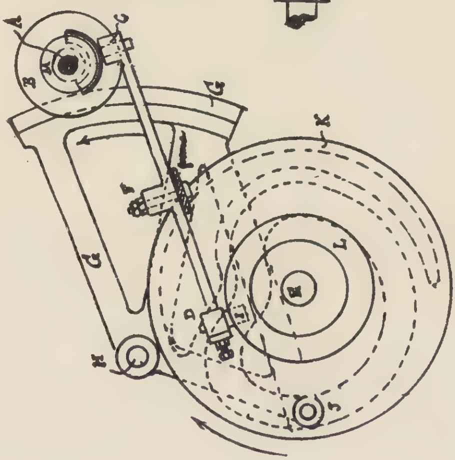


Fig. 38.

long steel detaching roller at the proper time. The rollers, N, O, are rotated by frictional contact with the long roller, A.

The quadrant, G, is constantly moved upwards and downwards by the rotation of the cam, K, K. The clutch box wheel, M, gears with it, and is therefore constantly being moved first one way round and then the other.

One complete downward motion of the quadrant may give $\frac{7}{8}$ or more of a forward revolution to the clutch box wheel, M, while each upward motion of the quadrant always brings the wheel, M, back to the same place.

The clutch box wheel, M, is loose on the long steel roller, and it depends upon the box being open or closed as to how much the detaching rollers are rotated, the other or driven half of the clutch box being fast to the long steel roller.

It is the purpose of the small double cam, L, L, to open and shut the clutch box as required.

It is customary (1) to have the clutch box engaged during all the time of each downward motion of the quadrant.

(2) To have the box open at the commencement of each upward motion and to remain so for about half the distance, at this time the detaching rollers of course not being rotated.

(3) About half-way of the upward motion the clutch box is again engaged and the backward or return rotary motion of the detaching rollers thereby effected.

Approximate Amount of Motion.

The diameter of the long steel roller may be $\frac{7}{8}$ in., and, taking the downward motion of the quadrant to give $\frac{7}{8}$ of a forward or delivery revolution to the roller each time, we get a delivery of cotton from the detaching rollers on each occasion equal to—

$$\frac{7}{8} \times \frac{22}{7} \times \frac{7}{8} = 2{\cdot}4 \text{ in.}$$

The length of cotton fleece returned at each backward motion at each head will therefore be approximately equal to—

$$2{\cdot}4 \div 2 = 1{\cdot}2 \text{ in.}$$

The return motion, however, is usually greater than 1·2, and in some cases the length delivered on each occasion reaches upwards of 2·75 in.

It will be seen that the net or gain forward movement will in most cases be approximately equal to $1\frac{1}{4}$ in. The amount given in by the feed rollers in each case is something like $\frac{1}{4}$ in., which gives a net draft of about 5 between the feed rollers and the detaching rollers.

In Fig. 38 the quadrant, G, is shown just commencing its upward motion, as indicated by the arrow.

The total amount of motion imparted to the rollers cannot very well be altered in any existing frame of this kind except by having more or less teeth in the clutch box wheel, M, when a wheel with a less number of teeth would give an increased motion to the detaching rollers.

The relative time of opening and closing of the box can be easily varied by unscrewing the clutch box cam and turning it slightly round on the cam shaft.

If, however, good work is to be obtained, any alterations of this sort must be strictly limited.

If the closing of the clutch box is delayed until after the upward motion of the quadrant has commenced, then there will be a slight return motion of the detaching rollers when they should be stationary.

At the fulcrum, F, of the clutch box lever there is a slot by which the clutch can be put deeper or more shallow in gear as required.

Inside the clutch box is usually placed a thick piece of leather.

It may be added that lately this apparatus has been strengthened in various ways. For instance, the small cam for the clutch box is secured by two set screws to the cam shaft instead of by one as formerly. Again, the large quadrant cam has been immensely strengthened by being made double, so as to sustain and operate the cam bowl on each side.

Lecture Diagrams of Position of Cams.

The relative positions of the different cams of a comber and those of the parts which are controlled by the cams are so difficult to thoroughly understand that an attempt has been made to illustrate and explain these by means of the lecture

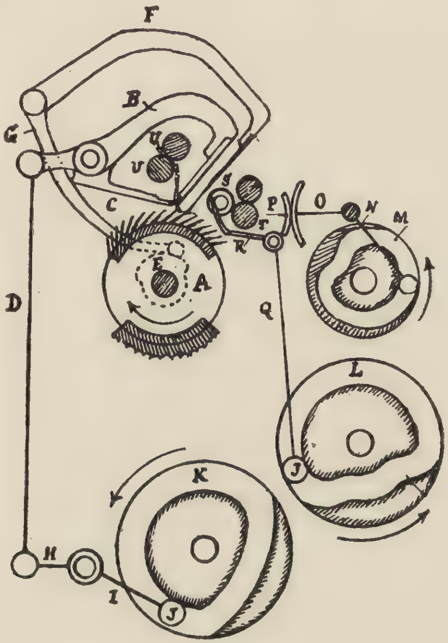


FIG. 40.

Reference Letters.

A	Cylinder.	L	Cam Groove for detaching Roller Lifting.
B	Arm of Top Nipper.	M	Cam Groove for Quadrant.
C	Bottom Nipper.	N, O	Lever or Arm for Quadrant.
D	Vertical, Back, Screwed, Nipper Rod.	P	Short Top Steel Detaching Roller.
E	Cam for actuating Top Comb.	S	Leather - covered Detaching Roller.
F	Upper Lever or Arm of Top Comb.	T	Long Steel Detaching Roller.
G	Lower Lever or Arm of Top Comb.	Q, R	Arms or Lever for lifting and dropping Detaching Rollers.
H, I, J	Bottom Lever or Arm for Nippers.	U	Top Feed Roller.
K	Cam Groove for Nippers.	V	Bottom Feed Roller.

diagrams given in Figs. 40 and 41, which refer more especially to Dobson's latest combers.

The reference letters are in each case the same. Fig. 40 shows the position of all parts during actual combing, while Fig. 41 shows the position of the same parts during detaching.

It must be clearly understood that the cams are shown *out of position* in order to assist in explaining their settings and actions.

It may be stated that, without counting any duplication of cams, there are five cams usually on a Heilmann comber. In this case they are as follows:—

(1) The top comb cam, E, on the cylinder, A.

(2) The nipper cam, K.

(3) The lifting cam, L.

(4) The quadrant cam, M.

(5) The clutch box cam (not shown in Figs. 40 and 41).

All of these cams, excepting that for the top comb, are secured to the cam shaft, the latter being rotated in a single nip comber at the same speed as the cylinder, by means of a large 80's wheel on the cam shaft gearing with and receiving motion from the 80's index wheel on the cylinder shaft.

Position of Parts for Combing.

Referring now to Fig. 40, we have given the positions of the nippers, top comb, detaching rollers and cylinder needles during the actual combing action. The lettering is the same as in Fig. 41.

Also we have given the approximate position of each of the cams at the same time.

Summarising the positions of the working parts we have:—

(1) The nippers holding the cotton down into the range of action of the cylinder needles.

(2) The nipper, K, therefore acting with its full or concentric portion on the cam bowl, J.

(3) The detaching roller, S, held by arm, R, out of the way of the cylinder needles.

(4) The lifting cam, L, therefore just nicely begun to act with its full or concentric part on its cam bowl.

(5) The quadrant at O in its lowest position.

(6) Therefore the cam, M, acting with its fullest part on the proper cam bowl.

(7) The top comb held away from cylinder needles.

(8) The cam, E, therefore acting with its full part on the lower arm, C, of the top comb.

Action of these Parts during Combing.

During the time of actual combing, the cam, E, as in Fig. 40, will hold the top comb out of the way of the cylinder needles. In general terms, therefore, it may be stated that all these cams have their full parts acting on the bowls during combing, and their thin surfaces during detaching. The full part of cam, K, will hold the nippers close down to the cylinder needles; the cam, L, will hold the leather-covered detaching roller well out of the way of the cylinder needles; although the cam, M, may be moving the quadrant along the portion of its upward motion, yet the detaching rollers will not be rotated owing to the clutch box being kept open by the cam not shown here, but marked L, L in Figs. 38 and 39.

Position of Parts during Detaching.

This is shown in Fig. 41 as stated; at this time each of the four cams shown has its bowl working on the thin part of the cam.

(1) The nippers are open and are held out of the way of the cylinder needles and well behind the top comb.

(2) The nipper cam, K, therefore is acting with its thin part on the bowl or runner, J.

(3) The detaching roller, S, is shown resting on the fluted segment of the cylinder.

(4) To allow of No. 3, the lifter cam, L, is acting with its thin or small concentric portion on the bowl, J.

(5) The quadrant is shown just commencing its downward or delivery motion.

(6) Therefore the cam, M, is shown pressing outwards on the proper cam bowl.

(7) The top comb is shown to be dropped amongst the fibres of cotton.

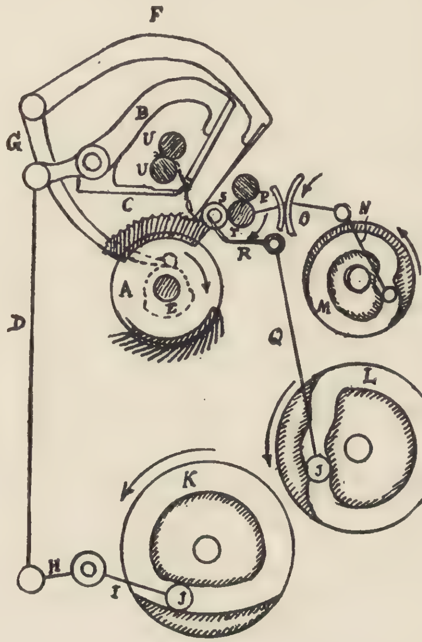


Fig. 41.

(8) Therefore the cam, E, fixed on the cylinder, A, for operating the top comb, is shown with its thinner concentric portion acting on the lower arm of the top comb.

Action of Parts during Detaching.

The three cams, K, L, M, being all on the same cam shaft, of course revolve in the same direction as shown in Figs. 40 and 41, this being opposite to that of the cylinder.

The revolution of the cylinder in Fig. 41 will cause the fluted segment of cylinder to take the cotton forward. During the operation of the segment upon the cotton, the configuration and action of the four cams is such that E will allow the top comb to remain down; K will keep the nippers out of the way; L will maintain the top detaching rollers in proper attaching and detaching position; M will all this time be continuing the downward motion of the quadrant.

Pauses in the Quadrant Cam.

A good proportion of each of the circumference of the cams for the lifters, top combs and nippers, is made concentric with the centre of the shaft, in order to hold the parts they act upon stationary in one position for a fair proportion of each nip.

In the case of the quadrant cam the conditions are different, and the writer is of opinion that in times past a good deal of trouble has arisen in connection with the quadrant and roller box system, owing to the outlines of the quadrant cam not being laid out to the best advantage.

A good deal of improvement has, however, been effected in this direction recently, and also the quadrant cams have been made double instead of single, this latter having proved to be a very good thing.

There are three principal positions in the circumference of the quadrant cam where it is possible that concentric portions may be of some advantage, these representing the top, middle and bottom positions of the quadrant respectively.

In some recent combers at any rate it was noted the pauses or concentric portions in actual work were as below:—

Duplex Comber.

For top of quadrant about $\frac{1}{30}$ part of the circumference.
,, bottom ,, ,, $\frac{1}{16}$,, ,,
,, middle ,, ,, $\frac{1}{9}$,, ,,

Single Nip Comber.

For top of quadrant, about $\frac{1}{30}$ part of the circumference of cam.
,, bottom ,, ,, $\frac{1}{8}$,, ,, ,,
,, middle ,, a slower motion only.

Comparing these two tables of actual practice it will be noted that the longest dwell in the first table is allotted to the middle position of the quadrant, while in the second case the longest dwell is provided for the bottom position of the quadrant. The smallest of the three pauses is found in each case at the top.

Although the outlines of the cams may be influenced by the fact that one comber is a single nip while the other is a duplex, it does not follow that the differences above pointed out are entirely due to this factor, but may be at least in part owing to the variation of opinion on the part of the makers.

A few words may be profitably expended as to why proper pauses or concentric portions of the cams may exercise a beneficial effect.

Taking the top position of the quadrant, it must be remembered that just here the change of direction of motion of the quadrant is accompanied by the return or backward motion of the rollers being changed to their forward or delivery motion. The return motion terminates when the quadrant reaches the top, which should happen just *before* the leather roller is made to touch the fluted segment of the cylinder.

If the leather roller touched the fluted segment before its backward rotary motion were finished, the two parts would be acting against each other, with disastrous effects on the cotton and leather.

If, on the other hand, the downward motion of the quadrant is begun too quickly it is possible the leather roller may not have got sufficiently near the segment when the delivery of the cotton begins.

By having a slight pause at the top of the quadrant we can prevent both evils.

(1) We can allow the leather-covered roller to finish its dropping motion just *after* its return rotary motion has terminated, and so prevent the segment and leather roller from working against each other.

(2) We can prevent the delivery motion of the rollers from starting prematurely and so interfering with correct detaching.

It is the opinion of the author, however, that this pause must be only of a very limited character, and practical men should see that the downward motion of the quadrant, and therefore the delivery motion of the rollers, should start either before or at least simultaneously with the leather roller touching the segment.

In the majority of cases it is probable that the downward motion of the quadrant, and therefore the delivery motion of the rollers, have got nicely going before the leather roller touches the segment, and this is probably the safest plan.

Referring now to the pause at the *bottom* position of the quadrant, it is of primary importance to remember that at this point the clutch box is opened, and a dwell on the quadrant cam exercises the same effect on the detaching rollers as does the opening of the clutch box. In each case the rotary motion of the rollers is thereby stopped.

Here also it must be remembered that the delivery or forward motion of the rollers must be approximately twice the amount of the return or backward motion.

This is obtained principally by keeping the clutch box engaged for the whole of the downward motion of the quadrant, but only for the *upper half* of its upward motion. It is not the dwell of the cam which causes the rollers to be stopped during combing, as many students and others often imagine, but it is the fact of the clutch box being then open.

The bottom pause or dwell of the quadrant aids in obtaining the desired effect.

We want to keep the clutch box engaged until the finish of the downward motion of the quadrant, and in trying to do this without a dwell on the cam at the lowest position there would be a danger of the clutch box being kept closed until after the upward motion of the quadrant had begun, with the result that the detaching rollers would have a slight but undesirable return motion.

This has been tried, and the evil effect produced. By keeping the quadrant stopped a little at its lowest position we can safely leave the clutch box engaged to the full limit required, because the dwell in the quadrant cam would stop the rollers even if the clutch box did not open.

In this connection the pause of $\frac{1}{8}$ allowed in the second table appears to the author a very good proportion.

This pause then (1) ensures that a full amount of forward motion is secured.

(2) There is no shaking or return motion of the rollers at the bottom of the quadrant.

(3) Aids in the withdrawal of the loose half of the clutch by allowing the clutch wheel to slide along the teeth of the quadrant more freely.

We have now to refer briefly to the third or *middle* pause. The need for this may not be as evident as in the case of the top and bottom pauses, and in the second of the two tables of pauses previously it consists of merely a reduced speed, and not any actual dwell whatever. In the case of the duplex, it is given at about $\frac{1}{9}$ of the circumference of the cam.

It is approximately in the middle of the upward motion of the quadrant that the clutch box is engaged, and it is precisely at this moment that the dwell or slow speed of the quadrant should be acting.

Briefly put, this pause ensures the engagement of the clutch box with less danger of breakage to the teeth of the box itself, as well as to those of the quadrant and quadrant wheel.

It allows the teeth of the quadrant wheel to slide more freely across those of the quadrant. It prevents the quadrant half of the clutch box from being quite as rigid and unyielding at the moment of engagement.

It may be noted here that in the notch wheel system of operating the detaching rollers the cam for the lever of the notch wheel is much similar in shape to the quadrant cam.

Along with the foregoing remarks readers may peruse the matter commencing on page 103 ("Quadrant and Clutch Box").

Internal Disc.

As there has been considerable trouble in times past with breakages in connection with the clutch box and quadrant, the author is of opinion that it might prove a good thing to introduce a thin iron disc inside the clutch box, after the principle of that used in the roller box of a self-acting mule.

In this way a little shake or looseness could be permitted in the teeth of the driven half of the box, which could not fail to be beneficial to the various parts concerned by preventing torsion and strain at the moment of engagement.

This might be accompanied by pauses in the quadrant somewhat as follows :—

At the top $\frac{1}{30}$ part of the circumference.
,, bottom $\frac{1}{8}$,, ,, ,,
,, middle $\frac{1}{20}$,, ,, ,,

The teeth of the clutch box of the comber have to be shaped so as to give or take rotary motion both ways, whereas the teeth of the roller box of a mule need only be shaped to give motion one way.

As it appears to the author, the actual work of rotating the detaching rollers is not at all heavy, and ought not to lead to much breakage of parts, and if such breakages occur, they are probably due largely to the frequency and manner of engaging and disengaging the clutch box: hence the suggestion of the thin internal disc.

It may be added that the detaching rollers can be turned pretty easily by the fingers of one hand by simply pulling round at the fast half of the clutch box when the latter is opened.

In the next chapter will be found a description of the notch wheel arrangement, with a special essay on the detaching roller.

Friction Clutch.

As might naturally be expected, instead of the clutch box in the quadrant system, experiments have been made with friction clutches. Some of these have given a fair amount of satisfaction, and there can be no doubt that friction clutches would be much less noisy than clutch boxes in this position.

On the whole, however, clutch boxes have proved to be much more reliable and really effective. It is well known that frictions are affected by changes in the atmospherical conditions, so that they stick on some occasions more than others. In cotton spinning machinery the greatest application of friction driving is found in connection with the self-actor mule, where it is effectively applied for backing-off, drawing-up and turning the cams. In none of these cases is a slight occasional slipping of the frictions of any particular consequence, although excessive slippage would be quite fatal to proper working.

The driving of the detaching rollers of a Heilmann comber is, however, an infinitely more delicate operation, and even a slight and varying amount of slippage is exceedingly detrimental. Any such slippage would result in an insufficient amount of cotton being either returned or, on the other hand, delivered, resulting in bad piecing of the cotton or in cutting the fleece.

The results of dilatory disengagement of the frictions would also be objectionable in a different manner.

Such considerations as the foregoing appear to have led to the frictions being discarded.

CHAPTER IV.

THE DETACHING AND ATTACHING MECHANISM OF THE COMBER—THE DUPLEX COMBER.

There is no machine in a cotton spinning mill which requires more delicate setting, timing and general handling than the comber. Further, there is no part of any machine used in cotton spinning whose action on the fibres of cotton is more difficult to thoroughly comprehend than the action of the detaching and attaching mechanism of a Heilmann comber. The parts principally concerned in this work are: (1) the leather detaching roller; (2) the short top roller; (3) the long steel detaching roller; (4) the fluted segment of the cylinder. Before each successively combed tuft of cotton can be passed forward it must first be detached from the uncombed portion, after which it is attached to the already combed cotton, hence it is proper to place detaching before attaching to be in correct sequence.

The action, more especially of the leather roller and the short steel or brass roller, is most peculiar and difficult to comprehend. On this account it has been considered advisable to give a special essay on this subject.

It must be distinctly understood that Heilmann combers are only at present under discussion, as practically no others are used in English cotton spinning mills, and these are nearly all made by one of the following firms: Messrs. Dobson and Barlow (of Bolton), Messrs. Platt Brothers (of Oldham), and Messrs. Hetherington (of Manchester). In Oldham, Asa Lees' have lately begun to make combers. Of the four component parts of the detaching and attaching mechanism under discussion, it is probable that the action of the fluted segment of the cylinder is the easiest to understand. As the cylinder performs its rotation once to each nip in the single nip machine, and once to every two nips in the duplex comber, the successive rows of needles pass through the cotton while the latter is held by the nippers. Afterwards the nippers open, and the fluted segment comes beneath the combed fibres and carries them forward, assisted by the leather detaching roller, which has been lowered into actual contact with the fluted segment for that purpose. The newly combed fibres are thus carried forward until they meet the returned end of the last previously combed cotton, after which the fluted segment continues its rotation so as to similarly deal with the next tuft of cotton to be combed. As previously stated, the action of the two top detaching rollers is very difficult to understand, as they have a compound motion very much similar to that of an epicyclic train of wheels, *i.e.*, they have a rotary motion carried on simultaneously with a bodily motion through space. Their action is further complicated by both these motions being intermittent and reciprocating, and still further by the rotary motion one way being greater than that in the opposite direction. As regards their movement through space, they are lifted away from the cylinder during the time the cylinder needles are operating on the cotton fibres, and then promptly moved down towards the cylinder to meet the fluted segment, and to act in conjunction therewith in taking the combed fibres forward. As regards the rotary motion of these rollers, this is derived by frictional contact with the long fluted bottom steel roller, and is first made in such a direction as to return the rear end of the already combed cotton, as it were, into the machine—an action which is carried on usually until the web in the front sliver tin is somewhat tight. As a matter of fact, this return action is sometimes carried on so far as to injure the web by cutting and tearing it; an extreme which should be avoided as far as possible. It may equal—at any rate, in some cases—upwards of $1\frac{1}{6}$ in. or more of surface movement, being often something like half a revolution of a leather detaching roller of $\frac{3}{4}$ in. diameter. An instant after this backward motion has been completed, the forward motion commences by which all the portion last returned—together with the newly combed and detached portion —is once more delivered into the front sliver tin. This forward revolution must always be greater than the backward revolution in order to pass the cotton finally forward, and the amount of cotton passed forward depends principally upon the excess of the forward revolution per nip over the backward revolution. The two motions may bear proportion to each other of say 12 or 13 is to 6. That is to say, while the rollers may return every nip approximately an inch of cotton, more than double that amount may be delivered during each nip. It may be as well to state here that the cycle of motions on a comber is performed every nip, so that it is usual to say that a comber makes so many nips per minute, which in a single nip comber is equal to saying that the cylinder makes that many revolutions. As stated, it is the usual practice to impart the rotary motion of the two top detaching rollers by their being kept in frictional contact with the long steel detaching roller. The bodily movement of these two rollers through space is only very slight and is usually derived quite independently from the cam shaft; it is mainly intended to remove the leather roller out of the way of the needles of the cylinder when the latter are in action, and should be nicely sufficient to attain this in one direction, while the return motion should be continued until the weight of the leather roller is resting on the fibres on the cylinder segment. To time and set and otherwise accurately adjust the leather roller is one of the most delicate operations about the practical working of the machine, and this point will afterwards be specially dealt with.

Loose End Bushes.

The ends of this roller are usually sustained by loose bearings, which at the proper time rest on the lifters. These loose ends or bushes must be very carefully and accurately constructed if good and uniform combing is to be done, and their construction has been subject to more or less variation. In some cases there is just one square side made on each bush for it to rest on the lifter by. In other cases there are two and even four square sides on each bush. The special advantage of the latter construction is that when one side of the loose bush is worn another may be used, while the special advantages of the one flat side are: (1) less likelihood of the bushes being put in with wrong sides down; (2) cheaper construction. When the four sides are used, each side should be properly stamped or numbered to prevent mixing.

It may be stated that sometimes the loose bushes of the leather detaching roller are made cylindrical without any flat sides. When this is so special care should be taken to have the bushes of material that will not easily wear. In all cases, and whatever construction of these loose bushes is adopted, constant watchfulness should be exercised to detect any signs of wear in them or on the ends of the leather rollers themselves.

Leather-covered Rollers.

It is the writer's experience that a slight fault in the action of the leather-detaching roller is more likely to affect the proper delivery of the cotton than almost anything else, while at the same time such faults are by no means of infrequent occurrence. Let the action of these rollers be faulty, and it will be a difficult matter indeed to get the cotton delivered forward without curled and thin places. Practical men are well aware that there is often a difficulty in getting the short top steel roller to work flute and flute with the long bottom steel detaching roller, especially, perhaps, when the flutes are very fine. If this exact working in unison is not secured, then we may expect curling and faulty delivery of the sliver of cotton. Speaking about leather-covered rollers generally, and for all spinning machines, it is common knowledge that every care must be taken to have them well and truly covered if satisfactory results are to be obtained from them; but if the writer were asked to suggest one position more than another where skilful, accurate roller covering is necessary, he would say the leather detaching roller of a Heilmann comber. This is a point which appears also to be realised in some of our fine spinning mills, since in some cases a trueing-up machine is used in these mills for the leather detaching rollers. The difficulty of getting these rollers sufficiently true is enhanced by their length, since the longer a roller is the more difficult it becomes to put on it a leather absolutely uniform in thickness all through its length, and this length in some modern combers equals 10 in. or $10\frac{1}{2}$ in. for the leather detaching roller. If this roller be only in the slightest degree thicker at one point than elsewhere then the fibres will be delivered imperfectly, because the thick part of leather will hold others off the fluted segment of the cylinder, and also off the long steel detaching roller. So important is this point that it might be recommended in many cases to take out the leather detaching rollers at intervals, and have them trued up and varnished, or varnishing may be done whether trueing-up is or not.

Single and Double Nip.

Here it may be pointed out that good comber overlookers may fall into a trap with regard to the time of action of detaching rollers when first brought into contact with the duplex combers on the clutch box system. The writer has personally known of several such cases in which a great deal of time and trouble have been expended in trying to make a duplex comber to work with the clutch box closing at three-quarters of the index wheel as on a single nip. This is quite impracticable owing to the presence of two sets of needles and two fluted segments on the cylinder. By closing at $\frac{3}{4}$ on the double nip comber the portion of cotton returned by the detaching rollers is liable to be caught by the cylinder needles owing to the premature rotation of these rollers. The real time is fifteen or sixteen teeth of the index wheel later for closing the roller box. This point is of special importance to any comber man who is first called upon to deal with the new duplex combers, as it is the most radical of the alterations in timings and settings for the duplex as compared with the single nip. At the present time it is very questionable whether the duplex comber is making any very great headway in England, owing to one or two serious disadvantages which we may discuss at a later stage.

Curling.

Keeping detaching rollers well cleaned, oiled, varnished, covered and set, may be briefly summarised as the main point to bestow attention upon in order to prevent curling, and to get the cotton delivered forward in a uniform and regular manner. If any one head of a comber is working faultily in these respects it is an easy and excellent practice to forthwith examine the detaching rollers in the above respects. The centre of the leather roller should be a certain distance from the nippers to secure the most perfect detachment, and not to reject long fibres for waste, or to take short fibres forward into the front can. In a single nip comber making eighty-five nips per minute, or in a duplex comber making 120 nips per minute, the feed and delivery portions of cotton are that number of times absolutely broken off and re-pieced, and upon the action of the detaching mechanism principally depends the character of the piecings. From this statement it will be easy for any one to conceive what an important effect the three detaching rollers and the fluted segment of the cylinder will exercise on the appearance of the combed and delivered sliver. As stated previously, a common effect produced on the sliver by defective action of the detaching mechanism is that it appears full of curly places, which are clearly evident to the merest tyro about the machine. Perfect parallelism of the four principal parts of the detaching and attaching mechanism with each other is of the greatest importance. At the same time it is an increasingly difficult matter to secure such parallelism for the full width of the parts because of the tendency to increase the width of lap at each head from $7\frac{1}{2}$ in. to upwards of $10\frac{1}{2}$ in. The difficulty is still further increased by the fact that the leather rollers are somewhat heavily weighted at each end, as this practice tends to keep the ends better in contact with the fluted segment than the middle portions. To get over this evil in a few cases it has been deemed advisable to cover the leather rollers with a slight convexity in the centre, which is a somewhat dangerous and difficult practice. Perhaps a better practice would be to give the fluted segment of the cylinder a very slight convexity according to a well-defined gauge or templet. There would thus be less danger of going to excess and doing more harm than good. Another apparently trifling but really important practical point is to see that the leather detaching rollers are not mixed up or turned round about when varnishing and scouring; that is, when the best results are aimed at.

As before stated, so important is it that the leather-covered detaching rollers should be true that in many cases spinners have begun to use trueing machines, one of the best forms of which is shown in Fig. 42.

Hetherington's Patent Automatic Machine for Grinding and Trueing the Leather Coverings of Top Rollers.

In the comber it is indispensable that the leather-covered detaching rollers should be absolutely true from end to end, so that the roller may nip the fine cotton fibres on the fluted segment of the comber cylinder, otherwise the piecing is bad and much waste is made. This condition is difficult to realise owing to the inequalities in the leather, unless by means of some corrective process after covering. For this purpose Hetheringtons' have designed and patented the well-known grinding machine illustrated in Fig. 42. Its use has been so successful in the comber that it has been extended to the drawing rollers and even to the rollers of slubbing frames with great advantage, where quality of work is the first consideration.

The top roller to be operated upon is fixed in the two brackets on the table; they are adjustable to admit varying lengths of rollers, and one of them has a cross-adjustment, in order that the rollers may be set perfectly parallel.

The fast and loose pulleys, 3½ in. in diameter, should run

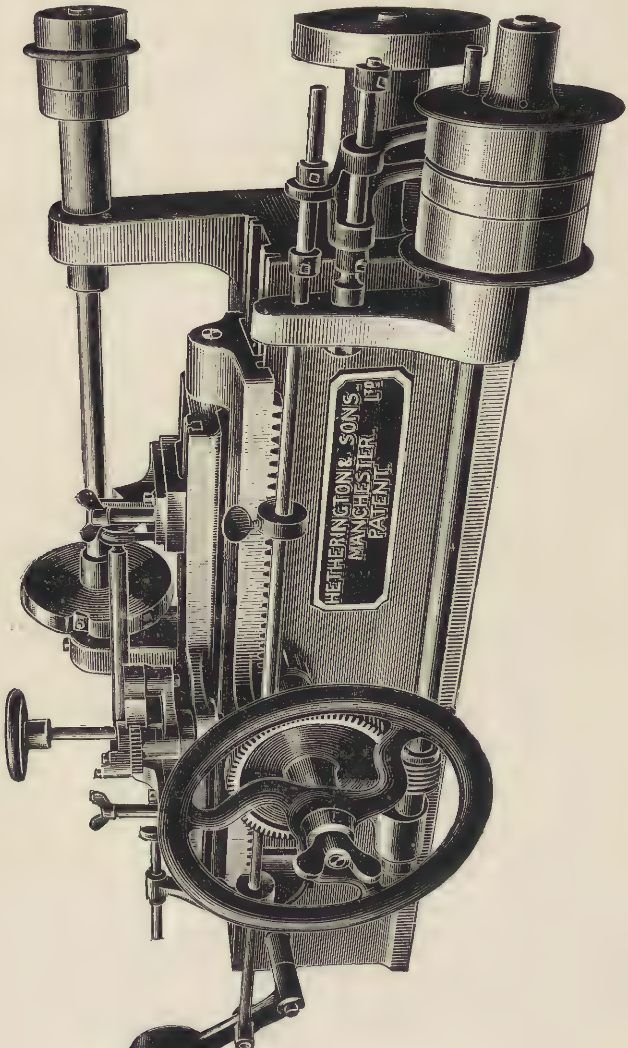


Fig. 42.

at about 1,400 revolutions per minute; attached to the fast pulley there is one for communicating motion to the pulley on the lower shaft, which again communicates motion to the small pulleys for rotating the top rollers.

On the lower shaft is the pulley, which communicates motion to the reversing shaft by means of two straps, one crossed and the other open. On this reversing shaft is a worm working into a worm wheel, which gives a longitudinal reciprocating movement to the table by means of a rack and pinion.

The leather covering of the top roller is brought into contact with the grinding disc by a vertical screw; and the feed is applied to the grinding surface by means of a ratchet wheel (connected with the screw), and a catch actuated at each traverse of the table by a slide bar, which is adjustable to any length of roller.

The grinding material for covering the metal disc may be either emery-cloth or glass-cloth, or even paper coated with these substances; sandpaper is also a good grinder, two strips being tightly fastened on the periphery by means of the small plates and screws.

The two small brass pulleys are for putting on the ends of the top rollers, and they must be fixed inside the two brackets.

After grinding the rollers must be varnished, and Hetheringtons' give a good recipe for varnish as reprinted below.

Recipe for Roller Varnish.

Take one pound of chrome yellow, and mix with quarter pound lamp black and quarter pound rouge, roll well with a roller to take all the small lumps out; then get ten ounces of joiner's glue, and boil it in two quarts of water, add to the above, and let it simmer for half-an-hour, continually stirring it. If it should be thicker than ordinary paint dilute it with warm water, and bottle. Before using, this varnish will require slightly warming.

The author may add that gelatine has often been found to give better results than glue.

Varnishing.

Continuing our remarks upon the detaching rollers, we may say that it is a very common practice to fit underneath the front table a small stand or creel for the leather rollers, to hold say eight rollers at a time. This is very convenient for placing the rollers in for varnishing purposes and to allow them to dry. The varnishing of these and other rollers is, however, not always done with sufficient care, and often so carelessly that the roller is left with thick, rough places on it, quite fatal to satisfactory work. The varnish should put a smooth surface on the rollers, and should not peel off or set hard ; it is best if it can be kept so that it needs no warming and yet will dry thoroughly in about five or ten minutes. Opinions vary as to the length of time the detaching rollers should go without varnishing, some overlookers applying it once a week, and others leaving it over for upwards of a month.

A point of practical importance for keeping the leather detaching rollers in good condition is to see that the top combs and other parts do not scrape or rub against the leathers. As we have before said, there are placed behind the small end stands or supports of the leather rollers fine adjustment screws, which are used to give a final levelling up to the leather rollers in order to get the most perfect parallelism of these rollers with the fluted segment and the other rollers, as well as with the nippers and top combs. During the periodical varnishing of the leather rollers it is the practice with some men to go round the rollers and just touch up the back screws where it is deemed necessary. A special key is used for the purpose by which the screws can be easily adjusted. The roller box for operating the detaching rollers—where the notch wheels have been dispensed with—is sometimes rather noisy, and has at times given a little trouble with the teeth breaking out and the boxes catching on the points of the teeth and not engaging with sufficient promptitude. Various little improvements have, however, been applied for remedying such defects, and we believe it is common now to cut the roller box wheels.

Cams and Clutch Box.

Owing to the complicated and compound motion of the detaching rollers several cams are required. On some combers, for instance, there are four cams on the cam shaft, and three out of the four are required to operate the three detaching rollers. Taking the quadrant and clutch box system, the work of these cams is divided out as follows: One cam to open and shut the clutch box at the proper time; a second cam to move the quadrant up and down; a third cam to give the bodily motion to the rollers. It may be said that in recent years all the cams on all the combers have been made of greater strength, and have been improved in shape, so that they impart a steadier and smoother action to the various parts. The double cam for opening and closing the roller box, for instance, has been made to screw to the shaft by two set screws instead of one, because somewhat frequent adjustment of this cam soon caused the one set screw to become stripped on the thread, and the same with its internal screw on the boss of the cam. As previously stated, about $4\frac{3}{8}$ of the index wheel is correct to close the box on a double nip machine as against $\frac{3}{4}$ for the single nip. So important is this setting point that the writer has known closing of the roller box at $4\frac{3}{4}$ to make the machine totally unsatisfactory in working, while closing at $4\frac{3}{8}$ has been quite satisfactory in every respect. It is the opening and closing of the roller box at the proper time that principally regulates the proportions of cotton passed forward and returned back every nip by the detaching rollers.

In Dobson's comber the rotary motion of these rollers is obtained from the quadrant, and if the roller box were kept always closed the rollers would be revolving all the time, but no cotton would be definitely passed forward, because the forward and return motions would be opposite and equal.

If the clutch box were open all the time then the detaching rollers would not be rotated at all, if we possibly except a slight motion which might be imparted to the leather roller by the cylinder segment for just the very brief time these two parts were in contact at each nip.

When the quadrant is moving downwards the detaching rollers are delivering the cotton, and when the quadrant is moving upwards the cotton is being returned from the front sliver tin. If, therefore, the clutch box were allowed to be closed during the whole of the downward motion we should get the maximum delivery of cotton, and if closed during the upward quadrant motion we should get the maximum return of cotton.

In actual practice the box is kept shut for all or nearly all the downward motion and open the first half of the upward motion, and the proportions are varied according to the judgment of those in charge of the combers by turning the clutch box cam round on the cam shaft. It has also been deemed advisable to strengthen the quadrant cam and to provide a double instead of a single cam. The roller box is also often provided with a small spring to keep it more firmly shut, although this practice tends to keep the cam bowl pressing against one side of the cam. Owing to various improvements in detail the teeth of the clutch box are now much less liable to break out than formerly.

It must not be forgotten that one or two eminent firms of comber makers do not make the clutch box and the quadrant at all, but pin their faith to improved forms of the old notch wheel for giving the proper rotary motion to the detaching rollers. Many practical men still prefer the notch wheel system. It is claimed, however, for the quadrant and clutch box system that it takes up a good deal less space, so that a room with forty or fifty combers would have to be appreciably larger for combers with the notch wheel than with the quadrant. The latter system is also claimed to be easier of adjustment and much less liable to derangement by the wearing or disturbance of pins and catches. There is, however, considerable difference of opinion amongst practical men as to these relative merits and demerits of the two rival methods of rotating the detaching roller. The notch wheel is fully described and illustrated a little further on.

Quadrant and Clutch Box.

In connection with the detaching and delivery of the combed sliver, it is usual to say that the quadrant moves forward at 6 for Egyptian cotton and $6\frac{3}{4}$ of the index wheel for Sea Islands cotton. In other cases the same thing is expressed by saying the detaching roller moves forward at 6, and detaching takes place at $6\frac{1}{2}$. Both the foregoing expressions are rather ambiguous, and the writer has often known both advanced students and practical men to be somewhat puzzled to know exactly what is meant by these instructions. It is a good deal better and clearer to say the quadrant must begin to move down at 6 of the index wheel for Egyptian, and $6\frac{3}{4}$ for Sea Islands, and the leather detaching roller must be clear of the lifters at $6\frac{3}{4}$ in each case. When the quadrant begins to move down, the steel detaching rollers begin to deliver the combed sliver, so that with this explanation it will be seen that "detaching roller forward," and "quadrant forward," and "quadrant down," all mean the same thing, *viz.*, the cotton is to begin issuing from the detaching rollers. It is very difficult for even practical men to thoroughly understand why it is that the iron detaching rollers should begin to deliver the sliver before the leather roller commences to bring forward the last combed tuft of fibres, as shown by the relative times of 6 and $6\frac{3}{4}$. It must be remembered, however, that the fluted segment of the cylinder is bringing the last combed fibres forward before this of itself without the assistance of the leather roller, so that the latter, as it were, only meets the fibres and assists them forward. This must be done, however, soon enough to make a good piecing and good selvedges of the sliver, and this partly explains why some practical men prefer to have "quadrant forward" and "commence detaching" at the same time. At the annual scouring times this detaching mechanism needs as much attention and cleaning as anything. The fluted rollers and fluted segments should have all the dirt thoroughly cleaned from the flutes, and the leather rollers should be made as good as new.

The iron detaching rollers in their backward motion may return upwards of $1\frac{1}{4}$ in. of the combed sliver into the rollers, and there is that much therefore to come forward again before it could be out of the reach of the last combed tuft. It is a most curious circumstance that while the detaching rollers deliver every nip something like $1\frac{1}{4}$ in. of sliver which is never returned, there is only something like $\frac{1}{4}$ in. of sliver projected through the nippers in the same time. That is to say, the net forward motion of the detaching rollers each nip—after deducting from the total forward motion what is returned by the backward motion—is practically five times as great as the net forward motion of the feed rollers per nip.

The surface speed of the calender rollers on the front table is about equal to the net forward surface speed of the steel detaching rollers, and the draft between the feed rollers and the calender rollers may be taken approximately at about five. Although there are several points on a comber at which draft is put in, yet there are really only two of importance, *viz.*: (1) between feed rollers and calender rollers; (2) between back and front rollers of draw box.

We have said that the clutch box is in most machines allowed to be engaged during all the downward motion of the quadrant. During the up stroke of the quadrant the clutch box is only engaged about half the time. It is good practice to construct the quadrant cam to give a slight pause, or slackening of speed to the quadrant teeth just at the time when it is desired to engage the clutch box, this point being approximately in the centre of the up stroke of the quadrant. The quadrant should have enough teeth in it to give about one full revolution to the steel detaching roller during any one complete up or down stroke, providing the clutch box is kept in gear all the stroke. It may be said that the recent development towards putting in more cams for driving the lifters for the detaching rollers will certainly give more power of adjustment and more direct action on the lifters, while, on the other hand, there may be a little difficulty with them at times in having to pull so many cams off the cam shaft, in the case of break-downs to such parts as the double worm that drives the calender rollers from the cam shaft.

In making any adjustments or settings of the working parts great care must always be taken to avoid the necessity of having to shift the long steel detaching roller, especially with the quadrant comber. Unless this precaution is exercised there will probably be trouble in getting the quadrant to work freely and yet certainly with the quadrant wheel all the time of the upward and downward strokes.

It may be just here noted that the "times" for these parts are slightly later for the duplex than for the single nip comber, as indicated by the following table :—

Quadrant down	. Single nip	. 6	= 24 teeth.
,, ,,	. Duplex .	. $6\frac{3}{4}$	= 26 ,,
Detach at . .	. Single nip	. $6\frac{3}{4}$	= 16 ,,
,, ,, . .	. Duplex .	. $6\frac{7}{8}$	= 27 ,,

The quadrant forward motion may be considered as the leading or fundamental setting of the cam shaft, because alterations in the timing of this require to be followed up by alterations in the lifter, nipper and clutch box cams. Suppose, for instance, it was desired to put the quadrant forward motion later; the 80's cam shaft wheel would be moved out of gear, and the cam shaft turned so as to have the quadrant beginning to move down the required amount later. This would make the nipping, lifting and clutching later, so that each one would probably have to be independently followed up and altered sooner again. This is not, however, as great a business as might be thought by a beginner since all these three settings are comparatively easily made within limits. When the quadrant is put right the cam shaft is usually not far wrong for the other positions and settings to be readily met by the slots provided for their adjustment.

Bodily Movement of Detaching Rollers.

As regards the movement of the two top detaching rollers bodily through space, this is derived from another cam on the cam shaft, which—through the proper bowls and levers—gives a slight and intermittent rocking motion to a strong shaft under the front sliver table. From this shaft other rods, studs and levers reach up to the leather roller and the piecing roller. There are various points of adjustment in connection with these parts, and nothing about the machine requires more care and skill than the proper timing and setting of these parts. By an adjustment slot in the face of the driving cam the time of the index wheel when the leather rollers shall be down on the cylinder segment can readily be varied for all of the rollers at one operation. There are points of adjustment for regulating the amount of clearance of the ends of the leather roller from the lifters when the rollers are on the segment: (1) for all the leather rollers at one operation; (2) for one or two leather rollers at a time; (3) for each end of each leather roller. So finely have these leather rollers to be adjusted that it is common to use a thickness of writing paper to determine the clearances above specified. The amount of clearance, the amount of bodily motion of the top detaching rollers, the time of the index wheel for this motion to begin and terminate are all of the utmost importance, and require the finest adjustment to get the very best results. In addition to this, it must be remembered that the amount and timing of the backward and forward rotary motions of the detaching rollers have to be made to act in unison with the backward and forward motions through space. It was principally in the complicated action of the parts under discussion that Heilmann made the comber to imitate the action of the human fingers. It is good for the maintenance of the comber in public favour that the index wheel has been applied so as to give great assistance in getting the various parts to work harmoniously together; otherwise a great deal more trouble and expense would be involved in keeping them in good working order, and giving a good quality of combed sliver, with a minimum of waste.

The motion as made by Messrs. Hetherington for imparting the bodily motion to the top detaching rollers is shown in Fig. 43.

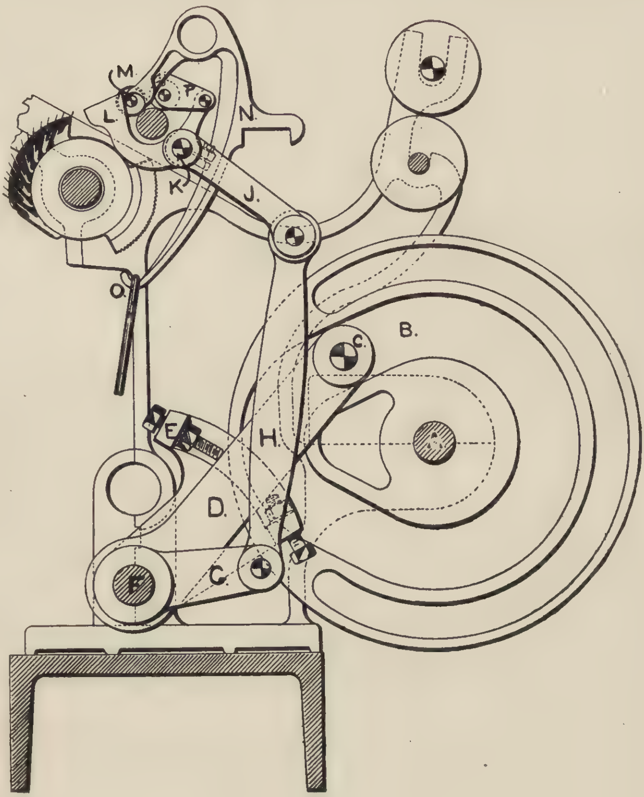


FIG. 43.

Index of Parts.

A Cam Shaft.
B Groove of Lifter Cam.
C Bowl or Runner for Arm, D.
D Lifter Cam Lever or Arm.
E Horse Shoe or Setting Bracket for F.
F Lifter Shaft.
G Lifter Shaft Lever.
H Lifter connecting Rod or Link.
J Lifter Lever.
K Stud in Lever, J.
L Small Lifter Lever.
M Leather-covered Detaching Roller.
N Detaching Roller Weight Hook or Lever.
O Lower Finger or Hook for detaching Roller Weight.

Hetherington's Lifter Motion.

There are various arrangements of levers and different forms of cam for imparting the small bodily movement through space to the short top detaching and delivery rollers. In Figs. 43 and 44 we are able to fully illustrate these arrangements as provided by two of our most noted comber makers. Fig. 43 shows Hetherington's arrangement, while Fig. 44 shows the motion as made by Platt Bros., of Oldham.

Action of Parts (Fig. 43).

The parts are shown in Fig. 43 neither in detaching nor in combing position, but just in the transition state from one of these stages to the other, with the making-up piece at the top.

As the cam, B, continues to revolve it will bring its small full part against the bowl, C, and move C slightly upwards. This will be accompanied by a similar upward motion of arm, C, link, H, and lifter lever, J. This will cause a slight turning of stud or rod, K, so as to bring the two short lifter brackets, L, P, downwards until the leather-covered detaching roller, M, rests upon the fluted segment of the cylinder.

M will only be allowed to rest on the fluted segment for a moment, and then will be lifted off by the further continued rotation of the cam, B. The concentric or thinner portion of the cam, B, is sufficiently extensive to hold the short detaching rollers up until the next operation has been fully carried out. To do this, of course, the levers, D, G, H, J, are pressed down by the cam.

Shapes of Cams.

It will readily be understood that many shapes of cams have been experimented with for lifting and lowering the detaching rollers to the best possible advantage. The most striking development in this connection during recent years has been the doing away with the long lifter shaft, on the part of one or two makers, and coupling the cams directly up to the thin top fulcrum shaft of the lifters.

This has been accompanied by the introduction of a very different shape of cam in Dobson's machine. The most recent

Fig. 43 (*b*).

Fig. 43 (*a*).

form of lifter cam as made by Messrs. Dobson & Barlow was shown in the previous chapter.

Fig. 43 (*a*), as given herewith, shows an ordinary nipper cam in comparison with Fig. 43 (*b*), which is a cam as ordinarily used for quadrant or notch wheel.

A most important thing to notice about the lifter cams in Fig. 43 is that the thickest or fullest part is the one which places the leather roller on the fluted segment, whereas in the later cams of Dobson's with the direct coupling-up of the horns or levers it is the thin part of the cam which does this work.

In each case, however, there is a concentric portion of considerable extent which holds the leather roller up during combing.

Platt's Lifter Motion.

The shape of the cam and the direct coupling of the lifter horns in Messrs. Platt Bros. most recent combers will be noticed in Fig. 44, which shows the parts with detaching just commenced.

It will be noticed that the outline of the cam A′ is much similar to the latest of Dobson's as shown in Figs. 40 and 41 at L. In each case it is the thin portion of the cam which places the leather roller upon the fluted segment of the cylinder.

In Fig. 44 the cam is rounded off, whereas in Dobson's latest the cam is shaped out in order to give a slightly more extended concentric portion, with the idea of keeping the leather roller longer on the fluted segment. The latter is probably a desirable object to be aimed at, while, on the other hand, the rounder cam tends to smoother working of the cam bowl. The lower end of the lifter lever, of course, follows the course of the cam bowl, and the lever itself is fulcrumed on the shaft, H, with two short arms extending from this point.

Curling.

As previously stated, it is the opinion of the writer that the difficulties of a comber centre more about the attaching and detaching mechanism than any other part. Very slight defects in this mechanism affect the piecing up and appearance of the sliver very appreciably. Curling is a very common evil; this meaning that the sliver presents a wavy or curly appearance

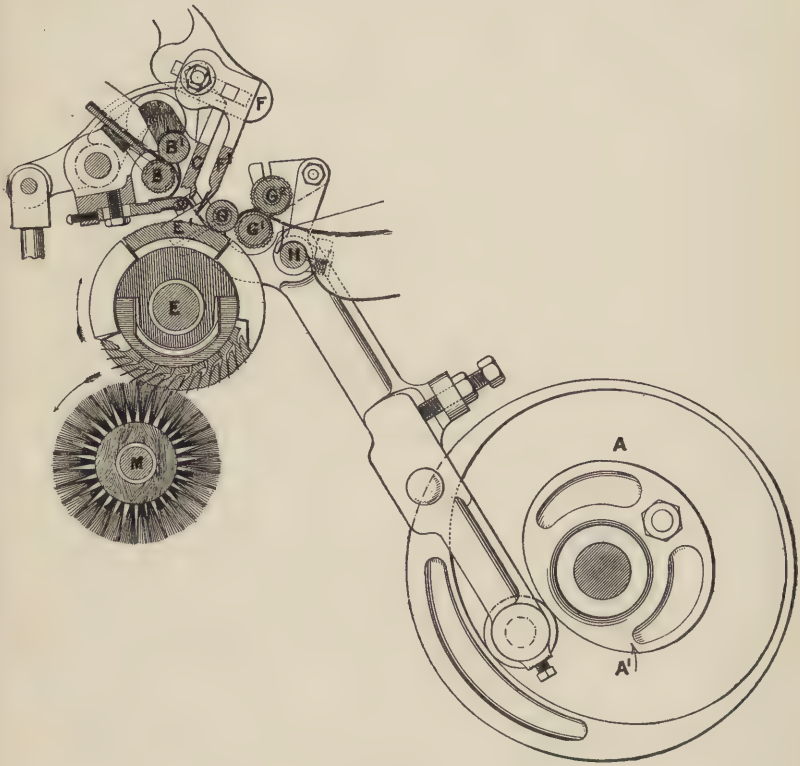


FIG. 44.

Index of Parts.

A′ Lifter Cam.
A Groove for Lifter Cam.
B Bottom Feed Roller.
B_1 Top Feed Roller.
C Top Nipper.
D Cushion Plate.
E Cylinder Shaft.
E′ Fluted Segment of Cylinder.
F Arm for Top Comb.
F′ Top Comb.
G Leather-covered Detaching Roller.
G_1 Long Steel Detaching Roller.
G_2 Short Top Fluted Detaching Roller.
H Fulcrum Shaft for Lifters.
M Brush for cleaning Cylinder Needles.

as it issues from the detaching rollers. When this evil has been present in nearly all the heads to a limited extent only, the writer has known an improvement to result from degging the floor with water all about the combers, or by leaving buckets of water all night under the worst combers. In a few cases the same principle has been experimented on by the application of permanent humidifiers on a small scale. The worst of these various methods of humidifying for combers appears to be their tendency to rust the needles and the bright parts of the machine, and the great majority of practical men consider these evils worse than those sought to be cured.

Setting.

Numberless cases of curling have been remedied by setting the top steel roller more perfectly parallel to the leather-covered roller, and more perfectly working flute and flute with the long steel detaching roller. There is a difference of opinion as to the best size of flutes for these detaching rollers, some flutes being twice the pitch of those on other machines. It appears to be easier to get the top roller flute and flute with the bottom one when the flutes are coarse, while it is probable that the finer flutes give a finer and smoother sliver. In some cases the top steel rollers have been known to bind in their end bearings, in this manner giving a curled sliver. On the other hand there has been manifested at times a tendency for these top steel rollers to jump up and shake about in working, and on the duplex comber this evil has been considered sufficiently great to warrant the application of weights and springs to hold them down. The *conducting tins* in front of the detaching rollers sometimes have the mouthpiece or sliver hole at the end, and sometimes in the middle, and this may have an effect on the appearance of the sliver. When the outlet holes are at one end of the tins there is a tendency to tear the sliver at the other selvedge, and with the trumpet holes in the middle of the tins some people consider there is too much ballooning of the sliver during delivery. The diameter of the top steel roller has been varied from $\frac{3}{4}$ in. to 1 in., and sometimes it is made with a covering of brass.

It is the practice to set the top steel roller equidistant from the leather roller, with about an 18's gauge. In making this setting every care should be taken to have the lifters of the leather roller in proper position. The two top detaching rollers may be (1) in their highest or nearest position to the front table; (2) in their lowest position, with the leather roller resting on the fluted segment; (3) in a position between these two extremes. It is the writer's experience that in each of these three positions the two top detaching rollers may be a different distance apart from each other. There may be, for instance, such distances as the following: 1st position as above, a 20's gauge, (2) an 18's, (3) a 19's. Suppose now that the rollers were set when in either the 2nd or the 3rd positions to a somewhat fine gauge, or to writing paper; in all probability they would rub when in the first or detaching position. Rubbing of these two top detaching rollers together is not to be allowed in any case, and is absolutely fatal to effective working. The proper thing is to set them when the leather roller is resting on the fluted segment of the cylinder, and to just check this setting by testing with a gauge when in the front position to see that a clearance is still maintained between them.

In this connection it is important to remember that any errors in the setting of the loose ends of the leather rollers may affect the parallelism of the rollers. Suppose, for instance, when the leather roller is resting on the fluted segment there is a clearance of one piece of writing paper at one end, and of two pieces of writing paper at the other end, the closest end will be lifted up more than the other end during detaching, and to that extent will destroy the parallelism of the leather roller with the other two. This bad effect cannot exist without affecting the appearance of the sliver more or less.

The lifters should always be carefully and accurately adjusted before the top steel roller is made parallel to the leather roller. Greasy and extremely cold detaching rollers and conducting tins will affect the proper delivery of the sliver, and it

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has been previously explained how bad covering of the leather roller or want of varnishing and oiling, etc., were detrimental. Every care should be taken to secure free and easy working of both of the top detaching rollers in their bearings. There are no other leather-covered rollers used in cotton spinning that are, at the same time, so wide and so weak as the leather detaching rollers of a Heilmann comber taking a wide lap. At the same time middle weighting is impracticable for these rollers, so that no other rollers demand the same amount of trouble and care bestowed on them. After these rollers have been varnished or covered, the resulting sliver and waste should be noted to see if satisfactory.

Various Points.

Referring to the single nip comber fitted with quadrant motion, it may be said that it is a good practice to close the catch box at $20\frac{1}{2}$ to $20\frac{3}{4}$ of the index wheel. The leading motion may be timed to six of the index, and the actual detaching may begin at $6\frac{3}{4}$. Variations in these times affect the relative amount of tightening and of ballooning of the slivers in the front tins.

It is absolutely essential to the proper working of the comber that the detaching rollers should be timed to be working at the same moment as the feed rollers and the top comb and fluted segment of the cylinder. Indeed, most of the times cluster around the fluted segment, which has to be coming nicely under the feed rollers at about four of the index end, to have its leading edge a trifle over an inch from the bottom detaching roller, at five of the index. Because of this the top comb has to be down an instant later, and immediately after the top comb gets down, detaching must commence.

Referring to the *catch box* of the long steel roller, care should be exercised never to allow the teeth of either half of the box to absolutely touch the bottom of the spaces in the other half, otherwise there will be a rattling of the box as many times per minute as there are nips. Certainly the rattling may stop of itself before the comber has been working very long, owing to the points of the teeth getting worn and broken off. Blunt teeth, however, are not conducive to free and easy engagement of box, and tend to allow the box to jump out of gear, rendering necessary a very tight roller box spring with consequently more force required to operate the box and more wear of the catch box cam. To prevent rattling of the roller box and wear of the teeth it is good practice to put substantial leather washers inside the box, sufficiently thick to maintain a clearance of $\frac{1}{32}$ to $\frac{1}{16}$ between the bottom of the teeth. This practice causes sweeter and more noiseless working of the motion, and saves the teeth by shock of engagement being cushioned and sustained by the leather washers instead of the teeth. The thickness of leather may reach upward of $\frac{3}{8}$, and may be all in one piece or composed of two or three thicknesses. If after long working the teeth of the roller box become blunt even with the leather washers inside, then it may be desirable to take the long steel roller and the roller box out and slightly reduce the thickness of the leather washers in order to get a little deeper engagement of the teeth so as to compensate for the wear.

If anything like a satisfactory delivery of the combed sliver is to be obtained, the greatest care should be exercised to prevent any parts of the *lifter* mechanism from catching other parts of the machine. Substantial weights have to be hung on the leather detaching rollers, and it goes without saying that if the chains, hooks, or other parts connected to these weights are so disturbed as to relieve the rollers of some of the weight at the critical moment of attaching and detaching, the results will be unsatisfactory. Practically the same effect will result if any of the horns, levers, or brackets of the lifters rub against other parts during their oscillation. The loose bushes at the end of the leather detaching rollers are somewhat long, and the utmost care should be taken to have them a good fit and well oiled and cleaned.

Bowls.

In times past a most serious defect of many combers has been the liability of the lifter cams to *wear at the corners*, and also for the bowls fitting into these cams to wear, and also the studs to wear on which the bowls are supposed to work freely. It is to be feared that the machinists, on the one hand, have not bestowed sufficient attention and skill on the construction of these parts; and the mill people, on the other hand, have not bestowed sufficient care and attention on their proper oiling, cleaning and setting; the net result being quite disastrous to the efficient action of the detaching rollers. Recently, however, there have been very considerable improvements in these respects, and the latest combers show great perfection of detail with regard to the construction and setting of the cams, bowls, studs and levers. In some cases, at least, it has become the practice to have the bowls and studs thoroughly hardened after being turned, and much better provision has been made for oiling these parts.

Great care is taken to have the bowls very accurately fitting the cams both in diameter and width. The wearing of flat places on these bowls and studs may be likened in effect to similar wear on the bowls and studs connected with the sector, locking lever and copping rail of a mule.

Referring again to the *piecing roller*, it may be said that several variations in the construction of this roller have been tried. In some cases of steel rollers the flutes as made to-day are little more than half the distance apart as compared to those made by the same makers a very few years ago.

In some cases these rollers have been tried covered with leather, and in other cases they have had a top coating of brass. As before said, sometimes these piecing rollers are held down by springs, and in other cases they depend for their contact with the botton roller entirely upon their own weight. Within limits the diameters of these rollers have also been varied, but the space available for their working prevents much variation in this respect.

Defective Quadrants.

A word must now be said regarding the quadrant itself which imparts the rotary motion of the detaching rollers. In the earlier makes of comber with this quadrant motion, trouble has often resulted from the quadrant not being in gear with the quadrant wheel equally at all parts of the upward and downward motions. At one part a quadrant might be just engaged the proper depth of tooth, while at other portions of the same traverse it might be too deep or too shallow in gear. If alterations were made to put the gear right at one place, it would go wrong at other positions—the result breaking of the teeth of the quadrant and quadrant wheel, with occasional missing of teeth. The most recent constructions show great improvements in this respect, since the quadrants and quadrant wheels are most carefully machine cut, whereas formerly they were cast. This newer practice is a little more expensive in first cost, but will doubtless more than pay for itself in process of time.

A still more important and more recent improvement in connection with the quadrant is to operate it by means of a double cam, which supports and operates it from both sides at once, whereas the former practice was to have a single cam acting on one side of the quadrant only. With the two cams there is perhaps the slight disadvantage of being a little more awkward to adjust at the first.

Small Detaching Rollers.

It is not practicable to reduce the diameter of the leather-covered detaching roller very much, although the space it fits in on a Heilmann comber is so very limited that a very small diameter of this roller would have important advantages.

In order to produce satisfactory detaching, however, it is necessary to weight these rollers somewhat heavily at each end, which necessarily tends to spring the leather-covered rollers somewhat in the middle, thus giving imperfect grasping or pinching of the fibres at this point. This effect is of course worst in combers with very wide heads, and is one principal reason why the author is not in favour of such extreme widths with present constructions. At the same time it is quite certain that some good firms who keep all parts of the machine in the best working order and under the closest supervision, have got good results from $10\frac{1}{2}$ in. laps for many years.

With a view to an improvement in this direction the Société Alsacienne have begun to make the detaching rollers with big helicoidal grooves, and of very small diameter, using the best materials possible. This grasping of the fibres by such rollers takes place successively from one end to the other, so that the flute does not grasp the beard of cotton all at once on the whole length of the working space. In this way they are enabled to reduce the amount of weight on the rollers, and consequently their diameters.

At this point a slight digression from the special subject of detaching mechanism may be permitted.

Combing Machines at the Paris Exhibition.

A year or two ago one of our eminent English firms of machinists, *viz.*, Messrs. Dobson & Barlow, carried on experiments with a new combing machine of foreign invention. This new comber was designed to be fed with slivers instead of specially formed laps, and was supposed to give a largely increased production. For one reason or another Messrs. Dobson finally rejected this comber in favour of an improved model of their well-known single nip Heilmann comber. Since then certain practical men, who were formerly students of the author's, have informed him that the new foreign comber had been successfully introduced into several of the Massachusetts mills, and if only the price of it could be reduced, it would probably receive extensive adoption. The writer, therefore, was not surprised to find at Paris that the Société Alsacienne were exhibiting no less than three or four of these patent combers, thus demonstrating that this firm is making a determined effort to displace the Heilmann from the proud position which it has held for the fifty years of its existence. Since the comber is one of the few cotton spinning machines that was invented abroad and by a foreigner, it is fitting that the Continent should take a leading part in inventing improved forms.

Messrs. Platt Bros. exhibited a splendid example of the Heilmann comber, which the writer had had the pleasure of examining some months previously when on a visit with his day students to the extensive workshops of Messrs. Platt Bros.

This machine is made with eight boxes or heads for laps $10\frac{1}{2}$ in. or 11 in. wide.

The specialities to be noticed in its construction are as follows: The gearing headstock is built upon a solid cast-iron base plate, and has two frame ends supporting a planed table,

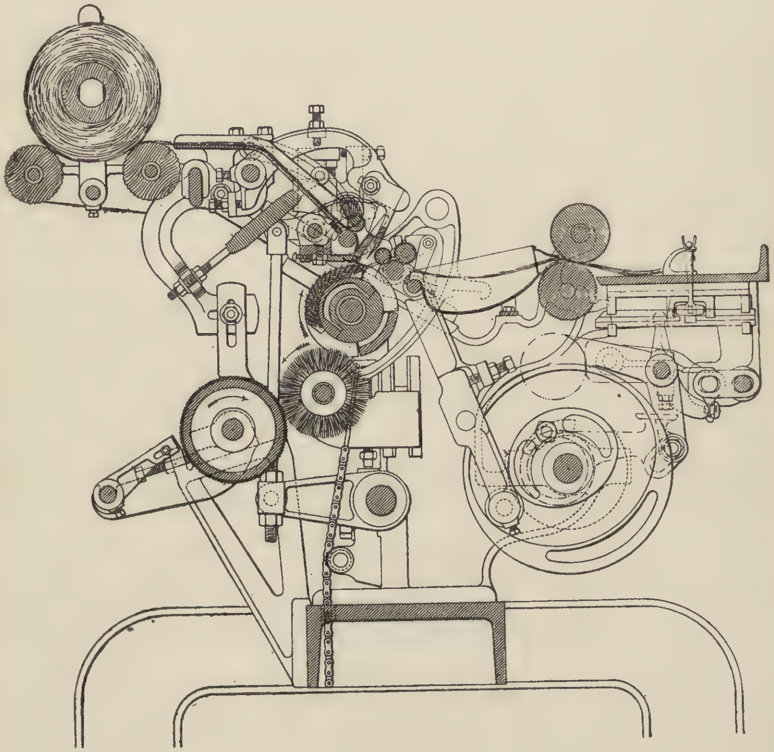


FIG. 44 (*a*).

thus giving great solidity and steadiness to the principal working parts. When it is remembered that the comber is an intermittent machine, going through all its changes upwards of ninety times per minute, the importance of this more solid foundation will be manifest. At the same time, the base of the machine has been widened, thus further contributing to greater steadiness and smoothness of action of the working parts, especially when running at very high speeds. All parts of the machine are shaped, planed and bored by improved machinery, so as to make them interchangeable.

The cam shaft contains improved cut nipper cams applied at both ends of a cam shaft which is carried through the machine, thus preventing torsion, and therefore securing a better nip. All cams for giving reciprocating motion are cut by improved machinery, thus giving a smooth motion in spite of much higher speeds than formerly obtained, coupled with the consequently increased productions.

The wrought-iron notch wheel is made broad on the face and case-hardened to prevent wear, and must give better results than the cast-iron notch wheels formerly employed.

The bottom feed rollers and detaching rollers are made of cast steel. The brass top detaching rollers used by this firm have wrought-iron case-hardened pivots, working in brass levers, with wrought-iron links and studs case-hardened.

The intermediate shaft (and all its levers, connecting rods and joint pins for lowering and lifting the top detaching rollers) is replaced by cams acting directly from the cam shaft, thus obviating all backlash.

The comb shells, comb strips and fluted segments are all interchangeable, any shell, fluted segment or comb strip fitting any barrel. Moss's patent adjustable guides, fixed to comb barrel, are applied for condensing or narrowing the edges of the sliver, both before and after the combing, thus making firmer and more solid selvedges.

The circular comb brushes are fitted with Freemantle's patent oscillating motion, for the better cleaning of the circular comb.

There is applied a tumbler stop motion in the sliver plate, opposite each box, to stop the machine when any of the slivers break.

The coiler cans are of the usual dimensions of 36 in. by 9 in. inside measurements. There is a stop motion in coiler cover to stop machine when a can is full. The draw box can be fitted with either three or four pairs of drawing rollers, the top rollers having loose bosses.

The machine at the Exhibition contained as top clearers in the draw box iron flats with stationary cloths, but the firm sometimes apply either revolving clearers, with endless clearer cloth, driven from the front roller, or iron flats with Ermen's self-stripping clearers. There is an indicator to the draw box showing number of hanks and decimal parts of hanks.

It may be added that the production of such a comber as the above may reach from 8 to 13 lb. per hour of combed cotton, according to circumstances. It may have a speed of up to 360 revolutions per minute of the frame shaft, giving up to 95 nips per minute, according to class of cotton and the quality of combing required. The indicated horse-power required to drive may be from $\frac{1}{2}$ to $\frac{3}{4}$.

It is a somewhat curious fact that while our English machinists confine themselves to the manufacture and sale of the Heilmann cotton comber, such foreign machinists as make a cotton comber at all appear to devote an immense amount of time to bringing out other types of comber. A probable explanation is that this is being done in the hope of bringing out some machine which will out-rival the machines so long and successfully made by certain eminent English machinists. In America it would appear that very few cotton combers indeed have been made by any of the American machinists, either of one description or another. It is well known that cotton combers are only used in mills producing high or fine qualities of yarn, and in such cases quantity of production is often quite secondary to quality. This affords a possible explanation why new combers meet with little favour, as their aim has generally been increased quantity, and not increased quality of work done. In this respect the comber can be compared to the mule. No one can deny that the modern fine self-actor mule is immeasurably ahead in production and in good shaping of cops of the hand-mule, and yet it is a matter of fact that a fair number of hand-mules are still working in England, because the quality of the yarn itself is kept up by them.

The *brass ends* for the leather-covered rollers are in some cases made much longer than in others, and it is a matter of opinion as to whether the long or short brasses are the better.

Fineness of Flutes.—There is quite a difference of opinion amongst practical men as to whether the flutes of the detaching rollers should be comparatively fine or coarsely cut. Both methods are in use and have been for many years. In favour of the coarse flutes it is contended that they are much easier to be set parallel and flute and flute with each other than the finer flutes, while the latter are also liable to have the flutes nearly worn off after working for some time.

To the author's positive knowledge cases exist where finely fluted detaching rollers have been taken out and replaced by the more coarsely cut rollers.

On the other hand, some practical men contend that the finer flutes give a more glossy sliver and more perfect piecing, and are less liable to produce torn and cut edges on the slivers, the latter being a somewhat common evil.

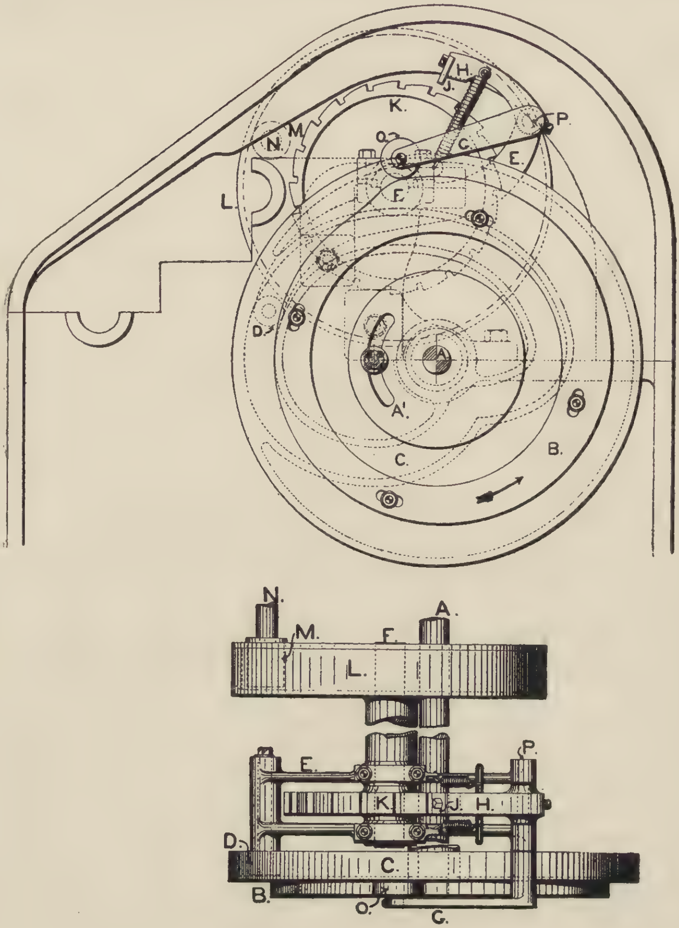
Brass-covered Rollers.—In many cases it is considered much better to cover the top fluted detaching roller with brass to improve its working and duration.

Leather-covered rollers have also been tried for this position but have received very little favour.

Although this piecing roller is called a detaching roller along with the others it really has nothing whatever to do with actual detaching, but simply helps to deliver the cotton forward, and more especially to return the combed end of the cotton back again for piecing purposes.

Hetherington's Notch Wheel Arrangement.

In the last chapter we fully described the quadrant method of driving the detaching rollers, and here we may appropriately describe the notch wheel arrangement as made by Messrs. Hetherington. It is shown in Figs. 45, 45 (*a*), 46 and 46 (*a*), and others are quite the same in principle.



Figs. 45 and 45 (*a*).

Reference Letters to Figs. 45 *to* 46 (*a*).

A Cam Shaft.

A′ Slotted Circular Plate, or Cam Disc secured to Shaft, A.

B Frog Motion Cam, or Ring for lifting Frog or Catch, H.

C Large Face Cam for operating Lever, E.

D Bowl or Runner working in C and carried by Lever, E.

E Lever or Cradle centred at F, having a Bowl at one end working in Groove of Cam, C, and its other extremity carrying Frog Motion, G, H, at P.

F Shaft sustaining Notch Wheel, K, and Internal Wheel, L, and also acting as centre for Lever or Cradle, E.

G Lower Arm of Frog Lever, carrying Bowl, O, and fulcrumed and carried at P.

H Frog or Catch held down by Springs shown.

J Steel changeable Finger or Tooth fitted to H.

K Notch Wheel.

L Internal Wheel.

M Small Wheel driven by Internal Wheel and fitted on long Steel Detaching Roller.

N Long Steel Detaching Roller.

O Bowl or Runner of Frog Motion Lever, E.

P End of Cam Lever, E, carrying the Frog Motion or Cradle, G, H.

Action of Notch Wheel Arrangement.

As before stated, the duty of this motion is to suitably rotate the long steel detaching roller, which latter gives rotary motion to the two top short detaching rollers by frictional contact.

The notch wheel arrangement does exactly the same work as the quadrant and clutch box of Dobson's comber. The notch wheel system is far the older of the two and is still the more generally applied method, there being a difference of opinion as to the relative merits of the two systems. The author is convinced that either method will give good results if kept in good condition and correctly set. Fig. 45 shows the frog or catch, H, J, held out of gear with the notch wheel, K, by means of the bowl, O, resting on the full part of the edge cam or ring, B. Fig. 45 (*a*) is a plan. Fig. 46 shows the frog or catch in gear, and the bowl, D, on the thin part of the cam, C. Fig. 46 (*a*) shows the bowl, D, on the full part of the cam, C.

As in the quadrant system, there are two cams connected with the notch wheel system.

The first or face cam is marked C in Figs. 45 to 46 (*a*), and is the one which really imparts rotary motion to the detaching rollers; being therefore equal to the quadrant cam, and of practically the same shape.

The second or ring cam is marked B in Figs. 45 to 46 (*a*), and its sole duty is to release or engage the pawl or catch, H, J, at the proper moments.

The manner in which the rotary motion of these cams is made

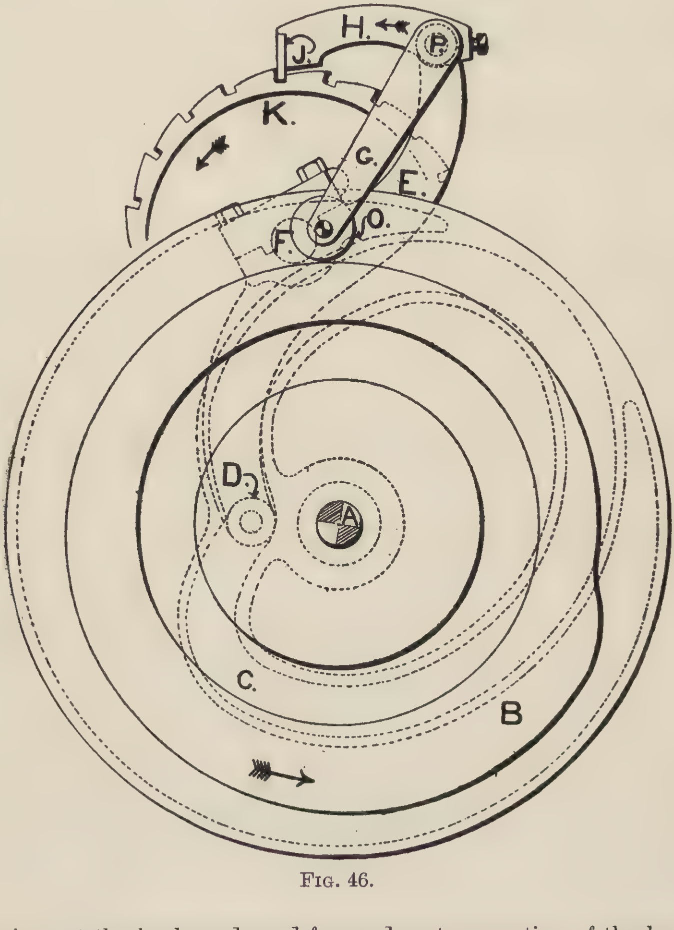


Fig. 46.

to impart the backwards and forwards rotary motion of the long detaching roller may now be traced.

As the face cam, C, rotates, it oscillates the lower arm of the lever or cradle, E, which rocks about on the shaft, F, as a fulcrum or centre. The opposite or outer end of lever, E, carries the stud, P, about, and this centre, P, sustains the frog-motion or cradle, G, H.

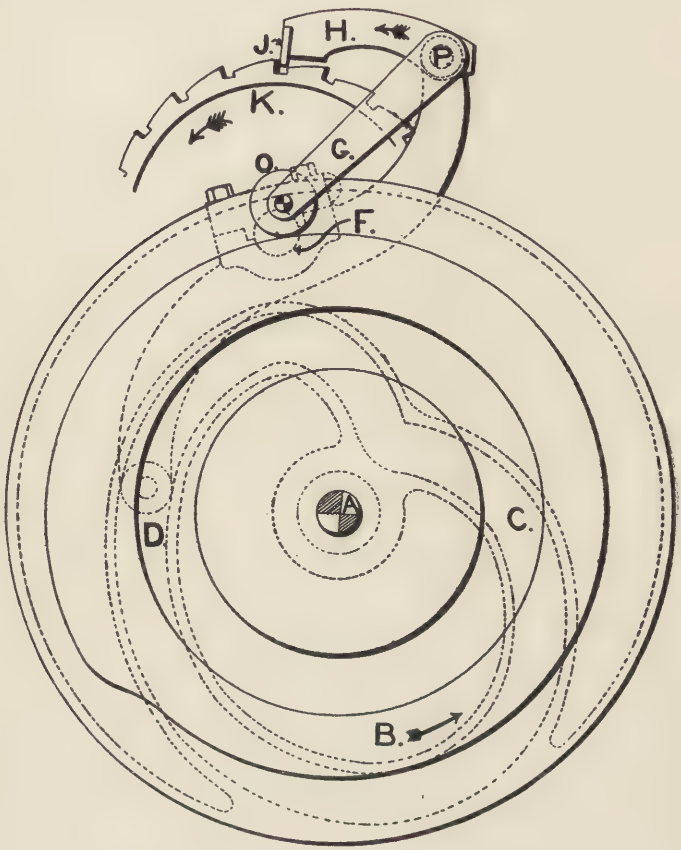


FIG. 46 (*a*).

It will be noticed that the notches in the notch wheel, K, are so shaped that the steel finger or tooth, J, can move the notch wheel either one way or the other. If the catch, H, J, were always engaged with the notch wheel, K, then the latter would be constantly oscillated an equal distance backwards and forwards.

But here comes in the use of the ring cam, B. This is so shaped that at a certain larger portion of its circumference, as shown in the sketches, it holds the frog or catch, H, J, out of gear with the notch wheel, so that the latter is at that moment stopped.

During all the time of the forward or delivery motion of the detaching rollers the frog or catch, H, J, is allowed to keep in gear with the notch wheel, but during about half of its return motion the frog, H, J, is kept out of gear with the notch wheel by the full part of the cam ring, B. In this way the amount of forward or delivery motion of the detaching rollers is practically double that of their return motion, since the motion of the notch wheel, K, is conveyed to the detaching roller in a manner to be now described.

On the same shaft as the notch wheel, K, is the internal wheel, L, which therefore partakes of the same movement as K.

Gearing with the internal wheel is the small wheel or pinion, M, which is fastened to the long steel detaching roller, N. In this way is the roller, N, moved first backwards and then about twice as much forwards. Summarised, the cam, C, oscillates the catch, H, J. The cam, B, moves the catch in and out of gear. The catch drives the notch wheel, and therefore the internal wheel. The latter drives the detaching roller wheel. A little further on Hetherington's notch wheel arrangement for the duplex comber is sketched and described.

Change Wheel.

The large notch wheel on the same shaft as the internal wheel may be considered in a sense as a change wheel, although it is perhaps not often altered when once a frame has got going on a certain length of staple.

On different combers the notch wheels are found to contain a different number of notches.

The notch wheel may be considered to be a driven wheel, and therefore a less number of notches would mean that the detaching rollers would make one complete forward motion in less time than with a larger wheel. This might be thought to suit longer staple cottons on which at the same time a larger feed roller wheel might be used.

The net result would be a greater length of feed and a greater length of delivery, thus reducing the number of times the long fibres would be acted upon by the cylinder needles.

In this way a $1\frac{3}{4}$ in. Sea Islands fibre could only be acted upon by the needles four or five times over, or an equal number to an Egyptian fibre of $1\frac{1}{4}$ in.

The author is not here contending for either one plan or the other, as this would depend upon individual circumstances.

It must be distinctly understood that alterations in the time of acting of the detaching rollers do not alter the length delivered.

It must also be remembered that alterations in the size of notch wheel—or in the size of small quadrant wheel, where the latter was used—would compel also a corresponding alteration in the speed of the calender rollers and the rate of taking up by the draw box rollers.

If slivers drag or stick and slacken on the front table the latter may require polishing up, while if they break excessively it may possibly be due to the back roller of the draw box going too quickly.

Time of Motion.

Although, as the writer has pointed out in the setting chapter, it is dangerous to delay the forward movement until the commencement of detaching, yet it should be stated that for Sea Islands cotton some people prefer to start these both at $6\frac{1}{2}$ for the single nip comber, alleging that it tends to give better selvedges. This scarcely agrees with our own ideas.

Amount of Motion.

A slowly running comber may feed about 17 in. of lap per minute to each head, a medium speed 20 in., while a duplex may feed 30 in. or more.

One rough method of determining the relative amount of forward and backward rotary motion of the three detaching rollers is to count how many teeth the quadrant moves in its downward motion with the clutch box in, and to compare this with the number of teeth of quadrant moved upwards with the clutch box shut.

A very much better method is to take a piece of writing paper and place it between the top and bottom detaching rollers, and at the end of say the forward or delivery motion mark with pencil the paper quite up to the nip of the rollers. Then turn the comber by the fly wheel until the exact termination of the backward or tightening motion of the rollers, and mark again. Then go on and complete the forward motion, and again mark. The distance between the first and second markings would be the amount of backward motion, and the distance between the first and third marks would be the amount of forward motion.

For instance, in one case of actual testing by the author of a single nip comber in this manner, the backward motion was found to be $1\frac{1}{2}$ in., while the forward motion was $2\frac{3}{4}$ in. In the case of a duplex comber these distances were found to be respectively $1\frac{3}{8}$ in. and $2\frac{3}{8}$ in. The gain in the one case was therefore $1\frac{1}{4}$ in., and in the other 1 in.

Uniformity.

To get the detaching rollers, nipper, combs and other parts to act more uniformly on the cotton, it is the practice in some cases to have full and half laps working alternately behind the comber, although there are some firms who do not trouble to do this. It is to be feared that the comber—which is essentially a quality-giving machine—does not tend to equality in the counts of sliver. There are some managers who strenuously maintain that they must have their combers giving a sliver which shall only vary two grains, *i.e.*, one grain up and one grain down from a given weight for about four yards. They say that the comber ought to do better than the drawframe in the matter of uniformity as in other respects. This the writer cannot agree with at all. There is no denying that the comber makes the fibres of cotton parallel to a very perfect degree, and yet we find that in actual practice we cannot dispense with the use of drawing frames where we have combers, nor would the writer recommend the discontinuance of even one head out of the usual number, because we need them to get uniformity of the sliver before it finally passes on to the slubbing frame. From reasoning alone we should be inclined to think that a comber would tend to give a more or less uneven sliver. In a single nip comber making 80 nips per minute the feed portion of the cotton is absolutely broken off from the delivery portion and then repieced that number of times. In a double nip comber making 120 nips per minute the breakages and piecings are made 120 times per minute. Can frequent breakages and repiecings be made at any machine used in cotton spinning without tending to produce inequalities? Most readers will say no. We think it may be taken for granted, therefore, that the constant detaching and attaching of the fibres produces non-uniformity in the slivers delivered from the comber. Again, the action of the combs appears calculated to tend to the same effect. These finely disposed parts which add to the quality by taking out short fibre, tend to non-uniformity by taking out more fibre at some nips than others, due to variations in quantity of short fibre present in any given length of cotton, and also due to the manner in which the cotton is held by the nippers. There is yet a third point conducive to variations in the comber sliver; often there are slight laps formed on the feed rollers and detaching rollers, and partial breakages of sliver occur in the front conducting tin and on the front table and in the draw box. It goes without saying that these breakages cannot occur without conducing to inequalities in the weight of any given length of sliver. As before stated, this would appear to be a fair inference to make from the presence of the above irregularities in the working of the machines. But actual investigation and wrapping of the combed sliver appear to fully bear out these conclusions. The writer is acquainted with many actual tests which nearly always lead to the conclusion that it is a very difficult matter to produce a uniform sliver from the comber. In some cases the management have themselves carefully watched the passage of cotton through the various machines concerned in preparing the laps to place behind the comber, and have then watched the sliver made at the comber, and have finally superintended the actual wrapping of the sliver, but nearly always the sliver has varied to a fairly large extent. In actual practice, however, want of attention on the operative's part has also to be contended with. There is such a thing as a front stop motion applied on the front table of some combers, acting on the principle of the drawframe stop motion so as to stop the machine on the failure of any one of the six or eight slivers to reach the front table properly. This motion should tend to prevent single, but many comber men deem such a stop motion more trouble than it is worth. Such is the truth of the foregoing statements, that wrapping of the slivers individually as they issue from the detaching rollers upon the front table must infallibly show wide variations in counts. It must not be forgotten, however, that all combers on the Heilmann principle are made to act also as drawframes, and the slivers from the six or eight heads are passed along the front table and through the rollers of the draw box and into the sliver can together. In the draw box these slivers are attenuated nearly to the dimensions of one, and an average of them is thus obtained which greatly obviates the inequalities just discussed. In wrapping comber slivers it is often the case that a few wrappings will come out without showing a very wide variation, and then there will come up wrappings that are utterly disconcerting in their amount of variation from the standard weight. The doubling at the draw box is a fine thing.

Parallelism of Parts.

While on the subject of the detaching rollers reference ought to be made to the important part played by the bottom long steel detaching roller in the setting of the parts which actively operate on the cotton. In erecting a new comber, after getting the roller beam and stands up, it is early necessary to put in this roller, because the settings more or less are ruled by it. For instance, the cylinder segment must be set to clear the long detaching rollers by about a 21's gauge. Then the bottom feed roller must be set with probably a $1\frac{13}{16}$ in. gauge from the same detaching roller—at any rate for the good grade of Egyptian cotton which is usually combed. Then again, the front edge of each cylinder segment has to be set with say $1\frac{1}{4}$ in. gauge from the long steel roller with the index wheel at the proper time.

The writer has heard different people assert that sometimes the bottom long steel detaching roller has been made slightly convex in the centre, but such rollers as he has himself measured have not shown any such convexity.

With regard to the short top steel roller—or piecing roller, as it is sometimes termed—every care must be taken to keep this as perfectly parallel as possible to the leather detaching roller, and to the bottom steel roller. Sometimes in actual working this parallelism gets destroyed, and the delivery of the cotton is interfered with. Such want of parallelism is often demonstrated by the roller making a rattling noise which differs from the noise made by the other working parts sufficiently for a practised ear to detect it. This short roller has to rest on the long bottom roller, and every care should be taken to ensure these two rollers working flute and flute with each other. As before stated, the top roller receives its reciprocal rotating motion entirely from the bottom roller, and in many combers there is practically only the very light weight of the top roller itself to maintain the connection. In some combers, however —and especially duplex combers—there is a small spiral spring which prevents the short steel piecing roller from jumping. Great care should also be taken to prevent the leather detaching roller and the top steel detaching roller from rubbing against each other. At the first glance we might think the two rollers were in contact, but such is by no means the case, and actual contact between them is sure to interfere greatly with the effective delivery of the combed sliver. They should be set a distance apart equal to about a 19's gauge, which is probably equal to a little more than $\frac{1}{64}$ in., and perfect parallelism should be ensured by the use of the same gauge. In some cases the top steel roller is covered with brass to give a better grip of the fibres. These rollers ought not, however, to perform any draft or attenuation action on the cotton, but simply to pass the fibres forward to the sliver tin, and return a sufficient portion each nip as may be required to meet the last combed portion of cotton. There is also a considerable difference of opinion as regards the fineness of the flutes in the detaching rollers, and also as regards the depth of the flutes. The construction and position of the top steel detaching rollers is such that they often get disturbed slightly in their position, so that it is advisable to bestow watchful attention upon them.

THE DUPLEX COMBER.

In the textile arts there are numerous machines which are fascinating for the extreme ingenuity of their mechanism, but it is probable that none are more so than the combing machine. In the comber the fibre is treated in a more delicate and intricate manner than perhaps in any other machine. Since its invention by Heilmann some fifty years ago, numerous attempts have been made to effect radical improvements in its construction and action, and more especially so on the Continent of Europe. In England, at any rate, these improved machines have met with very little favour. Constant experiments have been made with a view to the adoption of a machine to come somewhere between the modern card and the Heilmann comber, such a machine to take out short fibre more effectively than the card, but to be much more productive than the ordinary Heilmann comber. Quite a number of machines have been experimented with in which the comber has been fed directly with card slivers, and the weight of the cotton fed operated upon and delivered has been much heavier than on the Heilmann comber. This comber had its origin abroad, and from France and Germany most of the improved machines appear to have sprung.

At the present time the only improvement of magnitude on Heilmann's single nip comber which has received favour in England is the duplex comber. Three leading English firms are principally concerned in making the comber, *viz.*, Messrs. Platt Bros., of Oldham; Messrs. Hetherington, of Manchester; and Messrs. Dobson & Barlow, of Bolton. The two last-named firms are prepared to make the duplex comber, and have constructed a fairly large number for use both at home and abroad.

In the single nip comber all the principal parts, such as the feed rollers, nippers, top combs, and detaching rollers, act once for one revolution of the cylinder. The duplex comber is essentially a Heilmann comber in which all the above parts are made to act twice for each revolution of the cylinder.

In the single nip comber the cylinder contains one set of needles and one fluted detaching segment with two making-up pieces between these parts. The needle segment is set on the cylinder just opposite to the fluted segment, and while the making-up pieces are on the top the principal parts of the comber are practically inoperative.

Dobson's Make of Bourcart's Duplex Comber.

Bourcart acted on the principle that too much time was lost by the making-up pieces; that is to say, they were on the top a longer time than was necessary for the changing of the various parts from one position to another. He therefore divided out the circumference of the cylinder into eight parts instead of four, as follows:—

(1) Two needle segments instead of one.
(2) ,, fluted ,, ,, ,,
(3) Four making-up pieces instead of two.

He managed to get these extra parts: (1) By having the four making-up pieces of the duplex comber only occupying about half the space taken up by the two making-up pieces of the single nip; (2) by reducing the rows of needles from 17 to 13 on each segment; (3) in some cases slightly increasing the diameter of the cylinder, but not always.

The eight parts of the duplex comber are acting, according to the index wheel, somewhat as follows:—

(*a*)	1st fluted segment	5 to $8\frac{3}{4}$
(*b*)	1st making-up piece	$8\frac{3}{4}$ to 10
(*c*)	1st needle segment	10 to $13\frac{3}{4}$
(*d*)	2nd making-up piece	$13\frac{3}{4}$ to 15
(*e*)	2nd fluted segment	15 to $18\frac{3}{4}$
(*f*)	3rd making-up piece	$18\frac{3}{4}$ to 20
(*g*)	2nd needle segment	20 to $3\frac{3}{4}$
(*h*)	4th making-up piece	$3\frac{3}{4}$ to 5

In the single nip comber one making-up piece would take up more of the index wheel than any two of the above making-up pieces.

The difference in general appearance between the single and double nip combers is practically nil, and the differences in constructive detail are so comparatively slight as to require pointing out to all but the initiated. (1) All the parts operated from the cam shaft, such as the quadrant, clutch box, notch wheel, nippers and bodily motion of the top detaching rollers are made to act twice for each revolution of the cylinder by the simple expedient of driving the cam shaft exactly twice as fast as for the single nip. (2) The cams secured on the cylinder shaft for lifting the top comb are made double instead of single. (3) There are two feed pegs instead of one for operating the star wheel and feed rollers. Practically all the cams have also had to be varied in the pattern somewhat from the single nip cams.

It must be clearly understood that on the duplex comber each of the principal parts performs all its movements for half a revolution of the cylinder, and therefore half a revolution of the index wheel. The differences in timing between the single and duplex combers will be evident from the following table:—

EGYPTIAN COTTON.

	Single Nip.	Duplex.
Clutch in gear	$\frac{3}{4}$ of the index wheel	$4\frac{3}{8}$ of the index wheel
Feed Peg acting	5 ,, ,,	$4\frac{1}{2}$,, ,,
Top Comb down	$5\frac{1}{2}$,, ,,	$4\frac{1}{2}$,, ,,
Detaching Roller to deliver	6 ,, ,,	$6\frac{3}{4}$,, ,,
Leather Roller down	$6\frac{1}{2}$,, ,,	$6\frac{7}{8}$,, ,,
Nip at	9 ,, ,,	9 ,, ,,

A perusal of the foregoing table will show that the difference of importance in the timing consists in the clutch box commencing action at $\frac{3}{4}$ for the single nip and $4\frac{3}{8}$ for the double nip. For the duplex, therefore, the clutch is engaged $3\frac{5}{8}$ of the index wheel later than for the single nip, whereas none of the other times differ more than one mark, or four teeth of the index wheel. The later engagement of the clutch box compels a later forward motion of the steel detaching roller.

As regards the setting of the various parts a certain distance from each other, there are practically no differences between the single and double nip combers.

Although Bourcart's duplex comber has now been more or less satisfactorily at work for several years, there are differences of opinion as to its relative value as compared with the single nip.

It is clear that the special advantage to be claimed for the duplex is increased production, since it is contended by many that it is as easy to run the duplex comber at 125 nips per minute as the single nip at 85 nips.

On the other hand, it is claimed that the quality of work from the duplex can never equal that from the single nip, because the cotton in the latter machine is acted on by 17 rows of needles, as against only 13 rows on the duplex.

It is also the writer's experience that the duplex is more noisy than the single nip, and also the detaching rollers are carried rather too rapidly through space.

Another disadvantage experienced by the writer with regard to the duplex is the inability to vary the timings as freely as in the single nip, because of the needle segments and fluted segments following so closely after each other in their action on the cotton.

Hetherington's Duplex Comber.

It is a common thing with many practical men to imagine that the needles of the cylinder of the duplex comber act more quickly on the cotton than those of the single nip. This is not true even when the cylinder has been somewhat increased in diameter. The circumferential speed of the cylinder of the duplex comber at 120 nips is less than that of the single nip comber making only 80 nips per minute, because the revolutions of the former are only 60 as against 80 for the latter.

This ability of the duplex comber for the needles to pass more slowly through the cotton fibres appears to the writer to be a manifest advantage.

Wherever combers are used at all their use is a proof that high-class yarns are required, and therefore masters and managers view with disfavour any innovation about the comber which may possibly lead to a lowering of the quality of the yarn. This is one reason why only a limited number of people have adopted the duplex comber.

At the time of writing there appears to be quite a tendency on the part of even the makers of the duplex comber to prefer the latest and most improved forms of the single nip comber.

Messrs. Hetherington say of their double nip comber :—

"To this machine we apply two detaching roller cams, which form the subject of a patent. The one cam makes one stroke of the roller, and its neighbour the next one. This organ has always been the one that limited the speed of the machine owing to the great strain upon it. By doubling the cams we can run easily at 130 beats per minute in the double nip machine, for, with the exception of the detaching roller, every organ in the machine is only making 65 revolutions or strokes, in place of 85 in the single nip machine. The detaching roller, although making more strokes per minute, is moving slower when actually in motion in the double than in the single machine.

"The time is gained by the pauses between the strokes of the roller being of shorter duration. An increase in the diameter of the cylinder means an increased speed of the detaching roller and a quicker passage of the needles through the cotton. By our double cam arrangement we have ample time between the passages of the needles to make the piecing, and can thus keep the cylinder the same size in both machines. The needles passing gently through the lap make less waste, and enervate the fibre less than a quicker speed does ; consequently the work is better done, and the yarn is stronger. The slow speed of all the working parts adds greatly to the durability of the machine, and the leather-covered detaching rollers last longer."

When reading the above quotation it must be remembered that in this, as in all duplex combers, the nippers, feed rollers and top comb have to act twice for each revolution of the cylinder. It will be evident that the surface speed of a single nip comber cylinder at 80 strokes per minute is greater than the surface speed of a double nip comber cylinder making 120 nips per minute, providing that both cylinders are of the same diameter. Clearly, therefore, the circumferential speed of the detaching rollers must be greater in the single than in the double nip comber in order to keep pace with the higher surface speed of the cylinder during detaching.

Also to increase production it is a common practice to feed the duplex comber with laps upwards of $10\frac{1}{2}$ in. wide. If the cotton used be at the same time of very short staple it becomes a little difficult to get good selvedges and to get a combed fleece of sufficient strength to properly keep up in the conducting tin, in the condensing or calender rollers, and on the front sliver table. Partly to strengthen the slivers it is sometimes the practice to use fluted calender rollers, and in special cases of eight head machines to place a pair of conducting rollers in the middle of the front table.

As stated previously, there are two principal firms in England associated with the construction of duplex combing machines, *viz.*, Messrs. Dobson and Messrs. Hetherington, both firms, however, also making the single nip. Dobson's double nip comber is Bourcart's patent and has been previously described. In both makes, of course, there are two sets of needles and two fluted detaching segments in the circumference of the cylinder. In each case two complete feeding, combing and detaching operations are performed to one revolution of the cylinder.

So long as the same circumference of the cylinder is kept the same for the double as for the single nip (which often is the case), the surface speed of the needles and fluted segments will be less in a duplex machine making 120 nips per minute than in a single nip machine making only 80 nips per minute. This slower speed is probably somewhat advantageous in some respects, although, as previously stated, there are objections to the duplex machine in other respects.

The manner in which the two firms referred to obtain the duplex motions differs very considerably. Dobsons' do it by allowing everything on the cam shaft to remain the same practically, and making the cam shaft to give two revolutions to one of the cylinders. In this way the nippers and the detaching rollers are made to act twice during one revolution of the cylinders.

Hetheringtons' contend that this high speed of cam shaft in the Bourcart machine is disadvantageous, and they, therefore, keep the speed of the cam shaft at the same rate as the cylinder shaft, and get their duplex motions by duplicating the cams.

This is easily enough done with regard to the cams for operating the lifters and the nippers, each cam in this case being made to have a complete cam course in half of its circumference, and this cam course being repeated in the other half of the circumference. This is exactly after the method of making a double cam and fixing it on the cylinder shaft for lifting the top comb twice in one revolution of the cylinder, this method being adopted in Dobsons' duplex comber.

Hetheringtons' method of obtaining the duplex rotary motion of the detaching rollers is not quite as simple and involves a little additional mechanism, which—with the kind assistance of Mr. Frederick Hardman—is illustrated in Figs. 47 and 48.

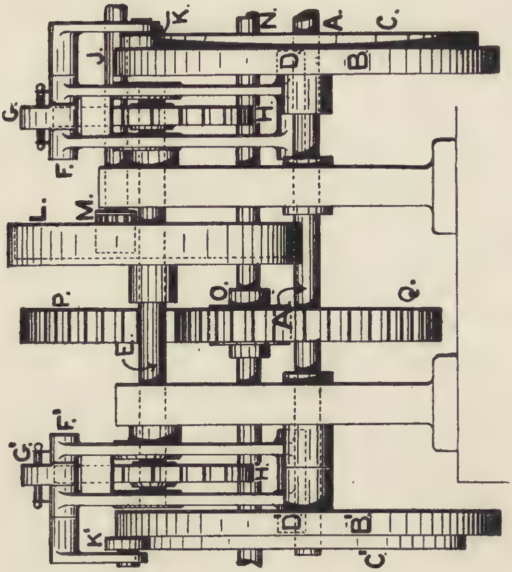


Fig. 48.

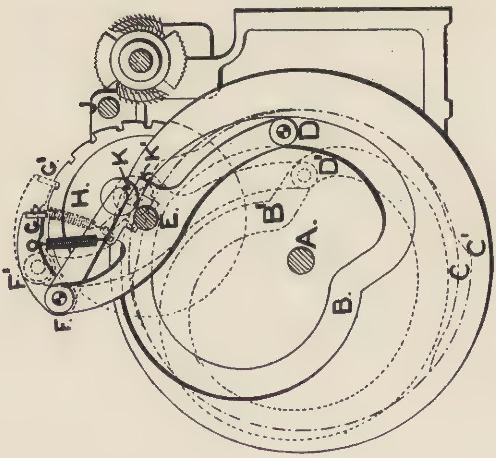


Fig. 47.

Index of Parts.

A	Cam Shaft.
B, B′	Face Cams for oscillating the Cradles or Levers, D, E, F.
C, C′	Large Ring Cams for lifting Frogs or Catches, F, G.
D′, D′	Bowls of Levers, D, E, F, running in Face Cams, B, B′.
E	Notch Wheel Shaft.
D′, E, F′	Cradles or Levers carrying Frog Motions.
F, F	Fulcræ for Frogs, F, G, and F′, G′.
G, G′	Hardened Catches fitting in Notch Wheels.
H, H′	Notch Wheels.
J	Long Detaching Roller.
K, K	Bowls running on the Ring Cams, C, C′.
L	Internal Wheel.
M	Pinion on Long Steel Detaching Roller driven by Internal Wheel.

Action of Parts.

As explained in connection with the notch wheel description of the single nip comber, the object of the face cam, B, is to oscillate the lever or cradle, D, E, F, and therefore to oscillate the frog, F, G. The tooth or catch, G, being kept in gear with the notch wheel, H, by the springs shown, the notch wheel is in this way made to move first one way and then the other. The ring cam, C, holds the frog, F, G, out of gear with H during part of the return motion, so that the forward motion is almost double that of the return.

The internal wheel, L, being on the same shaft, E, as the notch wheel also moves therewith, and communicates a corresponding motion to the detaching roller, J.

The way in which the double action of the detaching roller is obtained may now be described.

There are two face cams, two ring cams, two cradles, two frog motions and two notch wheels. The cams are fixed on the cam shaft opposite to each other, so that when one face cam, one ring cam and one notch wheel are acting on the shaft of the internal wheel the corresponding duplicate part is inactive.

In Fig. 47 the double sets of needles and flutes on the cylinder are shown near the long detaching roller, J.

A machine of this description, running at 135 nips or beats per minute, would mean 67·5 revolutions per minute of the cylinder, and 67·5 revolutions of cam shaft, thus giving a slower speed of both cylinders and cams in spite of the much increased production than would be got with 80 to 90 nips per minute with the single nip.

As before stated, however, many people object to the double nip comber on account of only 13 rows of needles passing through the cotton, as against 17 on the single nip.

In this connection the author begs to put forward what he considers to be quite an original idea, which may be of some practical importance.

It appears to the writer that it would be quite possible to use the duplex machine and yet maintain a high quality of combing by *reducing the length of feed per nip.*

It must be remembered that the same cotton fibres are usually combed several times over before being detached. Taking the rate of feed at $\frac{1}{4}$ in. per nip, it may happen that an ordinary Egyptian fibre is combed four times before being detached. Suppose the rate of feed be reduced to $\frac{3}{16}$ in. per nip, and only 13 rows of needles are passed through each nip.

In the first case we might possibly get four combings to equal—

$$4 \times 17 \text{ rows of needles} = 68 \text{ rows of needles}$$

to pass through the fibres.

In the second case we might possibly get $5\frac{1}{2}$ combings of the same fibres to equal—

$$5{\cdot}5 \times 13 \text{ rows of needles} = 71{\cdot}5 \text{ rows of needles}$$

to pass through the same fibres.

It must be remembered, however, that reducing the length of feed reduces the production unless the weight of lap per yard be increased in proportion.

It may be added that Hetheringtons' with their duplex comber provide top combs with double rows of needles—at any rate if required. In this way the tails of the fibres receive extra combing when pulled through the top comb.

Although in Hetherington's duplex comber there is an increased production as compared with the single nip, yet the wear and tear of many of the working parts ought to be less in the duplex than in the single nip machine on account of the reduced speeds of cylinder and cam shaft.

There is more work, however, imposed on many of the parts—such as lifter pins, swivels, connecting rod pins, detaching rollers, leather detaching roller bushes.

The cams and cam bowls ought to last longer.

As regards the speed of Hetherington's duplex, the pulley shaft may run at about 240 to 250 revolutions per minute, and take a pulley of about 12 in. diameter.

The space occupied is the same as for the single nip, because although the notch wheel motions are duplicated, space is provided by the removal of the lifter cams and nipper cams to the middle of the machine.

The usual width of lap may be say $8\frac{3}{4}$ in. wide, and the average weight per yard say for 60's to 80's about 288 grains, and for 110's to 120's about 220 grains to 240 grains per yard.

The following few particulars of settings refer more especially to Hetherington's duplex comber :—

In putting the cylinders upon the shaft, care should be taken that they are all in line, and in order to bring the other settings to their respective numbers upon the marked or index wheel, set the front edge of the fluted segment to the $1\frac{1}{8}$ in. cushion plate gauge from long steel detaching roller, with index wheel at $4\frac{1}{4}$.

To set the nippers put on the covered cushion plates, and so adjust them by the screws at the back that the edge of each cushion plate touches the front lip of each nipper plate, then screw the binding set screws tight.

In the next place adjust the distance of each cushion plate to the proper distance from the delivery roller. There are two gauges made for this purpose, being $1\frac{1}{4}$ in. and $1\frac{3}{16}$ in. in size respectively. The longer gauge is for the longer stapled cottons.

Next set the edge of each nipper plate as near as it will conveniently work from the cylinder combs. No. 19's gauge is generally used, and the springs to be on the nippers when this is done.

To give the requisite tension to the springs, the adjusting screws of the nippers should be against the stands, and the springs screwed up about $\frac{1}{4}$ in. For the settings of the cams the nippers should close at $8\frac{1}{4}$ to $8\frac{1}{2}$ of the index wheel.

The feed motion is generally set to act at 5 to $5\frac{1}{2}$, but for long staple a little earlier.

Feed pinions from 13 teeth to 20 teeth, about 19 teeth being often applied.

The delivery roller as for single nip.

In the next chapter are given full particulars of settings, etc., for Hetherington's single nip comber, and for the most part the same particulars apply also to the duplex.

CHAPTER V.

RESETTING OF COMBERS.

There is no machine in cotton spinning in which it is necessary to more frequently readjust the various working parts to gauge than is the case with the Heilmann comber.

This is on account of the great number of different setting points about the machine and their liability to become deranged.

In this chapter will be given a full description of the work involved in a complete resetting of a Heilmann comber, accompanied with sketches of the various gauges more or less used. In the next succeeding chapter will be given a complete description of the erection of a Heilmann comber, the two chapters being closely related.

First of all, the machine must be stripped of as many of its parts and details as may be requisite for a complete overhauling.

The top leather-covered rollers should be sent to be recovered, skimmed up and varnished.

The fluted rollers and fluted segments should be scoured, the various polished plates well rubbed up, and, generally speaking, the machine should have a thorough cleaning.

The machine should be tested by spirit level as to its truthfulness, and any broken or badly worn parts should be renewed.

Advantage might also be taken of the opportunity of applying any recent improvements that may be deemed worthy of a trial.

The cylinders should all be made fast to the cylinder shaft, with the index at 5, and the $1\frac{1}{8}$ in. gauge between flutes of detaching roller and front edge of fluted segment. The $1\frac{1}{8}$ in. gauge is shown by Fig. 48 (*a*). The long steel detaching roller should be set from 21's to 23's from the cylinder.

Setting of the Nippers.

There are several setting points in connection with the nippers, and it is not a very easy task to obtain a thorough understanding of the exact use of each individual setting point, and to put into working practice the knowledge we possess with relation to the nippers.

Our explanation of the details of the adjustment of the nippers will be very much aided by reference to Fig. 49, which has been specially prepared for the purpose.

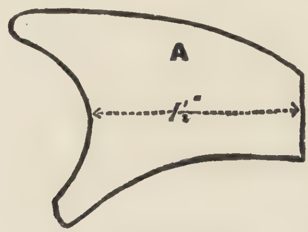


Fig. 48 (*a*).

There is still another and important setting point for the nippers, which, however, is not shown in Fig. 49.

This is at the bolt and slot, by which each nipper stand is secured to the principal bearing or stand. By loosening this bolt the nipper stands and all the various parts belonging thereto can be placed nearer to, or further from, the detaching rollers, the main object of such an alteration being to get the front edge of the cushion plate the required distance from the bottom detaching roller.

Order and Method of Setting Nippers.

First Setting: Top Nipper to Cushion Plate.

Having taken care to have the leather cushion renewed in the cushion plate or in the nipper bar, as the case may be, the two nippers may be set quite parallel to each other, and so as to bite a piece of writing paper firmly and equally for the full width of the nippers.

This setting is done by means of the small horizontal set

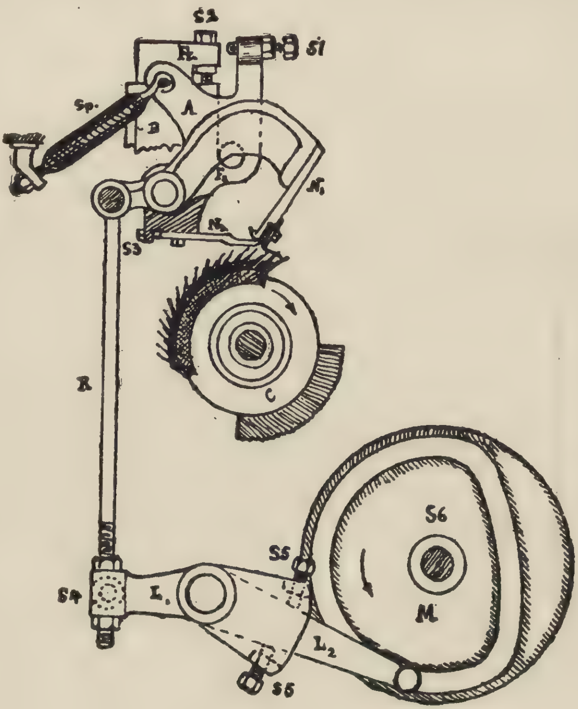


FIG. 49.

Index of Parts.

S 1 is the setting point for upward and forward sweep of Cushion Plate.

S 2 is the setting point for adjusting the Nippers from the Cylinder Needles.

S 3 is the setting point for adjusting Cushion Plate parallel to Top Nipper.

S 4 is the setting point for adjusting Connecting Rod, R, to the Nippers.

S 5 permits several Connecting Rods to be adjusted simultaneously.

S 6 is the Cam, by altering which the time of action of Nippers may be varied.

screws, S 3 (Fig. 49), fixed in the end or back of the cushion plate frame, and by having the leather cushion perfectly level.

In very many cases the nippers and frames or cradles are taken out and placed on the front sliver table, and the adjustments of cushion plate to top nipper performed with the swing frames or cradles thus taken out of the machine. It is held that the work can be done in this manner better than when the swing frames are not taken out, as is sometimes the case.

A word may be said on the importance of the cushion plate and nipper bar fitting perfectly to each other, and the cushion of leather being in perfect order.

Fig. 50.

The setting or testing of uniformity of the leather may be done first by the aid of the judgment of the eye, but afterwards tests should be made by taking a piece of paper say of $\frac{3}{4}$ inch wide and 5 or 6 inches long. This paper should be held between the nippers at different positions over the width of the nippers, and should be held firmly in each instance.

If this perfect setting is not obtained, then it is infallible that good fibre will be pulled from the grip of the nippers by the cylinder needles and carried round as waste to the back of the machine. The nippers will be unable to hold the fibres at those positions that would not hold the paper. On the other hand, there must not be any binding, or else the leather will soon be marked and cut, and possibly also the fibres of cotton, whereas with proper setting of the nipper and cushion plate the leather cushion may endure for a good length of time.

The two nippers should be tested for parallelism to each other by good thick paper being passed between the lower edge of the top nipper and the front edge of the cushion plate; or better still, a small turned up gauge of tin, copper or brass, equal to about 30's on the wire gauge, as shown in Fig. 50, may be used for this purpose. The gauge being held at A, the small turned-up piece, B, is passed under the bottom of the top nipper.

It must be well understood that the setting of the nippers to each other as above explained comprises really two operations. (*a*) The cushion of leather is made to be so uniform as to bite the slips of paper equally across the width of the nippers. (*b*) The nippers are set to be parallel to each other by means of the small 30's gauge, and so that the downwardly projecting lip of the top nipper just misses the front edge of the cushion plate by an amount of clearance equal to the thickness of this 30's gauge.

After the cushion plate has been set to the nipper in this fashion the cradle must be placed in position, with its two end pivots resting in the nipper brackets or stands, and the small caps or covers for these stands screwed in position to hold the cradle firmly in position.

As stated, however, in some cases the cradles are not removed from the machine, but the settings above described are performed while the cradles are in position, and this remark more especially applies to the combers as made by Dobson & Barlow.

On some combers it is difficult to take out the cradles before first removing the bottom feed roller, as this is greatly in the way of the cotton guides fixed on either end of the cushion plate.

Second Setting: Cushion Plate to Detaching Roller.

In making the various settings the cylinder and the long steel detaching roller principally share in ruling the adjustment of the various working parts.

After the cradles have been fixed in position, but before the spiral springs and the vertical connecting rods have been fastened in position so as to connect the nippers with the cam shaft, the cushion plate must be adjusted to be parallel to the long steel roller at a given distance from it.

For average Egyptian cotton the front edge of the cushion should be $1\frac{3}{16}$ in. from the long steel roller, while for poor Egyptian cotton $1\frac{1}{8}$ in. might be better, and for very good Egyptian cotton the distance might be say $1\frac{1}{4}$.

For Sea Islands cotton of fair quality the distance might be $1\frac{3}{8}$, and for very long Sea Islands cotton say $1\frac{7}{16}$ in.

In most cases, however, when this setting is once made at say $1\frac{3}{16}$ in. for Egyptian cotton it is not usual to alter it because the cotton may happen to be a bit better or worse.

The gauge used for this setting is of special shape, as shown in Fig. 51. The rounded portion fits against and partly round the long steel detaching roller, while the opposite straight edge of the gauge fits against the front edge of the cushion plate.

In making this setting it must be well understood that the nippers must be open, and therefore the front edge of the cushion plate will be in its most forward and nearest position to the long steel roller.

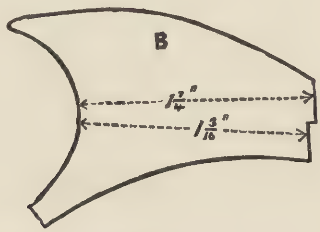


FIG. 51.

At the same time the horizontal cradle screws should be against the nipper stand and projecting through their own apertures about $\frac{1}{4}$ in. to $\frac{3}{8}$ in.

The adjustments of cushion plate to long steel roller may be made by loosening the bolts which secure the nipper stands to the main stands and sliding the nipper stands upwards or downwards (and therefore forwards), as may be required.

As stated, the bolts and slots by which these adjustments would be made are not shown in Fig. 49.

It may not be out of place here to emphasise the extreme importance of setting the various working parts *parallel to each other*. This remark applies generally to all the detaching rollers, feed rollers, cushion plates, top nippers and fluted segments. It applies very forcibly to the setting of the cushion plate parallel to the long steel roller.

Third Setting: Nippers to Cylinder.

After setting the cushion plate to the long steel roller, we may proceed to adjust the bottom edge of the nippers to a certain distance from the cylinder needles. Unlike the previous setting of the nippers, the present setting must be done with the nippers closed and in their lowest position, as they are in this position when holding the cotton fibres for the cylinder needles to act upon.

In setting the nippers great assistance is rendered by the use of a trowel gauge such as shown in Fig. 52.

This gauge is made double ended, each end being a certain thickness according to the wire gauge. In the gauge shown

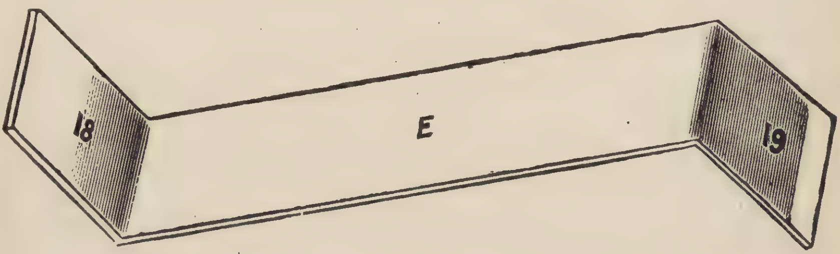


FIG. 52.

the two thicknesses are 18's and 19's, the latter of course being thinner than the 18's. E is the body of the gauge, which is shown full size.

For Egyptian cotton it is a very common practice to use the 19's gauge, while for Sea Islands cotton it is perhaps more usual to employ a 21's gauge.

The thickness of gauge employed exercises an influence on the amount of waste taken out, closer setting leading to the extraction of more waste.

There are two positions or setting points which are used more or less in connection with the setting of the nippers, these being (1) the vertical screws, S 2, and (2) the two nuts at S 4 at the bottom of the connecting rod, R, in Fig. 49.

Another gauge which it is necessary to use in setting the nippers to the cylinder is the one shown in Fig. 53.

This is a stop gauge of different thicknesses as shown, which is placed between the end of the stop screws, S 1, and the front of the nipper stand, P, in Fig. 49.

It is necessary to use such a gauge owing to the nippers having to be in their lowest position when being set to the cylinder.

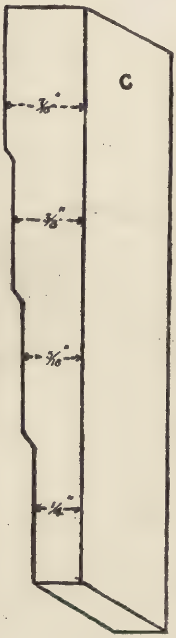


Fig. 53.

In actual working the back vertical connecting rods, R (Fig. 49), move the top nipper down towards the cylinder at the proper time, and the top nipper forces the cushion plate into position. When the nippers are in position for the combing operation, there is usually a space of $\frac{5}{16}$ in. to $\frac{7}{16}$ in. between the nipper stand, P, and the front edge of the screw, S 1, the distance being maintained by the power of the connecting rods.

In setting the nippers, however, it may be that the connecting rods are not then doing this and placing the stop gauge between the screws, S 1, and the nipper stand, therefore something is done to hold the nippers down into combing position.

One method of procedure would be as follows: While the cradle is loose place the $\frac{3}{8}$ in. gauge between the nipper stand and the horizontal stop screws. Press down the nipper and set it in a rough and ready manner to the fluted segment of the cylinder. Afterwards it will be found not to be very far out when we use the trowel gauge and set it to the cylinder needles.

Then while maintaining the stop gauge in position, we may with the left hand hold the trowel gauge between the cylinder needles and the bottom of the nipper, and by means of the right-hand vertical nipper stand screw, S 2, raise or lower the nipper stand—and therefore the nippers—to the extent required.

There are of course two nipper stand screws to each head—one on the right hand and one on the left hand. It is customary with this and certain other settings to have the left-hand screw turned out of the way while the setting is done by the other screw with the right hand, the gauge being operated at the

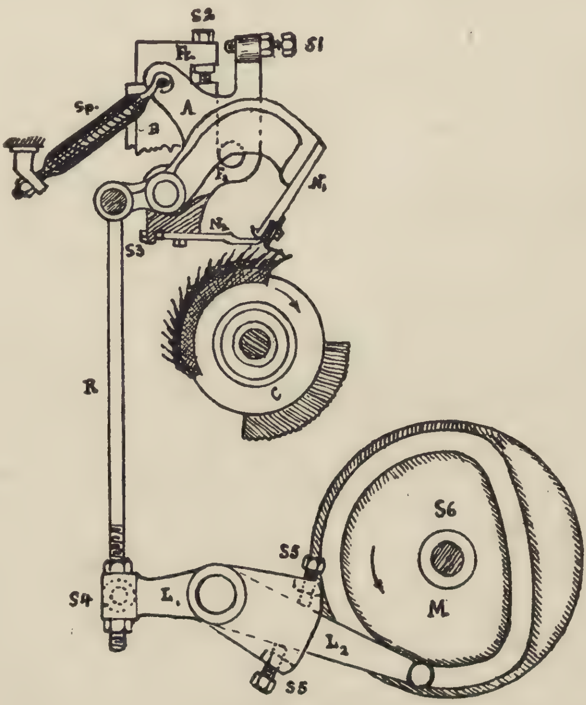


FIG. 49 [*repeated*].

same time with the left hand. Afterwards the left-hand screw may be adjusted by removing the stepped gauge, and allowing the right-hand stop screw to come against the nipper stand, and then adjusting the left-hand screw to also just come against its own nipper stand.

Fourth Setting: Connecting Rods.

After adjusting the nippers to the cylinder needles by the small vertical nipper stand screws in the manner just described, we may put on the spiral springs of the nipper cradles and screw them up to a pretty firm tension. Then our attention may be turned to making a proper working connection between the nipper cam, M, or S 6, on the cam shaft and the nippers themselves by means of the back vertical screwed connecting rods marked R in Fig. 49, which is repeated on page 153 to facilitate reference.

This may be very well illustrated by reference to cam, M, and the rod, R, etc., in Fig. 49. It will be noticed that the groove or path of the cam bowl is concentric or equidistant from the centre or cam shaft for more than half the circumference of the cam.

It will also be understood that when the cam bowl is working in this circular or concentric portion of the cam the arm, L 2, of the bottom lever, screwed or keyed to, and practically fulcrumed on, the long bottom nipper shaft, X, is held down in its lowest position.

This, of course, involves that the arm, L, and consequently the vertical rod, R, are held in their highest position. Following this out to the end it means that the two nippers are held during all this time in their nearest position to the cylinder needles.

To properly adjust the connecting rods, R, care must be first exercised to have the cam bowl on the circular part of the cam, M, as shown in Fig. 49. At this time, if the connecting rods are properly set, the $\frac{3}{8}$ in. stepped gauge can just be passed between the nipper stand and the screws, S 1, because the cam, M, and the connecting rods will then hold stop screws away from the nipper stands to that extent. Before screwing up at the connecting rods we may therefore insert the stepped gauge between the stop screws and stand. Then adjust the screws at the bottom of one of the vertical rods, R, until the stepped gauge is just eased by the weight of the nippers and nipper springs devolving on the rod, R, setting one rod on each head in this manner. In setting the other connecting rods we may turn the cam, M, until the stop screws, S 1, are just eased from the nipper stands, and then screw the rods up.

It will be profitable after finishing setting to turn the cam round to some extent, and afterwards with the nippers in their lowest position to test again with the 19's or 21's trowel gauge whether everything is clear and ready for work.

The setting screws at S 5 may be utilised to get the lever, L, L 2, in proper position and for the purpose of altering several connecting rods at one position.

Fifth Adjustment: Timing of the Nipper Motion.

As stated, the nippers are opened and closed by the revolution of the cam, M, on the cam shaft. This cam, M, is not really of itself directly secured to the cam shaft, but is bolted to a slotted circular disc which is keyed on the cam shaft. The nippers are kept closed when the cam bowl is working in the circular part of the cam groove, and the nippers are opened and closed and moved in and out of combing position by the eccentric portions of the cam. By loosening the bolt that fastens the cam to the round plate and moving the cam round, the time of opening and shutting of the nippers in relation to the other parts can be varied to a limited extent. It is a very common and excellent practice to close the nippers at 9 of the index wheel, although this does not mean that the nippers are then fully in position for the combing action.

The following is a fuller statement of the action of the nippers :—

(1) The top nipper may begin to move down at . . $6\frac{1}{2}$
(2) The two nippers may fully engage at . . . 9
(3) The two nippers may be in proper combing position at 11
(4) The nippers may begin to rise at . . . . $20\frac{1}{2}$
(5) The bottom nipper may come to rest at . . . $2\frac{3}{4}$
(6) The top nipper may come to rest at . . . 5

It must be distinctly understood, however, that by putting the nipping to commence at 9 all the other timings specified for the nippers will attend to themselves, and this is what is done in practice.

This timing is varied a little in practice from say about $8\frac{1}{4}$ to $9\frac{3}{4}$, and later nipping will sometimes give a little higher percentage of waste.

Why the Cushion Plate Lifts.

If the top nipper alone had motion it would be a very easy matter indeed to comprehend the action of the nippers. It is necessary, however, to bring the cushion plate away from the cylinder needles, which operation complicates matters considerably, and the manner of its accomplishment is elsewhere discussed in this treatise.

The question to be discussed just here is, Why should the cushion plate move upwards and forwards? The principal reason for this action is because it allows the cushion plate to bring the fibres well up to the back of the top comb. It is well known that the rear ends of the fibres are only combed by the fibres being pulled through the needles of the top comb by the detaching mechanism. The top comb cannot be lowered very much or it would catch in the cylinder, and even then the fibres would be pulled underneath the top comb without effective combing if the cushion plate were not moved upwards and forwards.

Not only does the upward motion of the cushion plate bring the fibres well behind the top comb needles, but also it brings the fibres and the cushion plate itself more clear of the cylinder, and also brings the fibres better within the range of action of the leather-covered detaching roller. It will be readily understood that by bringing the fibres further into the needles of the top comb, the upward and forward motion of the cushion plate considerably aids in giving an effectively combed sliver.

Setting of Feed Rollers.

The setting of the bottom feed roller is principally ruled—like the front edge of the cushion plate—by the position of the long steel detaching roller.

In making this adjustment a gauge is used, such as shown in Fig. 54.

This gauge may be made of say brass or iron, of say $\frac{3}{32}$ or $\frac{1}{8}$ in. in thickness. Its width is according to the distance at which the bottom feed roller is to be set from the long steel detaching roller being marked at $1\frac{13}{16}$ in. in Fig. 54. It may be held at F.

The following widths may be recommended for different classes of cotton:—

For short Egyptian cotton . .	$1\frac{3}{4}$ in.
,, good ,, ,, . . .	$1\frac{13}{16}$,,
,, short Sea Islands . . .	2 ,,
,, long ,, ,, . . .	$2\frac{1}{16}$,,

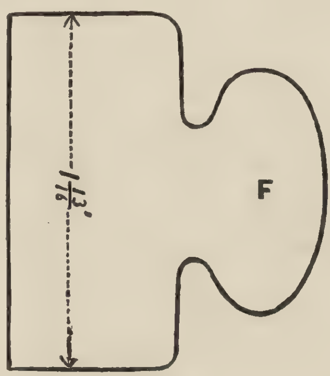


FIG. 54.

It will be understood that this distance—like that of the cushion plate, and that of the drawing rollers of the various machines—is increased with the length of the cotton fibre to be worked.

In making this adjustment it will be first necessary to remove the top nipper out of the way in order to get the gauge in position.

There are bolts connecting the feed roller bearings to the principal stands of the machine, and a fair amount of slot provided for adjustment purposes. By means of the proper gauge and these slots the bottom feed roller is adjusted to be the proper distance from the bottom detaching roller, and also to be quite parallel thereto, both conditions being essential.

It may be noted that as compared with the complete setting of the top comb, nippers and detaching roller, the feed roller setting is simpler to understand.

After the slides are made fast with the proper gauge between the steel roller and bottom feed rollers the top feed rollers are placed in position and set.

Top Feed Rollers.

The top feed rollers are held down to the bottom ones by fingers which are fulcrumed in the back stands, and are weighted by a spiral spring being attached at either end.

Although the setting of the top feed roller may not be as important or difficult an operation as some of the other settings, there are yet one or two matters about it which give better results if properly attended to :—

(1) Probably the most important thing about the top feed roller is to have it quite parallel with the bottom one.

(2) It is also good practice to have all the top rollers alike in angle, although this point is sometimes neglected by practical men.

(3) There is not much space for the detaching rollers, nippers, top comb and feed rollers, and care should be taken to have the top feed roller a fair working distance from the nippers.

Some people do not trouble to use a gauge for setting the top feed roller, but content themselves with judging by feeling and sight.

In this connection, however, better results and probably more speed would often be obtained from the use of a gauge such as shown in Fig. 55. In this sketh A, B is a plumb line; C is a gauge of brass, copper or iron, made to pass down the front of the feed rollers, D, E, as shown, and having an indicator marking for the plumb line.

Experience has demonstrated that differences in the setting of the top feed rollers may lead to a different manner of pulling the lap down the back guide plate and feeding it to the nippers. Erratic setting of this roller has often been proved to give a different pull or tension on one edge of a lap or ribbon of cotton than on the opposite edge.

The gauge shown (Fig. 55) has been devised by a student of the author's, and has a slight resemblance to the angle gauge used for setting the top comb. Great care is taken to ensure that one certain pair of feed rollers are adjusted to the very best advantage; then the gauge is fitted to this pair of rollers and the position of the plumb line noted. Afterwards all the pairs of rollers are adjusted to be the same as the first pair. The fingers or pivots for the top rollers are sustained in the stand by slots which permit of a sufficient amount of adjustment.

Finally, all the springs may be hooked to the fingers and put under a fair amount of tension.

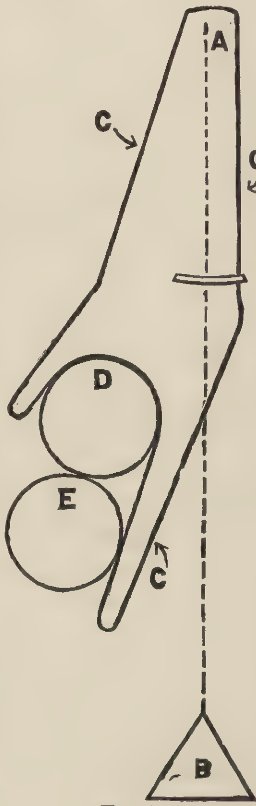


FIG. 55.

TIMING OF FEED ROLLERS.

The adjustment of the time of action of the feed rollers is quite a distinct operation from the "setting" of the parts as just described.

The mechanism by which the intermittent motion of the feed rollers is imparted from the cylinder is described elsewhere in this treatise.

Between the index wheel and the plate to which the feed peg is attached there is a circular plate keyed on the cylinder shaft. A long bolt secures both the feed plate and the index wheel to this circular disc, and therefore in effect to the cylinder.

It may be especially noted that, at any rate on many combers, the index wheel is not directly keyed or screwed to the cylinder shaft, but only to the circular plate disc in question. The connection between the index wheel and the circular disc is a non-adjustable one, but that between the feed plate and the circular disc is adjustable, by means of a slot of upwards of three inches in length made in the feed plate. By simply loosening the bolt and moving the feed plate backwards or forwards to the extent required, the time of action of the feed rollers may be quickly and easily varied.

It is a fundamental principle on a combing machine that feeding and detaching of the cotton must be proceeding practically at the same time, and, consequently, the feed rollers are usually set to begin moving at five of the index wheel for practically all classes of cotton on the single nip comber.

On the duplex comber, however, this timing may be $4\frac{1}{2}$, being a little earlier on account of the smaller amount of time devoted to the performance of some of the operations. In many cases $4\frac{3}{4}$ is taken for the single nip.

As discussed fully elsewhere in this treatise, it is considered that varying the time of feeding exercises some effect on the amount of waste taken out, the idea being that late feeding increases the amount of waste. Nothing can exceed the ease with which an alteration of the time of feeding can be effected, and for this reason it is a favourite position for making such experiments.

The feed rollers may be acting on any one occasion for a period of about 4 marks on the index wheel, or say 16 teeth.

Amount of Feed per Nip.

Not only can the time of the feeding operation be varied within limits, but also the amount of cotton fed per minute can be regulated by means of the change feed wheel, which is fixed on the same stud as the star wheel.

It is usual to have several of these belonging to each comber, as by their means the draft of the machine and the counts of sliver can be readily altered. As on nearly all spinning machines, a larger wheel on the comber gives a smaller draft and coarser counts. Such a wheel increases the amount fed per nip, which may be anything from say $\frac{7}{32}$ of an inch up to $\frac{3}{8}$ of an inch.

There is a difference of opinion as to the best amount to be fed per nip, but it is considered by some experts correct in principle to have a thinner and lighter lap, and to feed a greater length per nip, the longer the cotton fibre operated upon.

For one thing a lap which is lighter per yard is often required and used for Sea Islands cotton than for Egyptian cotton.

Also we may remember that an Egyptian fibre of $1\frac{1}{4}$ in. length is operated upon three or four times by the cylinder needles when we feed $\frac{1}{4}$ in. per nip, while a Sea Islands fibre of $1\frac{3}{4}$ in. length would probably be operated upon five or six times with the same length of feeding.

By giving a longer feed for longer fibres we maintain about the same amount of combing. On the other hand, it may be that for Sea Islands such extra combing is desirable, and in such cases the same length of feed may be kept for Sea Islands as for Egyptian.

It may be of advantage to some practical men who desire a maximum amount of combing without resorting to double combing to remember that a *short length of feed* probably leaves the fibres longer within the range of action of the cylinder needles, thus giving more effective combing. With a short length of feed, however, it would be probably necessary to use a heavier lap behind the comber.

A few more remarks on this subject may be found in the chapter on various discussions.

Various Minor Settings.

The Cylindrical Brushes.—These should be set so that the points of the bristles will touch the brass of the combs on the cylinders.

To expedite the setting of the brushes, when one has been set in the above manner a gauge, such as shown in Fig. 56, may be used.

This gauge may be adjusted by means of the sliding piece, *b*, in the slot shown, so that the two fingers, *a*, *b*, reach from and touch the shafts of the brush and cylinder where the brush has been made right.

Then the brush shaft may be quickly set equidistant from the cylinder shaft by means of this gauge for the full length of the comber. Such a gauge as this may be of iron or brass,

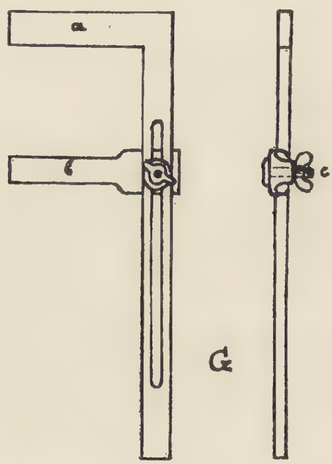


FIG. 56.

but often a simple piece of wood is used, cut at the moment to be of the right length.

Setting Doffers.—These having been put in position and having been covered, may be set up to the brushes by means of a thick carder's gauge, or something to serve the same purpose, thus leaving a nice clearance between doffers and brushes. Actual contact will cause the bristles to wear, and wide setting will give inefficient stripping.

Setting Lap Plates and Fingers.—The convex guide plates, down which the narrow laps pass on their way to the feed rollers, should be set nicely clear of the fluted wooden lap rollers or the rotation of these will be jerky and unsteady. The same guide plates at their lower ends should be set with the brushes just impinging against the bottom feed rollers, the upright iron fingers which keep the bobbins in the centre of the rollers and guide plates allowing about $\frac{3}{8}$ in. play over all.

Brush Tins.—The tin coverings for the brushes and cylinders and other parts of a Heilmann comber require to be very carefully adjusted, so that they shall not be acted upon by any of the working parts. This contact does sometimes occur and makes an unsatisfactory noise and shakes the tins.

They should be set say $\frac{1}{8}$ in. clear of the cylinder and well clear of the doffer and the cylindrical brushes. If they clear the cylinder and doffer about $\frac{1}{8}$ in. everything should be right.

These tins should be strongly built, with the curved parts properly concentric, or else there will be trouble with them.

Setting of Detaching Rollers.

In connection with the setting of the feed rollers, the nippers and the top comb, it was shown that two or three kinds of gauges were used in each case. In setting the detaching rollers—although the operation is both vastly important and very delicate—no gauge need be used excepting a trowel gauge such as shown in Fig. 52, but of thinner dimensions, and slips of thick writing paper.

At an earlier stage the fluted segment of the cylinder and the long steel detaching roller may have been set say to a 21's or a 23's gauge from each other. At this stage it is necessary to deal with the adjustment of the two top detaching rollers. The working and adjustment of the detaching rollers are so important that they are discussed separately in chapter iv., and therefore the subject is only dealt with briefly here.

The principal thing is to see that the leather roller rests fairly and firmly on the fluted segment at the proper moment, with all the lifters or horse heads just clear.

It is good practice to disconnect the 80's driven wheel from the cam shaft and then to put the quadrant on its top position, ready for just commencing the forward or delivery motion, with the index wheel at say $6\frac{1}{8}$, at which point the 80's wheel may be secured in position.

Unless it has been previously done, we should at this point put on all the brass ends or tubes for the leather-covered rollers. Then put all these rollers in position and suspend the weights from them.

We may then turn the machine slightly and allow the leather rollers to rest on the fluted segment a little *later* than the commencement of the forward motion. The latter having been put at $6\frac{1}{8}$, we may allow the leather rollers to rest on segments at $6\frac{3}{4}$ of the index wheel. As explained elsewhere in this treatise, it would be disastrous to the leathers and the cotton to have the segment touching before the starting of forward motion.

Setting of Detaching Rollers.

At this stage all the lifter cams should (in Dobson's latest combers) be put to lie on the full or concentric parts in order to hold the lifters in their lowest positions. In old combers there is only one lifter cam, of different shape, placed towards the end of the machine. In later combers the lifter cam is in the middle of the length of the machine, while in some of the most recent combers of all there is a lifter cam to every two heads of the machine.

There are three or four places at which adjustments of the detaching rollers can be made in one way or another :—

(1) The time of moving rollers forward can be varied by unscrewing the 80's cam wheel and turning the cam shaft as above indicated. (This is really, of course, setting the quadrant.)

(2) Each lifter cam is adjustably bolted to a slotted circular plate, which latter is secured to the cam shaft. By unscrewing at this position and turning the cam forward, or backward, the time of bodily movement of the top detaching rollers can be varied as required.

(3) Referring to Fig. 57, and taking the latest comber with a cam to two heads, by means of the screws, *a*, *a*, all the four lifters belonging to two heads can be raised or lowered together. On older combers with only one detaching roller cam, all the lifters on the machine can be thus altered by an equivalent setting point.

(4) Behind the tops of the lifters themselves are small set screws by which each lifter head can be independently adjusted to a very fine degree.

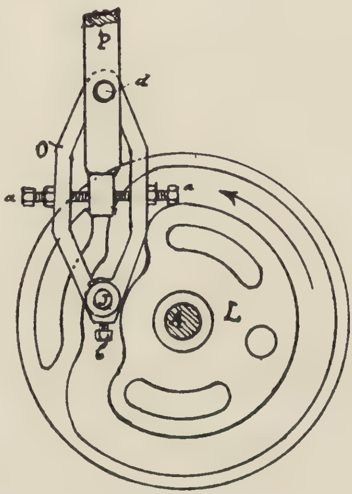


FIG. 57.

In any case, having got the forward motion set at $6\frac{1}{8}$, or whatever may be required, and the leather rollers weighted in position and resting on the segments, with the lifter cams set alike and on their full surfaces, the various setting screws may be made right. Those at *a*, *a* may be all adjusted so that the lifter tops are as nearly as possible alike, and nicely clear of the brass roller ends.

Then final adjustments may be made by means of the small set screws on the lifter tops. About a 30's thin gauge, or else slips of thick writing paper, may be made to just pass in between the brass ends and the lifters by means of the small screws. It must be clearly understood that if the lifter tops are not absolutely clear of the brass ends of the detaching rollers at the proper time, it will be quite impossible to get good detaching. On the other hand, if there be too much clearance the dwell of the leather roller on the segment may be extended too long. It is possible also to affect the amount of dwell somewhat by the way in which the various levers belonging to the lifters are centred. As previously stated, when studying the detaching roller setting, reference should be made to chapter iv.

There is only one setting point for each end of the short top steel rollers, and these are adjusted so as to get this top fluted roller quite parallel to the others, and just nicely clear of the leather roller at all times.

The long steel roller is adjusted by means of the bolts and slots in the big slides.

Adjustment of Top Comb.

In describing the method of setting the top comb, Fig. 58 should be of considerable assistance.

There are four adjustment places for the top comb—each one giving a different result, and affecting the comb in a different manner.

These four points are as indicated below, in reference to Fig. 58.

Method of Setting Top Comb.

Angle of Top Comb.

In setting the angle of the top comb an angle gauge such as shown in Fig. 59 is of great assistance and is commonly used.

As shown in Fig. 59, the gauge is fastened temporarily to the top comb by the wing nut at A, with the plumb line at I hanging vertically downwards. The top comb is never set to work in a vertical manner, but is usually set at from 26 to 30

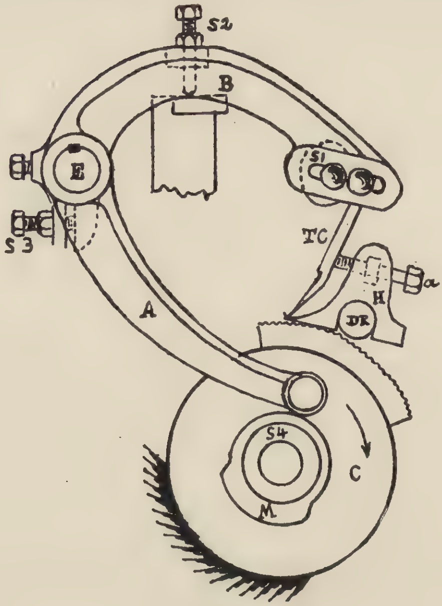


FIG. 58.

Index of Parts.

S 1 is the setting point for angle of Top Comb.

S 2 is the setting point for distance of Top Comb from Fluted Segment.

S 3 is the setting point by which the amount of upward motion of the Top Comb is regulated.

S 4 is the setting point or Cam by which the times of lifting and dropping of the Top Comb are determined.

(Other reference letters to Fig. 58 are as below.)

A Arm or Lever connecting the Top Comb Shaft, E, with the Cam, M.

B Arm to which the Top Comb, T C, is bolted and which is loose on Shaft, E.

C is the Cylinder.

D R is the long Steel Detaching Roller.

H is the Cradle Gauge shown in position.

T C is the Top Comb itself.

E is the long Shaft on which all the Top Combs are loosely and independently fulcrumed.

degrees angle with the vertical. The scale is marked out into divisions equal to 2 degrees each, so that 15's on the angle gauge would be equal to 30 degrees from the vertical.

Probably the most usual setting is 14's of the angle gauge.

In setting the top comb for angle the gauge in Fig. 59 may be secured to each top comb in succession, and the angle of the comb adjusted by means of the small bolts and slots at S 1 (Fig. 58). In making this setting it is essential that care be taken not to have the top comb catching against the top nipper blade

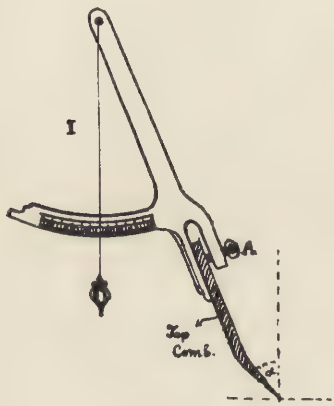


Fig. 59.

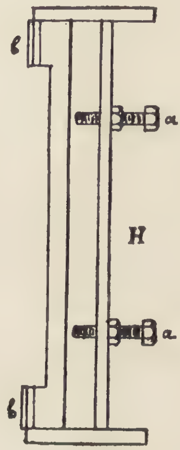


Fig. 60.

on the one hand, or against the leather-covered detaching roller on the other hand.

There is not much space for the top comb—especially with close settings—and it may easily happen that the top comb does catch the parts referred to, with the result that the free working of the parts is affected for the worse, and the needles of the top comb and the leather of the detaching roller suffer correspondingly.

There is a slot in the projecting wing of the arm, B (Fig. 58), by which the top comb can be moved nearer to the detaching roller, or to the nippers, as may be required, while there is another slot in the top comb itself for adjustments vertically. The top comb is double bolted to the arm, B, for the sake of greater security.

Cradle Gauge.

Many people object to using the angle gauge shown in Fig. 59 for setting all the top combs in succession, on the ground that it takes up too much time, while other people insist on it being used for all the top combs, on the ground that more accurate setting is obtained than by any other method.

In Fig. 60 is shown a form of gauge which is much in favour for setting top combs where quickness of setting is required.

When this gauge is to be used, it is the practice to first set one comb by the angle gauge, Fig. 59, and then to use the gauge in Fig. 60 for the other combs. One comb having been set by the angle gauge, the cradle gauge is put over the long steel detaching roller, and made to rest on the fluted segment of the cylinder. The cradle gauge is shown in actual position in Fig. 58, being marked H, while the detaching roller is marked D R. The screws, *a*, are then projected so as to just touch the comb that has been made right. Afterwards the gauge is taken to each head in succession, and the top comb fixed to rest against the screws, *a*, so that every comb will be alike. Carefully used there is not much reason why the setting done in this manner should not be quite satisfactory, and, as stated previously, it is a quicker method than using the angle gauge all the time.

By putting more angle in the top comb there is a tendency to take out more waste owing to the comb offering more resistance to the forward motion of the fibres.

Second Setting Point.

Quite as important as the angle of the top comb is its distance from the fluted segment of the cylinder, which is determined and regulated by the vertical setting screws, S 2, in Fig. 58.

Although important in its effects and results, this setting is not so difficult to perform as the previous one. A trowel gauge is taken in the left hand, a gauge thickness of 19's being often taken for Egyptian, and a thickness of 21's being often taken for Sea Islands cotton. The gauge is inserted by the left hand between the needles of the top comb and the fluted segment of the cylinder, care being taken to have the top comb in its lowest position and not held off the cylinder by anything, excepting by the screw, S 2, resting on the top of the stand, B. Meantime the left-hand screw of the top comb is turned out of the way, while the adjustments are made by the right-hand one. Afterwards the left-hand screw can be brought to just touch the stand as at B.

The closer the setting of the top comb to the fluted segment the greater the amount of waste extracted, partly for the same reason that more angle in the top comb has the same effect, *viz.*, because greater resistance is offered to the forward motion of the fibres, and more of them are left for waste.

In this connection it must be thoroughly understood that the top comb performs two distinct and important duties: (1) it holds back crossed and short fibres and impurities during the operation of detaching, so that the latter are taken out as waste by the next revolution of the needles of the cylinder; (2) it helps to comb the rear extremities of the fibres, by the latter being pulled through it by the detaching mechanism.

This serves to explain why closer setting and more angle of the top comb should tend to give a greater amount of fibre extraction.

Here it may be observed that—as elsewhere referred to—several alterations may be made with a view to varying the amount of waste, but very wide or high setting of the top comb will probably give a less percentage of waste than any other alteration. In this case a good deal of crossed and short fibre may be allowed to pass, although there is still obtained the advantage of having the cotton mostly acted upon repeatedly by the cylinder needles. Some fine spinners have resorted to this practice, in order to obtain what might be termed a super-carded yarn, taking out as low as from 6 to 10 per cent. of waste.

Third Setting : Sweep of Top Comb.

The upward motion of the top comb is affected by the full portion of the cam, M, which is set screwed to the shaft of the cylinder, C (Fig. 58). While the full part, M, of this cam is pressing up at the arm, A, the top combs are held up, this being during the time of combing by the needles of the cylinder. It will be as well to notice particularly that the top arms, B, are not fastened to the shaft, E, at all, although the lower arm, A, is so secured. There is a downwardly projecting lip cast to the upper arm, B, and through a second lip set screwed in the lower arm, A, is passed the screw, S 3, while the lip cast in the upper arm, B, comes against the point of the same screw.

Lifting of the top combs is done in this way: the lower arm, A, is moved upwards by the cam, M, and the point of the screw, S 3, then presses against the lip of the top arm and forces the latter upwards. The effect so far is as if both the arm A and the arm B were fast to the long shaft, E.

But by adopting the two lips or fingers referred to, and the setting screw, S 3, we obtain two very important requisites: (1) the sweep of the top combs may be varied within limits as may be required; (2) each top comb can be independently lifted for piecing-up, cleaning and other purposes.

In setting the sweep or upward motion the greatest care must be observed not to have the screws, S 3, projecting so far through as to have the weight of the combs resting against the screws, S 3, instead of on the stands, B, when the top combs are in their lowest position during detaching. The combs being in their lowest position, the screws, S 3, may be projected through their lips so as to be just clear of the lips on the top arms, B, when the thin part of cam, S 4, is presented to the arm, A. Although the top combs are forced upwards by the full part of the cam, M, they descend by their own weight, when the thin part of the cam is presented to the bowl of the arm, A.

Occasionally some people prefer not to have their top combs lifting at all, and when this is the case the screws, S 3, may be turned out of action until they are just clear of the lips on the top arms, B, even when the *full* part of the cam, M, is presented to bowl on the arm, A.

If the top comb is timed and set to go down at the proper time, and especially if it be timed to be down very early, it is not very probable that never lifting the comb will have much effect on the amount of waste taken out, although this is a question often asked. With anything like close setting, however, it is probable that always leaving the top comb down may lead to the pins in it being damaged. With wide setting of the top comb it is not likely that much damage, if any, will result from leaving the top comb down.

Fourth Setting: Time of Action.

For most cases it will be found good practice to have the top comb down at $5\frac{1}{2}$ of the index wheel, although it may be as early as $4\frac{1}{2}$ for a double nip comber.

These timings ensure that the needles of the top comb will have settled amongst the fibres before the forward motion of the detaching rollers commences, the latter being usually put to start at 6 to $6\frac{1}{2}$.

The timing of the top comb is altered by the adjustment of the cam, S 4, or M, which is set screwed to the shaft of the cylinder, C. Suppose the top comb is to be down at $5\frac{1}{2}$, then the index wheel is put to $5\frac{1}{2}$ with the pointer, and the cam, S 4, screwed fast to the cylinder just when the bowl of the arm, A, is beginning to press on the thin part of the cam, S 4. So long as the thin part of the cam continues to press against the cam, the top comb will of course remain down.

For a great many years it has been considered sufficient to have one cam for lifting the top combs fitted on the cylinder shaft at the gearing end. The adoption of higher speeds and eight head combers has led to the application in some cases of a cam on either end of the cylinder shaft, and in such cases care should be taken to set them both alike.

In the double nip comber these cams are made double acting so as to give two upward and downward motions to the top comb during each revolution of the cylinder, as against only one in the single nip comber.

Double Top Combs.

While there are usually 17 rows of needles on the cylinder to pass through the cotton, on the top comb there is only one row of needles as a rule.

Attempts have been made, however, to introduce top combs with two rows of needles, and these have met with a very moderate amount of adoption.

It may be said that in a double top comb the second row of needles causes somewhat less work to be imposed on the first row, and it is probably less difficult to maintain effective combing with double top combs than with single ones. The first cost of double combs is of course greater than for single combs, and although if anything the double comb must give better results, it is not in much favour. Satisfactory results appear to be got with the single comb, and it fills rather less space than the double comb.

Timing Diagram.

In order to help students in obtaining a clear conception of what is meant by the timing of a Heilmann comber, and the relationship which subsists between the various timings, the lecture diagram in Fig. 61 has been designed by the author. It should help to demonstrate also why such timings are necessary.

The outer large circle of this diagram represents the index wheel, and is divided out and numbered accordingly like that wheel.

The cylinder is shown fixed to the same shaft, as is the case in actual practice, with the fluted segment marked C. The $1\frac{1}{8}$ gauge is shown in position between D R and C. It might be stated that it would be quite practicable to work with a different set of timings altogether from what are usually given, providing of course that the same proportion and relationship were maintained between the various parts.

Setting Cylinders.

The real basis of the various timings, and the one particular thing which largely rules and determines the approximate timing of all the other parts, is the fixing of the front edge of fluted segment to be $1\frac{1}{8}$ in. away from the long steel detaching roller, with the index at 5.

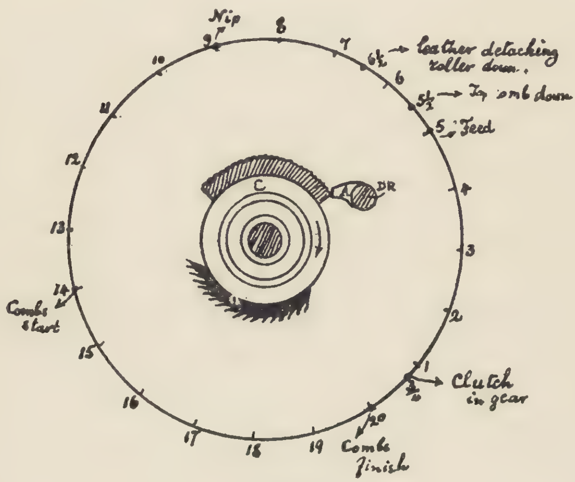


Fig. 61.

This, of course, is really setting the different parts of the cylinder to be level with the various working parts, such as the nippers and detaching rollers at a certain time or number of the index wheel.

For instance, with the front edge of fluted segment up at 5 as above indicated, the front row of needles will come beneath the nippers at say $12\frac{1}{2}$ to 14 of the index wheel.

Suppose, however, we had set the cylinders so as to have the front edge of fluted segment $1\frac{1}{8}$ in. from detaching roller, at 8 instead of 5 of the index wheel, then all the other timings would have to be fixed proportionately later, and this course could probably be adopted if there were any advantage in doing so.

For instance, in the table below is given a possible set of timings side by side with the official table.

	Official.	Possible.
Clutch Wheel in gear	$\frac{3}{4}$	$3\frac{3}{4}$
Feed at	5	8
Top Comb down at	$5\frac{1}{2}$	$8\frac{1}{2}$
Detaching Rollers forward at	6	9
Detaching Rollers touch Segment at	$6\frac{1}{2}$	$9\frac{1}{2}$
Nip at	9	12

In the official table it is, of course, understood that the front edge of fluted segment is set $1\frac{1}{8}$ in. from detaching roller with index at 5, while in the possible table the index is at 8 with the same gauge. It is *impracticable* to adopt one of the timings in the column of possibles without also taking the others.

It will be noticed from the lecture diagram and from the tables of timings that most of the timings cluster round about the time of fluted segment being up, and this is absolutely essential for the efficient working of the machine. For instance, it is essential that detaching takes place at this time, although it would be fatal to commence detaching before the fluted segment was up.

(1) Because of this with the segment up at 5, the delivery motion of the detaching rollers is put to start at 6, or just after segment is up.

(2) In the same way it is essential that the top comb be at work during all the time of detaching, so it is put to be down at $5\frac{1}{2}$.

(3) The leather detaching roller must not touch the segment before the forward motion commences, so it is put at $6\frac{1}{2}$ when the forward motion is at 6.

TABLE OF TIMINGS FOR HEILMANN COMBERS.

Name of Part.	Egyptian Cotton.		Sea Islands Cotton.	
	Single Nip.	Double Nip.	Single Nip.	Double Nip.
Clutch in gear	$\frac{3}{4}$ of the index wheel	$4\frac{3}{8}$ of the index wheel	$\frac{3}{4}$ of the index wheel	$4\frac{3}{8}$ of the index wheel
Feed Peg beginning to act . .	5 ,,	$4\frac{1}{2}$,,	5 ,,	$4\frac{1}{2}$,,
Top Comb down	$5\frac{1}{2}$,,	$4\frac{1}{2}$,,	$5\frac{1}{2}$,,	$4\frac{1}{2}$,,
Detaching Rollers to start delivering	6 ,,	$6\frac{3}{4}$ or $6\frac{5}{8}$,,	$6\frac{1}{4}$,,	$6\frac{5}{8}$ or $6\frac{3}{4}$,,
Leather Roller to touch Segment .	$6\frac{1}{2}$,,	$6\frac{7}{8}$,,	$6\frac{1}{2}$,,	$6\frac{7}{8}$,,
Nip at	9 ,,	9 ,,	$9\frac{1}{4}$,,	$9\frac{1}{4}$,,

In each case the cylinders are set so that the front edge of fluted segment is $1\frac{1}{8}$ inch from long steel detaching roller when index is at 5.

(4) Of course the nippers are open during detaching, and it is absolutely essential to have the feed rollers feeding the cotton while the nippers are open, so that feeding is put to commence at 5.

(5) When the foregoing actions are practically terminated (or even sometimes before), then the sooner we nip the better, so that nipping is put to commence at 9.

All these timings and their position in relation to the index wheel and the cylinders are indicated in the lecture diagram (Fig. 61).

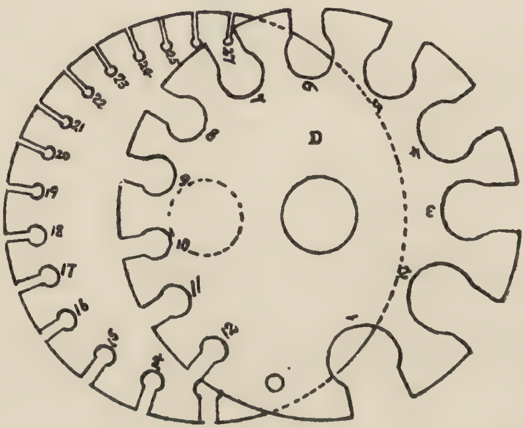


Fig. 62.

It is important to notice that the timings are divided into two sets: (1) those belonging to detaching; (2) those belonging to combing (the former being the more numerous).

Wire Gauge.

The trowel gauges used for setting the top comb, bottom edge of nipper knife, and the long steel detaching roller parallel to and the proper distance from the cylinder are marked 18's, 19's, 21's, 23's, etc., and the author has often been asked what these numbers meant.

It may be stated at once that they refer to certain of the apertures in the imperial standard wire gauge. These gauges are made of various shapes, but the slits in the gauges are constructed in each case with the greatest accuracy, to be of fixed dimensions as marked and numbered on the gauge.

A good form of wire gauge is shown in Fig. 62 in order to give a better idea of what is meant.

This gauge consists of two leaves and contains slits representing the different counts of wire from 1's up to about 40's, the thinnest apertures being represented by the highest numbers, as in the case of cotton yarns.

Take the case of 20's trowel gauge, it means that it would exactly fit into the slit marked 20 on the wire gauge; 21's would fit the slit marked 21, and so on.

In the case of 8's wire used in the thread boards of a ring frame, such wire would exactly fit into the slit marked 8, while 12's wire as used for the faller wires of a self-actor mule would exactly fit into the 12's aperture of the gauge. In actual practice it is not necessary for a comber fitter to be provided with a wire gauge, but he should take care that his gauges have been tested for thickness.

Percentage Balance.

The testing of the amount per cent. of waste being made by a comber is an important and frequent part of the duty of a comber master. As demonstrated elsewhere, it is not a difficult matter to find the percentage by calculation, and this is often done in actual practice.

In some cases, however, a little time is saved by using a percentage tester such as shown in Fig. 63.

In this case, when the test quantities of good cotton and waste have been obtained from the comber, the one is placed on one of the scale pans of the balance, while the other is placed on the other scale pan.

The percentage of waste is at once indicated on the scale shown by the pointer. In this way the trouble of making a percentage calculation is avoided, and this may make a practical difference in cases where a great deal of testing has to be done.

In Fig. 63 the testing balances are suspended inside a box which can be kept closed except just when using, thus aiding in keeping the apparatus quite clean and in good working order.

PARTICULARS FOR SETTING HETHERINGTON'S COMBERS.

The following particulars have been kindly supplied by the firm:—

The driving pulleys on combing machines are from 9 in. to 12 in. diameter (usually 10 in.) by 3 in. wide each, and they should make 260 to 300 revolutions per minute.

The space occupied by a combing machine of 6 heads is

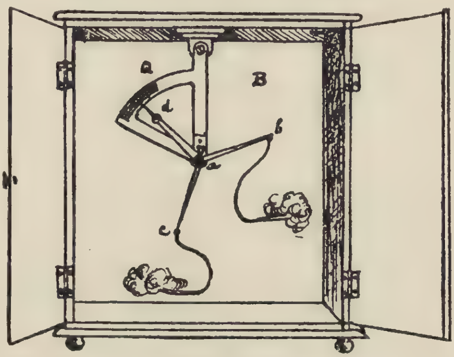


FIG. 63.

13 ft. 4 in. long by 3 ft. 6 in. wide; the width of the alley in front of the machine should at least be 1 ft. 3 in., but if there be plenty of room 1 ft. 6 in. would be better.

They make a short combing machine of 6 heads, with the driving pulleys placed inside, 12 ft. 7½ in. long.

There are three sheet-iron boxes wanted for the back of a combing machine; the size that suits best is about 2 ft. 8 in. long by 12 in. wide and 2 ft. high (outside measure), with a partition across the box for separating the waste from each head, or they will do made of wood ½ in. thick for the ends and sides, and ¾ in. thick for the bottom, on which should be put two cross pieces of the same thickness.

The weight of a yard of lap for the back of the combing machine should be about, say for 60's to 80's yarn, 230 grains; for 120's yarn, 190 to 200 grains.

In putting the cylinders upon the shaft care should be taken that they are all in line, and in order to bring the other settings to their respective numbers upon the marked or indicator wheel, let the first comb point to the centre of the front detaching roller when the pointer is opposite $14\frac{3}{4}$.

To Set the Nippers.—Put on the covered cushion plates, and so adjust them by the screws at the back that the front edge of each cushion plate touches the front lip of each nipper plate, then screw up the binding set screws tight.

In the next place, adjust the distance of each cushion plate to the proper distance from the front detaching roller. Two gauges are used for this purpose, one $1\frac{1}{4}$ in. and the other $1\frac{1}{8}$ in.—the former is used for long staple cotton, and the other for shorter staple.

Next set the edge of each nipper plate as near as it will conveniently work from the cylinder combs. No. 19 gauge is generally used for this distance, and the springs to be on the nippers when this is done.

To give the requisite tension to the springs, the adjusting screws of the nippers should be up against the stands, and the springs screwed up about $\frac{1}{4}$ in. For setting the cam the nippers should close at 9.

Set the top feed rollers parallel with the lower one. In gearing up the feed roller it is obvious that the feed should be made at the time the nippers are open, and it is generally set to commence when the pointer is $4\frac{1}{4}$ on wheel, but for long staple cotton the feed must commence a little earlier. The usual change feed pinion is 19 teeth, but some use smaller pinions, especially for fine work, and the lap can be made proportionately heavier with the smaller feed pinion.

The Front Detaching Roller.—The most convenient place to adjust the cam by is the dropping in of the catch into the notched wheel, and a suitable place is with pointer at $1\frac{1}{4}$, and the rollers must begin to move forward when the pointer is at $6\frac{1}{4}$.

The top rollers must be carefully covered and quite true, the cloth being 10 oz. of fine wool and the leather fine grained. It is a great improvement to turn up these top rollers after they are covered on Hetherington's patent roller trueing machine, and then varnish them to give a fresh skin to the leather, but in any case they should be varnished after being covered, and the varnish renewed from time to time as they require it.

To Set the Top Rollers.—Weight them and adjust them all from end to end of the machine by the small slides against which their pivots work, so that upon placing slips of paper between the ends of the rollers and these slides these slips of paper shall be all caught or released at the same moment from end to end of the machine on the covered part of the rollers coming in contact with the fluted parts of cylinders, or the reverse.

A cam allows these rollers to fall upon the fluted parts of cylinders, and moves them away, the movement of the cam being sufficient to allow the small slides to leave the pivots of rollers, the thickness of the fine gauge so as to ensure that the weights are pressing the rollers to the cylinders, and this cam may be so set that the top rollers touch the flutes of cylinders at $6\frac{3}{4}$ and come off at $9\frac{1}{4}$.

The brass clearing rollers require only to be set parallel.

The top combs should be set to the angle of the top comb gauge, and parallel with the nipper and leather rollers; as they are the chief instruments in controlling the waste, considerable attention should be paid to them. It is not absolutely necessary that they should have any movement, but motion is given to them, so that the waste they retain is the better cleaned out of them, but they should be down in their places at $5\frac{3}{4}$ at the latest.

They are set to various gauges according to the required quality of the work; the smaller the distance between the points of the combs and the flutes on the cylinder the greater the amount of waste made. No. 19 gauge is an average one for the distance, but it may be several gauges less.

The brushes should be set so as to penetrate the teeth of the combs, and require periodical adjustment, as they wear.

The doffers should be set to the brushes so as barely to touch them; if the doffers are too near the brushes the waste will be nepped.

The combs should be cleaned once or twice per day. The top detaching roller bearings and weight hooks require to be kept clean and well oiled. The pinching and set screws and nuts to be well screwed up.

The above numbers giving the positions on the marked or indicator wheel are merely approximate, and may with advantage be slightly varied to suit different descriptions of cotton.

CHAPTER VI.

THE ERECTION OF A HEILMANN COMBER.

Setting of Pulleys.

In determining the exact longitudinal position of a comber or similar machine, strict regard must be paid to the exact position of the frame end fast and loose pulleys in relation to the driving pulley on the line shaft. If this is not done there is likelihood of the belt constantly pulling too much against one side or other of the belt fork. As a matter of fact, the author has often seen this defect in actual practice, some machines having a bad tendency towards setting on of themselves as a direct result of the belt pulling too much towards the fast pulley.

It must be understood that it is often a very difficult matter to remedy such an evil when once the machine has been quite fixed up, and cases have existed where it has been necessary to go to the trouble of shifting the whole machine longitudinally.

To secure correct setting at the outset the following plan may be adopted :—

In Fig. 64 A is the driving shaft. Drop a plumb line from leaving side of the drum, B. Allow the plumb to touch fast pulley, C, at say $\frac{5}{8}$ in. from the inside edge of C. We need not stick exactly at $\frac{5}{8}$ in., but may be say from $\frac{1}{2}$ in. to $\frac{3}{4}$ in. The frame of the machine must be moved about to set pulleys, C and D, exactly right to the plumb, D being the loose pulley. The driving belt will then be in comparatively straight downward line, and although it will pull at an angle on its upward path on the opposite side of B, yet it will keep on the pulleys right enough.

Setting Driving Pulleys.

Besides setting the plumb line to be $\frac{5}{8}$ in. on the fast pulley as just described, it is also necessary to set the top driving

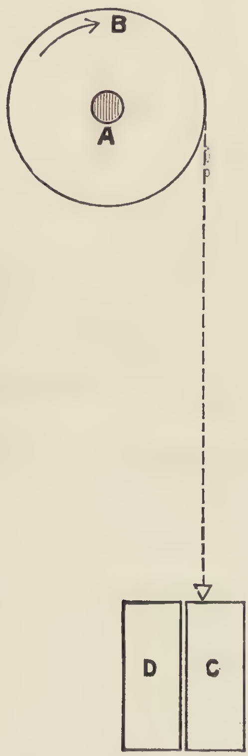


Fig. 64.

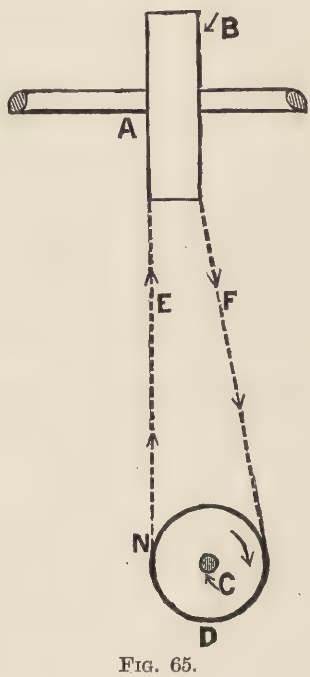


Fig. 65.

pulley on the line shaft at the proper position lengthways of the shaft. This, however, can if necessary be altered in a comparatively easy manner after the frame has been started, whereas in the other case it is difficult to rectify initial errors of setting. While the top pulley has generally plenty of space for adjustments, the frame pulleys are generally limited in space. The movement of the belt across the width or face of the top pulley is usually so small that very exact setting of the top pulley is not essential except when it is narrower than usual.

A method that may be adopted in setting the top driving pulley in its correct position lengthways of the shaft is as described below.

In Fig. 65 A is the line shaft, B is the top driving pulley, C the shaft of the machine, D the frame pulley, E is a line indicating the path of the belt in an upward direction, while F shows its path downwards.

In setting the pulley, B, on the shaft, A, a plumb line may be dropped from a point a trifle from the edge of the top pulley and to touch the edge of pulley, D, at N.

It will be noticed that the line of belt, E, which enters the top pulley must be almost perpendicular, whereas the belt will stop properly on the top pulley, B, even though the line of belt, F, which leaves top pulley is pulled at a considerable angle. On a comber it is not often, however, that this angle is very great on account of the comparatively small size of the top pulleys or drums. On a ring frame with driving by half-crossed belt the top drum at B is often very large and the belt is pulled at a great angle.

Lining Machine Up.

When a fitter is getting his setting line to place a cotton spinning machine at right angles to the line shaft he usually puts roughly into practice one of the very first and very simplest rules of geometry.

As this rule applies equally to fly frames, ring frames and other machines, as well as to combers, and as it really is very useful in actual practice, it is here reproduced in Fig. 66.

Method I.

Suppose at the point A, in the line E, F, it is desired to draw the line A, B at right angles to E, F. On either side of the point, A, mark off equal distances, A, E, A, F. With E and F as centres, any convenient radius, describe arcs intersecting in B. Then join A, B, and reproduce the line as far beyond B as may be required.

It may be remembered that the manner in which the line E, F is obtained is as follows: A plumb is dropped from the line shaft to touch the floor, first at say E, and then at F, these two points being any convenient distance apart. Then the points are connected by a chalk line made usually with the aid of a piece of chalked string.

It may also be noted that a rough and ready yet effective

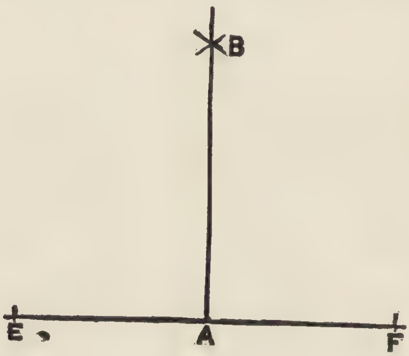


FIG. 66.

method of getting the intersecting arcs, often adopted by fitters, is to knock a nail in either end of a piece of wood perhaps three feet long and swing it on the points E, F, while the intersecting arcs are made.

Method II.

Sometimes, when not too near a wall or machine, which prevents such a practice, the fitters do not trouble to mark off equal radii from point A, as above, but proceed simply as below.

Having got the chalk line drawn beneath the line shaft, any two points, A and B (Fig. 67), in the straight line are selected at random, and with each of these points, A, B, in turn as centres, and with a radius greater than half the line A, B, arcs are described intersecting in E and F.

Then by joining the intersections in E and F, the line C, D is produced and extended as may be required.

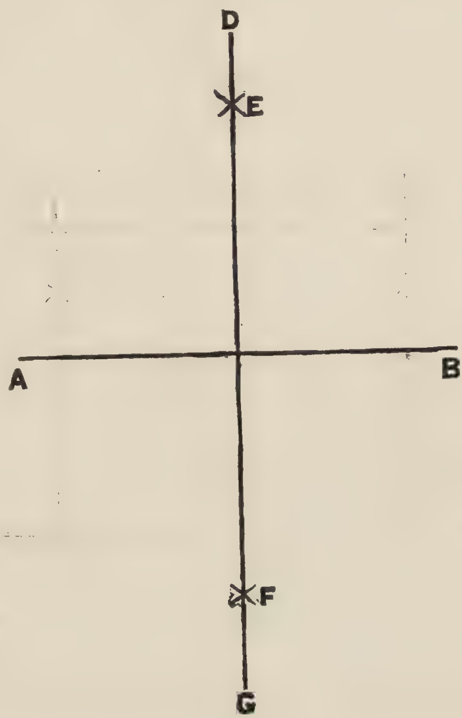


FIG. 67.

Really, of course, the foregoing is a simple method of bisecting line A, B.

It is well known that there are other methods of drawing one line perpendicular to another, but the foregoing are those most in favour with practical men in actual practice.

Often it is necessary in the erection and lining up of machines to draw one line parallel to another, and in such cases the following is a rough and ready yet accurate method of doing so :—

Referring to Fig. 68, to draw a line parallel to the given line, A, B, at any given distance from it.

At any two points, C, D, in the given line, A, B, draw two perpendiculars, or right angle lines, by the methods just described, and mark off on these perpendiculars the equal lengths, E, F, of the size required. Join the points, E, F, and the required parallel line will be determined.

The fact that of all the rules of geometry the foregoing are

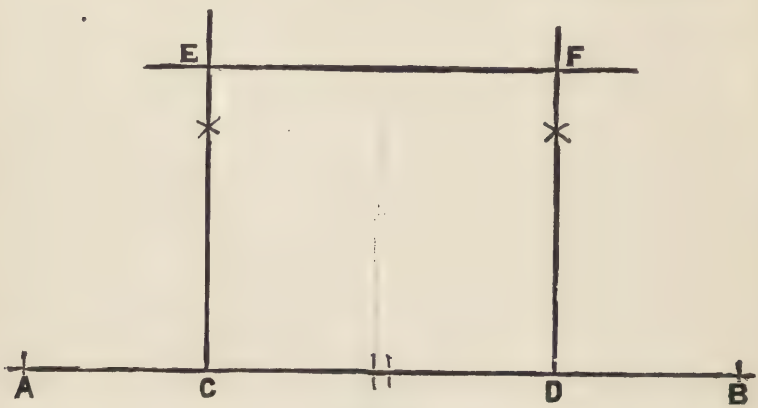


FIG. 68.

just those usually put into practice in the erection of spinning machines must be the excuse for their reproduction in this treatise by the author.

THE ERECTION OF A HEILMANN COMBER.

A brief essay may be acceptable on the actual erection of a new comber as distinct from the work of resetting.

First of all, the big frame end or stand for supporting the gearing and pulleys may be placed approximately in position.

In doing this it should be lined up from the next frame, so as to be parallel thereto. Providing there be no other frame convenient, it may be placed at right angles to a chalk line dropped from the line shaft.

Due regard must also be had to determining the proper position of the frame lengthways, so that the driving belt will work properly on the fast and loose pulleys of the machine. Full particulars of the method of doing this have just been given.

The heavy roller beam may be put in position to rest on the double gearing end above specified, and also upon the opposite or coiler frame end. There are strong ledges or supports to aid in the joining together of these parts.

A more thorough lining up of the roller beam to the one on the next frame may now take place if necessary; or it may be done after the strong stay rail has been put on. In some frames there is only a single gearing end, and especially was this the case with older combers, and in such cases the roller beam has to be placed on the two frame ends the first thing.

With the new double gearing ends some of the gearing may come ready fitted in position thereon.

There is no machine in cotton spinning which requires more perfect steadiness in order to ensure good work than the Heilmann comber. At the same time it is extremely liable to unsteadiness on account of the intermittent and sudden character of its various movements. On this account the roller beam is of extremely strong section, and not only so, but there is a very strong stay rail extending lengthways beneath the roller beam.

This stay rail connects the two frame ends together. At convenient intervals there are also placed two or three samsons, or iron supports, for the roller beam, and these are also bolted to the stay rail, thus binding the whole frame solidly together.

The stay rail and the samsons or spring-pieces having been placed in position, suitable packings may be inserted under the samsons and possibly also under the frame ends, in order to get the roller beam levelled to the spirit level for the full length of the frame.

Precautions may now be taken to ensure that the frame is quite parallel to the next one, or quite at right angles to the proper line dropped from the line shaft.

In levelling the frame up in this manner, and before the packings are cut, the machine may be levelled up on wedges, say two wedges to each frame end and each samson. The use of wedges in this manner facilitates the levelling up of a machine, and the same practice is often followed in the erection of other spinning machines than combers.

Stands.—The important duty of putting in all the roller stands may now be performed. These stands are, if possible, more important, and certainly do more work than the stands of any other cotton spinning machine.

They practically carry the whole of the parts of the machine which operate on the cotton during combing and detaching, as well as the cam shaft, and include: (1) cam shaft; (2) the lifter shaft (when one is used); (3) the long nipper shaft; (4) the cylinder shaft; (5) various lighter parts such as creels, etc.; (6) the rods, brackets and small stands for the nippers, detaching rollers, sliver tins, feed rollers, etc.

The stands for the doffers and doffer combs may be in separate pieces and bolted separately to the back of the roller beam.

It will be readily understood that the general working of a comber and the free and easy yet true working of the various shafts depend largely upon the accurate construction and adjustment of these stands.

Taking the case of the cam shaft, lifter shaft, nipper shaft and cylinder shaft, in order to ensure the greatest accuracy, it is the practice in the machine shop to bore all these four holes at one operation, and to bore several stands at the same time.

Each stand is bolted to the roller beam with four strong bolts, its position having been marked in the machine shop. A box key may be used in fastening these bolts, the nuts being put on the underside of the roller beam, and therefore rather awkward to get at without a box key. The strong central ledge cast down the middle of the under side of the beam to strengthen it is in the way of an ordinary key.

After the stands have been roughly bolted in position the cylinder shaft may be threaded through the proper holes from the gearing end of the machine.

Afterwards the cam shaft may be placed in position, this being a comparatively easy matter, simply requiring the caps to be pulled off the bearings, the shaft dropping into its bearings and the caps again putting on. The various cams on the cam shaft may come from the machine shop in at least approximately correct position longitudinally of the frame, but of course the various timings require to be adjusted at a later stage, and before this the proper connection of the various levers and horns has to be made.

It will be understood that a number of important but small things are left at the machine shop in their proper position on the gearing end and on the various roller stands, thus facilitating the work of the fitter at the mill.

There are also many of the smaller and less important fittings which can be put up at almost any convenient moment, so that at this juncture—or even before the cam shaft is put in—we may attend to some of these, and get them out of the way.

Of such may be specified the creel rods on top of the machine and the brackets for these, and the back wooden fluted lap rollers, brackets for holding the back tins, and brackets for holding the spiral springs for the cushion plates and top feed rollers. Some of these details may come from the shop in position. Also the rail or bar for the collecting tins may be put in.

In passing, it may be noted that the front tins or covers for the cylinders and other parts in some of the latest combers are adjustably secured to the cross rail for the sliver tins or collecting tins, thus securing the upper extremities of such covers in a firm yet adjustable manner.

In older makes of combers the covers were sustained at the top by simply being hooked to the thin fulcrum shaft of the lifters, and in this way were liable to give trouble by rubbing against some of the working parts. The newer method of securing them is decidedly an improvement both for rigidity and for adjustment purposes.

Here let it be fully understood that the order of fitting many of the parts will be varied according to the ideas of the fitter, or for other reasons, so that it must not be imagined for an instant that the procedure laid down here is in all cases exactly followed in the order given.

At this stage, if not previously done, the long *nipper shaft* and the long shaft for the lifters may be slided into position, there being apertures cast in the frame ends to permit of this. The setting of the levers and fingers which are fulcrumed on these shafts may be deferred until a later and more convenient stage.

It must be understood that in many of the latest combers the long lifter shaft is entirely dispensed with, and the lifters are coupled directly to the cams on the cam shaft.

It has been stated that many of the detailed fittings may come to the mill fixed to their proper bearings. For instance, referring to the headstock or gearing end, there might come with it the two endmost stands, the small star wheel of five notches with feed change pinion on it, the double carrier wheel below the star wheel for transmitting motion from the small wheel on the pulley shaft to the wheel on the brush shaft.

Other small parts come loosely tied near their working position, as, for instance, the loose brackets for the front table to rest upon may come tied to the stands.

Previously it has been stated that wooden wedges may be used to level the framing up at first; and in some cases of waiting for packing, etc., the replacement of these wedges by the proper wooden packings may be deferred even to so late a stage as we have now arrived at, rather than let the work be stopped for the sake of packings.

Attention may now be directed to the fitting up of the cylinder. It will be well understood that the needle segments will have to be carefully packed to prevent damage, and they may arrive at the mill in wooden boxes of special construction filled with lime to prevent rusting.

The needle segments, fluted segments, and making-up pieces may be all fitted in position, and when it is convenient screwed fast with the $1\frac{1}{8}$ in. gauge in position and index at 5, as dealt with elsewhere.

A very bad evil often present in combers is flocking. Some of the needles get bent or knocked down and then the fibre sticks to these needles. In such cases the cotton may accumulate in lumps and keep coming off in small portions of slubs or flocks and come out along with the web of good cotton. In some cases the web of cotton has been quite spoiled by flocking in this manner.

As regards the cylinder construction, it may be said there is first the central shaft which extends the full length of the frame, excepting as regards the coiler and the headstock.

This shaft has usually been made all in one long piece, but in some cases it is made in two parts bolted together by means of a face or flange coupling near the headstock end of the machine. The object of this is to facilitate repairs, and to this end it should be a step in the right direction.

On this central shaft are built up the different parts of the cylinder complete for each head, and each head is independent of the others, although all the heads must be adjusted to work in unison.

At each head there is screwed to the shaft a hollow boss, sleve or barrel, to which are secured the working parts.

The fluted segment for each head is fastened to this boss by means of sunk screws.

The making-up pieces are also fastened by screws in such a manner that they overlap the needle segments and help to hold them in position.

It will be understood that these various parts are not fastened directly to the cylinder shaft, but to the boss referred to.

The comb stock or needle segment is also screwed to the boss by sunk screws.

The needles are so liable to damage that the needle segments are made interchangeable, and need not be numbered, but should fit to any head of the machine indiscriminately. Various other parts of the machine are numbered from the gearing end to go in one certain position.

At this stage it may be convenient to fit the leathers into the nippers. Referring to Dobson's combers with the leather cushions put in the top knife, it is not a very difficult matter to do this, and if need be it may be done at a convenient position away from the comber, and care taken to have the leathers put in level and firm so that they will bite the fibres equally all across the nippers. There is a special lip set-screwed to the top knife to facilitate the insertion or removal of these leathers. The cradles may be put in position.

It may now suit us to put in position the long steel detaching roller.

Attention may be now devoted to fitting up of the big tins which cover up the cylinder and the brushes from the front of the comber.

The setting of these covers takes up a fair amount of time, and they are bolted to the back of the roller beam at the bottom, while in the latest combers they may be fastened by stays to the flat cross rail of the sliver tins.

To prevent the emission of fibre it is advisable to set the upper extremity of this tin close up to and beneath the long steel detaching roller, although it must, of course, be quite clear of this roller. To facilitate this setting it is possible to use a small brass gauge of U shape, and say $\frac{1}{16}$ in. thick, which is passed round the detaching roller so as to come between it and the top of the tin. These tins may be pushed up into position from the back, and should clear the cylinder by say $\frac{1}{8}$ in.

It may be found convenient to have one person trying the tins with the gauge at the front, while another bolts them to the roller beam at the back.

The *cradles* may have been put in position, as previously directed, before fitting the big tins or covers, since it is necessary to set the tins to the long steel detaching roller, and in some combers it is difficult to put in the cradles with the long steel detaching roller in position. Before putting the cradles in position they should be set, not only to bite slips of paper equally across the leathers, but also may be set to have the top nipper and the cushion plate quite parallel to each other, with the lower edge of the top knife just clearing the front edge of the cushion plate by about a 30's gauge.

With some combers it is the practice, however, to perform this latter setting with the cradles in position on the machine, in which case the lock nuts which secure the cushion plate must first be loosened with a properly shaped key, and adjustments made by means of the small set screws placed behind the cushion plate.

If not previously attended to, the *bottom feed rollers* may now all be placed in position. These rollers are, of course, set to be a certain distance from the long steel detaching roller, and parallel thereto, according to gauges and distances given elsewhere in this volume.

Nippers.—The important duty of setting the nippers may now be conveniently performed.

As described fully elsewhere, the setting of the nippers in all respects is an important and time-taking operation, and when a fitter has finished off with them he may be considered to have done something like half of his work, following, of course, the work previously specified in this description.

In a complete setting of the nippers several different adjustments are requisite as follows: (1) setting the nippers to bite slips of paper all across their width; (2) setting the bottom edge of top nipper knife to clear cushion plate by about a 30's gauge; (3) to $1\frac{3}{16}$ in. or other gauge from long steel detaching roller to front edge of cushion plate; (4) bottom edge of nippers to be about a 19's gauge from the cylinder needles; (5) adjusting to have the $\frac{3}{8}$ in. stop gauge between the horizontal stop screws and the nipper stands; (6) setting by the nipper cam to have the nippers working at the proper time.

As regards the first and second of these, as previously stated, with a new comber at any rate they may have been made before the cradles were hung in position on the comber. As regards the sixth or timing, this may be deferred for a time, and should not consume much time.

The nippers during some of the settings may be wedged in position by blocks of wood resting on the roller beam. Either now or a little later the setting of the nippers may be practically completed, all the setting screws being thoroughly well screwed up and the cradle springs put on. By this time the long front table may have been put in position, and if an indicator is to be used it may have been fixed in position on the front table towards the headstock end of the machine. These tables are highly polished, and hammers, screw keys, etc., should not be put on without paper beneath. There is a slit or space left in the front table purposely for the short indicator shaft to pass through. This indicator is driven by a worm fixed on the long thin shaft of the bottom calender rollers. Unlike indicators for the other spinning machines, those for combers are usually made to register the time the machine actually runs in a working week, being marked to register up to sixty hours. In some cases, however, hank indicators may be fitted to the draw box. At the same time the long thin shaft containing all the bottom calender rollers may be put in position, along with the brackets for holding the top calender rollers.

Draw Box.—Hitherto practically nothing may have been done in regard to fixing up the draw box, but at this stage most of the parts belonging to this may be fitted into position. If put in at all at this stage the top leather-covered rollers of the draw box had better not yet be weighted up, and the coupling up of the draw box to the cylinder may also be deferred a little or done now, as may be.

Index Wheels.—These are marked right-hand and left-hand, so that a left-hand wheel will not do for the other hand of comber. Many cases have occurred of mixing the index wheels up in this way, necessitating some trouble in taking the wrong wheel off, changing it, and afterwards putting on the correctly marked wheel.

When setting any of the timings to the index wheel it is good practice to turn this wheel a tooth or so beyond the exact timing point and then to turn back to that point in order to allow for backlash in the various wheels.

It has before been pointed out that in and between some of the more difficult and tedious fittings and settings many of the smaller details of fitting up may be attended to.

For instance, if not previously done, at this stage the fluted wooden lap rollers may be placed in position. Also the waste shaft and tins behind the machine, when such a shaft is used. In some cases the waste is dropped loose into rectangular tins placed under the machine and behind it, and if these were put in position too soon they might be in the way.

The perpendicular guides for holding the lap rollers in position may be threaded on the proper rods, and either set now or deferred a little as regards setting.

The *cylindrical brushes* may be fixed in position and set up to touch the brasses of the needle segments with the ends of the bristles.

As regards these brushes, it may be stated that they have usually been made of very good bristles on account of wear being very liable to take place, and also because of their work of cleaning the cylinder needles being so important. These bristle brushes are, however, very expensive, and latterly there has been a strong tendency towards the use of fibre brushes, which are a vast deal less in first cost.

While fibre brushes have in some cases given excellent results, there are some people who consider they will not clean the needles and prevent flocking as efficiently as the bristle brushes. They can scarcely be expected to be quite as durable or to keep their stiffness as well as good bristles.

The difference in price, however, is so greatly in favour of the fibre brushes that many people are using them. The brush is run at a pretty high speed, and a good deal depends upon its skilful handling and setting as regards its life and efficiency. There are usually long slots for adjusting the brushes after wearing, and also long slots to follow up with the doffers.

In many cases also these brushes are made to have a slight longitudinal traverse motion in order to increase their efficiency and durability.

If not done when setting the nippers, the back vertical screwed rods for the nippers should be placed through the horns.

Incidentally we may do a little sundry work, such as putting in the block rollers, putting on and coupling up the wheels which drive the draw box, and the worm and worm wheel, etc., for driving the doffers.

Clutch Box Leather. — Inside this box it is the usual practice to fit cylindrical pieces of rather thick leather in order to prevent a noise and shock by the continual and forcible shutting of the box. The work of putting these leathers in may now be performed if not done previously. There may be two pieces properly cut and shaped out and reaching in combined thickness say $\frac{3}{8}$ in. to $\frac{1}{2}$ in. thick. This thickness should be just sufficient to keep the teeth of the clutch box from touching the bottom of the spaces by about $\frac{1}{32}$ in. to $\frac{1}{16}$ in. or so, and should be good hard leather to prevent subsequent compression in working. Before the leathers are got to be of the exact thickness required it may be necessary to take out the long steel detaching roller a time or two and rest it in a suitable position while the box is taken off.

It may here be stated that comber erection is about the lightest kind of setting up that a man can be put to in a cotton mill, while, of course, being a very delicate and skilful operation. It is a good machine for a fitter to come to for a short time after having had a heavy job, but it is hard and heavy work for a man to go from comber fitting to some of the other machines.

In the case, for instance, of the self-actor mule, the work of fitting up this machine is infinitely heavier than that of a comber, and certainly it is as difficult.

On the other hand, there are few facilities in a cotton mill for the training up of competent men on combers, whereas no machine is better served in this way than the mule.

For this reason it is probable that there are proportionately more comber overlookers made out of fitters than any other kind of overlookers.

Doffers.—At this stage the important and somewhat tiresome duty of fixing, clothing and setting the doffers may be performed.

All the barrels or cylinders may be threaded on the doffer shaft. Afterwards each individual barrel may be keyed to the shaft, by means of the keys sent loose with the machine ; these keys being often rather thick to allow for certain and effective fitting. The keys are put in on the right hand.

In a right-hand comber the key of the barrel or cylinder next to the coiler may be put on the left hand, while the same may be said of the doffer cylinder next to the headstock on a left-hand comber.

This is done on account of insufficient space on the proper side in these positions.

It is unnecessary to key these doffer cylinders to the shaft from both sides.

The actual operation of *clothing the doffers* is a miniature reproduction of the method of clothing the doffer or cylinder of a carding engine. The teeth are secured in a strong leather foundation. At each end of each small doffer there are four wooden plugs of $\frac{3}{8}$ in. or $\frac{1}{2}$ in. diameter for the reception of the nailing on tacks. The tail ends are made somewhat after the manner of those on the filleting of a card, although it is a less important and less delicate job on the comber. Although a tack may not be put in every tack hole, yet in some holes a couple of tacks may be inserted to give a more satisfactory fastening for the tail end.

The whole operation of fixing and clothing the doffers of a comber may occupy four or five hours.

Doffer Fillet.

The firms who manufacture clothing for carding engines also manufacture the fillet used for the doffers of Heilmann combers. It may take say about 112 ft. of fillet, 1 in. wide, to cover the doffers of a Heilmann comber of 6 heads, using $10\frac{1}{2}$ in. laps.

The author is not aware that it is usual for any tension machine to be used in the operation of covering, as on a card, but the fitter may put round his waist a piece of good thick leather perhaps five or six inches deep, and in addition put a leather glove on each hand with just a hole for the thumb in each glove. These leather appliances are of course to prevent the teeth of the filleting from hurting the fitter. The filleting may be passed round the leathern waist belt and through the leather gloves, and guided, at a fair tension, upon the doffer by the fitter, while an assistant slowly turns the doffer shaft. To assist in giving the proper, firm, slow revolution to the doffer shaft during the covering operation a special handle and worm and worm wheel arrangement may be used, although in some cases it is deemed sufficient to fasten a large wheel temporarily to the shaft as a lever; such as for instance the large feed roller wheel of a card.

Quadrant.—Before describing the clothing of the doffers it was stated that leather washers were put inside the clutch box to prevent concussion. At the same time the coupling up of the quadrant to the clutch box might have been performed; but if not done then, it may be attended to at this stage.

The double quadrant cams put on the latest combers have complicated the work of fixing and coupling them up. The quadrant must be geared with the quadrant wheel sufficiently deep to prevent excessive backlash, and yet there should be no binding and wearing of the teeth through being geared too deeply. At the same time care should be exercised in having the cams to revolve, and to oscillate the quadrant upwards and downwards quite freely.

This is, of course, in addition to having the clutch box gearing to the proper depth of tooth, as before described.

Belonging to the same operation is the coupling up of the clutch box cam by means of the proper lever and fork to the clutch box itself. This must be done in such a way that the box opens and shuts quite freely without there being any binding in the fork, lever or cam bowl. Sometimes the fork will work easily one end up, while if fixed the other way up it will bind.

For accurate working of these double cams, it is essential in the first place that they be constructed at the machine shop to be as perfectly paired as possible.

Afterwards at the mill it is equally essential that the two cams be set exactly alike, as one of the cams may be fast directly to the shaft, while the other may be connected to the cam shaft by means of an adjustable circular plate or bush.

Various Details.

It may suit us to now again turn to some of the less important fixings, or if a labourer or apprentice be allowed to help the fitter he may be kept at such details in his spare time.

For instance, the front sliver or collecting tins may be put in position, these being numbered from the headstock end.

At some time previously it is probable that the back rails which carry the brackets for the nipper and feed roller springs will have been fixed up, this having been before specified. These rails are fastened by set screws to the large stands, and also sustain the large convex guide plates down which the sheet of cotton passes to the fluted steel feed rollers.

We might now put in the top feed rollers and weight them down with the proper springs, first having put on the levers or fingers which hold the top feed rollers in position, and to which the springs are hooked.

The curved lap guides or plates above referred to may have the small brushes attached to them, and then be fitted centrally in position on the proper rail. There is an adjustable steady washer to hold the curved plates in proper position.

These brushes are fastened underneath the curved plates by means of small bolts passing through the wood of the brushes, and through adjusting slots in the plates. Their object is of course to keep the bottom feed rollers clean, and they may just slightly impinge against the rollers.

The fixing, gearing up, and setting of the doffer combs may now be attended to if not done at the finish of the covering operation. In some cases these combs are oscillated by a crank motion at the coiler end of the comber, and in other cases by a crank motion fixed at the headstock end. In either case the coupling up of the driving and oscillating arrangement may be now carried out. All the combs should be set at the same angle and to the thickness of an ordinary steel rule from the doffer when the combs are about in their closest or most central position.

Leather-covered Rollers.—Attention may now be devoted to the important duty of fixing and setting the leather-covered detaching rollers. It is safer to at least finish off the work of setting these rollers with the weights on, and these should now be put in position and suspended from the proper hooks and chains. Care should be taken to see that each roller works freely in its brass bearings, and when once a roller has been set with certain brass bearings it is safer to keep the same bearings to it. Some of the leather rollers are $\frac{7}{8}$ in. diameter and others $\frac{13}{16}$ in. when covered, and it has been contended they would work better if made slightly convex, but the author has not found any to be used that were made convex. In any case they should be constructed, covered and adjusted with the greatest possible accuracy in order to get perfect detaching.

While on with the detaching rollers the short top steel detaching rollers may be also put in, the levers and horns for the lifters put in position and properly coupled up.

In the section of this book dealing with the setting of a comber full descriptions will be found of the necessary work included in fully setting the detaching rollers, so it need not be here recapitulated. This work of course includes setting the ends of the detaching rollers to be just clear of the lifter tops at the proper time, getting the three rollers parallel with each other, and setting the movements so that the backwards and forwards rotation of the three rollers and the bodily movement of the two top rollers shall all take place in proper sequence.

Top Combs.—At this stage the top combs may be fitted up and adjusted in practically every detail. The setting of the top combs at the various points may be ranked as one of the three or four important groups of settings, the others being the nippers, the detaching rollers, the feed rollers and the cylinders.

Of all these, the settings belonging to the top combs may be deferred to the last of the lot, since they occupy, as it were, a rather outside position, and it is requisite in setting them to see they do not touch the nippers or the leather-covered detaching rollers.

Because of their shape the top combs can be easily and safely packed. Occasionally, however, the needles get a little damaged in transit—and often so in actual working—and each fitter is usually supplied with a pair of pliers, very wide in the mouth, to aid in straightening any needles in the top comb that may have been damaged.

As stated, although the operation is very important, and involves several operations, it may be appropriately left until the comber is nearly ready for starting up.

For full instructions as to setting these combs the reader is referred to the section on resetting, but it may be stated that several details are really required in a complete resetting as follows :—

(1) The angle of the top combs ; (2) their distance from the fluted segment of the cylinder ; (3) the amount of their lifting motion ; (4) the time of lifting and dropping them. These adjustments might now all be properly made.

Coiler.—We have not before specifically alluded to the fixing up of the coiler motion.

It must, however, be understood that this can be fixed in position at almost any stage of the proceedings after the framings have been thoroughly put together and lined up. Except for the proper connection of wheels the coiler may be practically regarded as an independent attachment to the comber, in no way essential to the operation of combing and detaching ; but used as on a carding engine, in order to hold the sliver in a form convenient for the next succeeding process. The coiler bottom comes in position with the coiler top, so that we need not trouble to get the can in position to suit the throw of the eccentric as on a drawframe.

Top Feed Rollers.—It is probable that these may have been put in position, and held down in their places during setting, by the proper fingers and spiral springs. If, however, it has not been yet done, it should not be left over any longer. These rollers should be quite paralled to, and work flute and flute with, the bottom feed rollers, upon which they rest. They should also be set at a convenient forward inclination, with each roller set the same as the other, and a suitable distance from the top nipper. They should not bind in any way in the bearings.

The proper size of feed change wheel should be put on, and the feed peg set to move the star wheel at the proper time.

Final Details.—At the last there will always be various little details that will require attention, some of which might have quite conveniently been done previously. In our case the following items might be specified:—

There are covers or guards to various parts of the comber, and care should be now taken to ensure that these are all in their places, and quite clear of the working parts.

It may be that some of the wheels have not been put on, or some part of the gearing not properly coupled up, and, of course, all this kind of work must now receive attention.

The leather-covered rollers of the draw box may be put in and properly weighted up, and all the wheels of the draw box properly geared.

It is essential that the top and bottom rollers of the draw box should have each line set the proper distance from the next line, according to the length of cotton fibre, and also that the total and intermediate drafts of the draw box be right, although it is not every fitter that can readily determine whether these things are correct or not.

There is usually supplied with combers a rack to be bolted to the front of the roller beam in order to carry about 8 leather-covered detaching rollers, and this must be seen to be in its position.

Stop Motions.—There are often supplied with new combers one or two kinds of stop motions, as described elsewhere in this treatise, and care should be taken to have these properly fixed and coupled up. One of these motions may consist of a motion which automatically stops the machine for a full can, while another may serve to automatically stop the machine when sliver fails to come properly on the front table from any cause. In either case it is highly important that the working parts of these motions, such as spoons, rods, levers or springs, be adjusted to the best advantage.

Starting Up.

Before an actual start is made we must be quite certain that all the many nuts and screws are well secured, all the bearings well oiled, the cams greased, all the springs under proper tension, and the machine capable of being turned by hand without anything catching, binding, or getting fast.

Finally, the laps can be put in and the machine started off at a suitable speed.

Now is the time when it may be expected that any unskilful or careless fitting will be shown up if such exist. As soon as possible after starting the percentage of waste may be tested several times over, and, if necessary, slight readjustments made accordingly.

Messrs. Dobsons' Instruction Sheet.

Although the setting and timing of the Heilmann comber has been fully dealt with in the last three chapters of this book, yet it is deemed advisable to here reproduce the official timing sheet of the eminent firm of comber makers, Messrs. Dobson & Barlow, exactly as Hetheringtons' sheet was reproduced at the end of the previous chapter.

Appended is Dobson's instruction sheet:—

Send all top rollers to be covered, and scour fluted rollers and fluted segments; put the machine in its place and level it.

Setting Cylinders.—Put the cylinders in and set the index wheel to 5, and with $1\frac{1}{8}$ in. gauge between flutes of detaching roller and front edges of segments, make the cylinder fast to the shaft, and then set the detaching roller flutes to 23's gauge from flutes on segments.

Distance between flutes of detaching and feed rollers are as follows:—

Egyptian cotton . . .	$1\frac{13}{16}$ in.
Long Sea Islands cotton . . .	$2\frac{1}{16}$,,

Distance between flutes of detaching rollers and front edge of cushion plate as follows:—

Egyptian cotton . . .	$1\frac{3}{16}$ in.
Long Sea Islands cotton . .	$1\frac{7}{16}$ in.

Setting Nippers.—Put on the cushion plates and set them up to one thickness of writing paper from the nipper knife and to $1\frac{3}{16}$ gauge from flutes of detaching roller to front edge of cushion plate (the nipper must be open and the stop screws $\frac{1}{4}$ in. through); next set the edge of the knife to 19's or 21's gauge from cylinder needles with the right-hand screws only, and see that the distance between the detaching roller and cushion plate has not altered (a $\frac{5}{16}$ in. gauge for a duplex comber, or a $\frac{3}{8}$ inch gauge for a single nip comber, must be between the point of the stop screw and nipper stand); then set the left-hand screws by removing the gauge and letting point of screw touch the stand; then put on the springs. Move the cam round until the bowl is on the circular part, and put the $\frac{5}{16}$ in. or the $\frac{3}{8}$ in. gauge (as the case may be) again between the stop screw and stand, then screw up the nuts on one connecting rod until the gauge is just eased; now turn the cam round until the screw points are eased from the stands, then turn the cam back again as it was and try the gauge between the knife and cylinder needles.

Finally, see that all are quite clear and to gauge.

Set nippers	to 19's	wire gauge	to cylinder	needles	for Egyptian cotton.	
,, ,,	,, 21's	,,	,,	,,	,, Sea Islands ,,	
,, top combs	,, 19's	,,	,,	segment	,, Egyptian ,,	
,, ,,	,, 21's	,,	,,	,,	,, Sea Islands ,,	
,, ,,	,, an angle of 28 degrees or to 14's angle gauge.					

Setting Feed Rollers.—For Egyptian cotton with $1\frac{13}{16}$ in. between flutes of feed and detaching rollers make the slides fast, put on the top rollers and springs, and then set the rollers parallel to nipper knife and a convenient distance from it. For Long Sea Islands cotton a $2\frac{1}{16}$ in. gauge must be used between flutes of feed and detaching rollers.

Setting Brushes.—Let the bristles touch brass of the combs of one cylinder, then make a gauge to go between the brush and cylinder shafts, and set others to this gauge.

Brush Tins.—Set them so as to clear the cylinder and doffer about $\frac{1}{8}$ in.

Lap Plates.—Should be set clear of wood and feed rollers when the clearer brush is on.

Lap Guides.—Should be set $\frac{1}{4}$ in. wider than laps and central with boss of feed roller.

Top Detaching Rollers.—Move the 80's wheel on cam shaft out of gear and turn round the cam shaft until the quadrant moves forward, then set the index wheel to $6\frac{3}{4}$ for double nip and 6 for single nip, and put the 80's wheel in gear; turn the cam shaft round and see that the roller moves forward at $6\frac{3}{4}$ for duplex and 6 for single nip; then clean, oil, and put the brass tubes on the covered top rollers, and put rollers in, weight them, let them rest on the segments, and bring up the lifters until the nearest will admit one thickness of paper between it and the tubes (the bowl must be on the highest part of the cam). Then move the small slides on the lifters until each will admit one thickness of paper like the first one, and set the cam so that the roller will touch segment at $6\frac{3}{4}$ for duplex and $6\frac{1}{2}$ single nip.

Fluted Top Detaching Rollers.—Should be set with the greatest care so that the flutes be parallel in the flutes of bottom roller and quite clear from the leather roller when same is touching segment.

Top Combs, etc.—For Egyptian cotton set the top combs to 19's gauge from segments of cylinder and to 28 degrees angle or 14's angle of top comb gauge; for Sea Islands cotton set the top combs to 21's gauge. Put on the sliver plate and gear up all the draw box, coiler and wood rollers, set the doffer combs, and gear up the doffer shaft.

Timings for Double Nip :—

		Egyptian Cotton.		Sea Islands Cotton.
Clutch wheel in gear .	at	$4\frac{3}{8} = 17\frac{1}{2}$	teeth of index wheel.	$4\frac{3}{8}$
Feed	at	$4\frac{1}{2} = 18$	,, ,,	$4\frac{1}{2}$
Top comb down . .	at	$4\frac{1}{2} = 18$	,, ,,	$4\frac{1}{2}$
Detaching roller forward	at	$6\frac{3}{4} = 27$	,, ,,	$6\frac{3}{4}$
Detach . . .	at	$6\frac{7}{8} = 27\frac{1}{2}$	,, ,,	$6\frac{7}{8}$
Nip	at	$9 = 36$	,, ,,	$9\frac{1}{4}$

Timings for Single Nip :—

		Egyptian Cotton.		Sea Islands Cotton
Clutch wheel in gear .	at	$\frac{3}{4} = 3$	teeth of index wheel.	$\frac{3}{4}$
Feed	at	$5 = 20$	,, ,,	5
Top comb down . .	at	$5\frac{1}{2} = 22$	,, ,,	$5\frac{1}{2}$
Detaching roller begins to deliver . .	at	$6 = 24$	,, ,,	$6\frac{1}{2}$
Detach . . .	at	$8\frac{1}{2} = 26$	,, ,,	$6\frac{1}{2}$
Nip	at	$9 = 36$	,, ,,	$9\frac{1}{4}$

To Calculate Percentage.—Add the weight of cotton and waste together, then multiply the weight of waste by 100, and divide the product by the weight of both waste and cotton, thus :—

Waste . .	15 grains.	100
Cotton . .	58 ,,	15
	73	73)1500(20·5
		146
		400
		365
		35

Notes.—Be sure that all screws, etc., are well screwed up, and that all bearings are well oiled and the cams well greased, and mind the combs do not get damaged.

The greater the angle of the combs .	Greater the waste.
Later the nipper closes . . .	,, ,,
Late feeding	,, ,,
Close setting	,, ,,

Curling is caused by the detaching roller being badly covered or being short of lubrication, and the top covered roller not touching cylinder segment at the proper time ; or top fluted detaching roller not being set perfectly parallel with the flutes of bottom roller.

PRODUCTIONS FOR DOUBLE NIP.

No. of nips per minute.	Weight of lap per yard.	Width of lap.	Waste.	Lb. per head of combed sliver.	Kind of cotton worked.
120	8 dwt.	7½ inches.	20 per cent.	52·2	Sea Islands.
120	9 ,,	8½ ,,	20 ,,	59·16	,,
120	9 ,,	7½ ,,	18 ,,	61·48	Egyptian.
120	10½ ,,	8½ ,,	18 ,,	73·77	,,
120	9 ,,	7½ ,,	18 ,,	61·48	American.
120	10½ ,,	8½ ,,	18 ,,	73·77	,,

The above productions are based upon a speed of 120 nips per minute, and for good qualities of work produced. Dobsons' say they have machines working laps weighing 12 dwt. per yard and 8½ in. wide—this means increased production.

CHAPTER VII.

STOP MOTIONS: VARIOUS CALCULATIONS.

THERE are two or three descriptions of stop motions which are applied to combers when required. The one kind is on the spoon stop motion principle, in which the spoons are placed on the front table, and the failure of any one of the slivers results in the movement of the spoon lever and the knocking off of the comber, much after the manner of the stop motion on the draw-frame for the prevention of single. The prevention of single and waste is also the purpose of this comber stop motion. In some cases the spoons for all the slivers are placed in a line on the front table just before the slivers enter the back rollers of the draw box, but some practical men object to this on the ground that if the ends of cotton furthest from the draw box happen to break, the spoon stop motion does not act with sufficient promptitude.

To meet this objection it is now often the practice to arrange the spoon for each sliver on the front table, quite close to the calender rollers for that sliver. On many combers no stop motion whatever is applied for the prevention of single, because it is considered that the delivery of sliver from each head of a comber proceeds so slowly that breakages of the ends should always be detected and remedied before any particular mischief is done. On the other hand, it must be remembered that a comber tenter frequently has 48 "heads" to look after and keep straight, and it may readily happen that she is engaged elsewhere when an end breaks or goes wrong in any way.

Full-can Motion.

Another comber stop motion is the full-can motion, which has for its object the automatic knocking off or stopping of the comber when a certain definite length of sliver has been put in the can. It may be noted that a standard size of can—*i.e.*, 36 in. by 9 in.—will contain a surprising length of comber sliver on account of the parallel and smooth disposition of the cotton fibres which compose the sliver. The following is the description and calculation of a full-can motion actually at work: The bottom block roller is $2\frac{3}{4}$ in. diameter. There is a wheel of 24 teeth on the end of this block roller shaft, which drives a stud wheel of 43 teeth. On the same stud is a single worm which drives the first knocking-off wheel of 49 teeth, and this drives the second knocking-off wheel of 50 teeth. What we have to find is the length of sliver put in the can before the knocking-off motion acts. On one of the two knocking-off wheels there is a peg, and on the other a socket into which the peg must fit before knocking off can take place. If there were only one knocking-off wheel used, it would only have to make one revolution before knocking off took place, but in this case it takes 49 revolutions of the one wheel and 50 of the other, and therefore both wheels must enter into the calculation. The full calculation is as follows:—

$$\frac{2{\cdot}75 \times 22 \times 50 \times 49 \times 43}{7 \times 24 \times 1 \times 12 \times 3} = 1{,}053 \text{ yards in full can.}$$

It is highly probable that more weight and length of sliver can be got into the same size of can the more the fibres composing the sliver become parallel. For instance, it is very likely that the foregoing length of sliver, *i.e.*, 1,053 yards, could not be anything like as well got into the same size of can at the carding engine, the sliver being kept also of the same counts. Again, it is probable that at the last head of drawframe a still greater length of sliver can be got into a can than at the comber. To show this point the following particulars of the knock-off motion of a drawframe are given: There is a 26 wheel on the end of one of the calender rollers driving a 46 stud wheel. A worm on the same stud drives simultaneously a 49 knocking-off wheel and a 50. The calender rollers are three inches diameter, so that the full calculation works out as below :—

$$\frac{3 \times 3{\cdot}1416 \times 46 \times 49 \times 50}{26 \times 1 \times 12 \times 3} = 1{,}135 \text{ yards.}$$

A comparison of the two answers will show that there are 82 yards of sliver more put into the can at the last head of drawing than at the comber, the counts of sliver being practically the same in each case. It is evident that more than 1,000 yards of sliver can easily be coiled inside one can.

It is a fact well known to practical men that drawframe full cans are oftener heavier to knock about for the tenters than the card full cans, and because of this there are some good men who contend that the cans should be larger in diameter at the carding engine than at the comber and drawframe. The above knocking-off motions were applied to frames producing a moderately fine-hank sliver.

Stop Motions of Heilmann Comber.

The parts belonging to Dobson's automatic stop motion for a full can are illustrated in Figs. 69, 70 and 71.

Fig. 69 shows the parts standing in front of the draw box.

Reference Letters for Figs. 69 *and* 71.

- A Name Plate on Creel end.
- B Stop Lever for Knocking-off Rod.
- C Ordinary Stop Rod connected to Driving Belt Fork.
- D Automatic Knocking-off Rod.
- *d* Incline Stop Pin or Key on D.
- E Upright Connecting Link between Levers B and F.
- F Knocking-off Wheel Lever.
- G Bracket in which Lever, F, is fulcrumed.
- H Lower Knocking-off or Swivel Wheel.
- I Upper Knocking-off Wheel.
- J Single Worm Driving Wheel, I.
- K Stud Wheel driven from Front Roller.
- *a* in Fig. 71 Knocking-off Pin fixed in Wheel, I.
- *b* in Fig. 71 Knocking-off Snug or Socket for Pin, *a*, to fit in.
- M, N, O, P Wheels by which Front Bottom Roller, S, is driven from the Front Shaft, V.
- Q Driven Bevel on Front Shaft, V.
- R Bevel on Cylinder Shaft end.
- S Front Bottom Roller.
- T Front Top leather-covered Roller.
- U Bracket for Shaft, V.
- V Front Shaft running between Block Rollers and Draw Box Rollers.

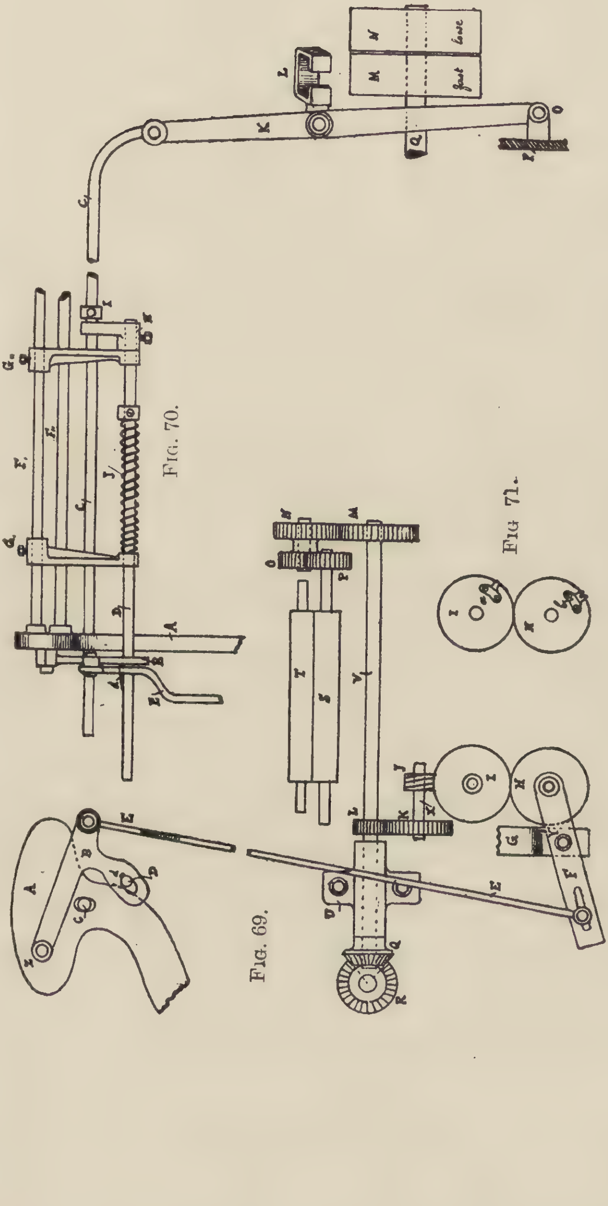


FIG. 70.

FIG 71.

FIG. 69.

Fig. 70 shows the parts standing in front of long table.

Reference Letters for Fig. 70.

A	Standard for the Creel.
B	Stop Lever for Knocking-off Rod.
C	Stop Rod (ordinary).
D	Knocking-off Rod (automatic).
E	Upright Connecting Link.
F_1, F_{11}	Creel Rods.
G_1, G_{11}	Stop Fingers for Knocking-off Rod.
H	Connecting Finger between Rods C and D.
I	Collar pressing against Finger, H.
J	Knocking-off Spring.
K	Upright Belt Lever.
L	Belt Fork.
M	Fast Driving Pulley of Comber.
N	Loose Driving Pulley of Comber.
O	Fulcrum for Upright Belt Lever, K.
P	Framing to which Lever, K, is fulcrumed.
Q	Pulley Shaft.

Action of Parts.

When it is simply required to start and stop the frame manually the long rod, C, is moved lengthways by the hand of the operator in the direction required, thus moving the belt from one pulley to the other.

As regards the automatic knocking-off motion for full cans the worm wheel, J (Fig. 69), is moved slowly round by the worm, J, which itself receives motion from the bottom front roller, S, in a manner not shown.

Of the two knocking-off wheels, H, I, the one contains 49 and the other 50 teeth, so that the pin, *a*, and socket, *b*, attached to them can only come together at long intervals as demonstrated by calculation on page 211, when they do come together the lower wheel, H, is pushed downwards, with the result that the lever, F, is swivelled on fulcrum, Y, and the rod or link, E, is lifted upwards.

Until this action takes place the knocking-off rod, D (Fig. 70), is held in position by the stop pin, *d*, catching against the top stop lever, B, although the spring, J, is all the time endeavouring to slide rod, D, longitudinally.

The lifting of the link, E, and therefore of the stop lever, B, releases pin, *d*, from its hold by the stop lever, B, when the spring, J, immediately slides the knocking-off rod, D, along.

Because stop rod, C (Fig. 70), is connected to rod, D, by the finger, H, and collar, I, the stop rod, C, is carried along with the rod, D, and in this way the driving belt is moved from the fast to the loose pulley, and the frame is stopped.

When it is required to start the frame the stop rod, C, is moved by hand to the left, and the same action compels also the movement of rod, D, sufficiently to the left to cause it to latch and be retained again by pin, *d*.

Hetherington's Stop Motions.

Having given a sketch and description of Dobson's measuring motion or automatic stop motion for full cans, we have now to deal more fully with automatic stop motions as applied to Messrs. Hetheringtons' combers. Stop motions may be applied to combers on the Heilmann principle to act as below: (1) upon the failure of an end or sliver to pass down the long front table of the machine; (2) upon the failure of a sliver between draw box and the coiler top rollers; (3) when the coiler can is full.

Front Stop Motion.

Stop motions on the spoon principle can be applied at or near the front table by any of the comber makers when required, but many practical men in England do not care to have them, partly on account of tenters getting to trust to the stop motions too implicitly and letting this serve instead of care and watchfulness on their part.

More work of course devolves upon the overlookers in keeping the motions in thorough repair. When these motions, however, are in the best working order they serve as an efficient check to big laps on the feed rollers and to imperfect delivery of the sliver from any cause.

The motion described below as made by Messrs. Hetherington is one of the latest and best for the purpose.

A great many of these motions have been sent to places where great exactitude of work is required. On the Continent the mill owners mostly insist upon some such motion.

This motion saves bad work by automatically stopping the machine when the sliver breaks or becomes very light.

We have now to refer to Figs. 72 and 73.

Index of Parts.

A Front Tumbler balanced on B.
B Knife Edge.
C Bottom extremity of Tumbler, A.
D Lever with specially formed hole through which C passes, and fixed to Rocking Shaft, E.
D′ Spring acting on Lever, D.
E Rocking Shaft used for both Stop Motions.
F Stud on end of Lever, F′, and sliding in Slot shown, belonging to Eccentric Lever, H.
G Cam Shaft.
G′ Eccentric on Cam Shaft used to oscillate Lever, H.
H Eccentric Lever.
J Notched Knocking-off Rod sliding through K.
K Bracket with oblong hole for J to slide along, and carrying also the Stop Rod, L.
L Stop Rod which can be acted on by J.
M Catch or Stop Piece fixed to stop Rod, M, and used to engage with N on Rod, L.
N Catch or Stop Piece fixed to Rod, J, and used to engage with M on the Stop Rod.
O Weight on Notch Knocking-off Rod, J, used to keep the end of J down in the hole in Bracket, K.
P Spiral Spring, which during working of Comber exercises a longitudinal pull on Rod, J.

Action of Parts.

Any one who thoroughly understands the action of one of the spoon stop motions of a drawframe should readily comprehend the construction and action of this particular motion, as it is to all intents and purposes quite similar thereto.

Briefly put there is a rectangular bar with a strong spiral spring always trying to slide the bar lengthways when the machine is working, but cannot do so because the bar is latched on a special bracket.

The failure of a sliver, however, to pass through the trumpet of the sliver tin causes the release of the bar, which is then forcibly slided along by the action of the spring.

The bar in question is connected by special brackets or fingers to the stop rod of the machine, and in this way the stop rod is slided along with the knocking-off bar. The stop rod being connected to the strap fork, the latter is thereby

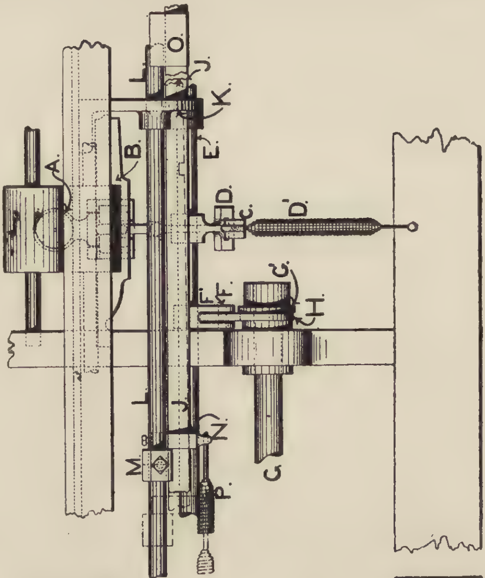


FIG. 73.

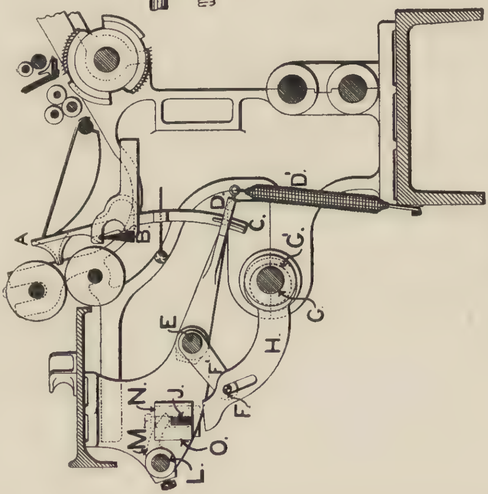


FIG. 72.

moved along so as to put the driving belt upon the loose pulley.

Referring now to Figs. 72 and 73, the eccentric, G′, is constantly oscillating the eccentric lever, H, but the arrangement at the stud, F, and slot, F′, is such that H is allowed to work up and down, without coming in contact with the knocking-off rod, J, so long as tumbler, A, is kept in position by the sliver.

When, however, a sliver breaks or becomes very light, through lap being finished or licking, or through a roller lap, or through imperfect detaching, the tumbler, A, yields to its heavier or weighted tail end at C, and moves into a position whereby C locks the lever, D, prevents oscillation, and, therefore, that of the rock shaft, E, and slotted lever, F.

During working the end of the lever, D, may have an extreme movement of perhaps $1\frac{1}{4}$ in., which is arrested by movement of the spoon or trumpet lever, A, C.

This locking of the rock shaft or levers, D, F, compels an upward motion of the eccentric lever by the slotted portion sliding up the stud, F, and this upward motion of H is sufficient to allow it to lift up at the knocking-off bar or notched rod, J, and so release J from the stop in the bracket, K.

Immediately rod, J, is thus released, it is slided along under the impulse of the spring, P, and the adjustable finger, N, carried by J, comes against the finger or snug, M, carried by the stop rod, L, so that the stop rod, L, is also slided along, and the driving belt is moved from fast to loose pulley.

It is possible also to make the machine to knock off exactly in above manner when the sliver comes out too heavy, this being done by the heavy sliver moving the tail end, C, of trumpet, A, a certain distance in the opposite direction to that of a light sliver, but also the same effect of locking levers, D, F′, and rock shaft, E.

For the better understanding of these stop motions a separate view is shown in Fig. 74 of the trumpet, A, C, the levers, D, F, the rock shaft, E, and the cam or eccentric, G′.

Fig. 75 shows the arrangement made by Hetheringtons' to automatically stop the machine when an end fails or runs very light at the coiler end.

For this motion use is made also of the same eccentric, rock

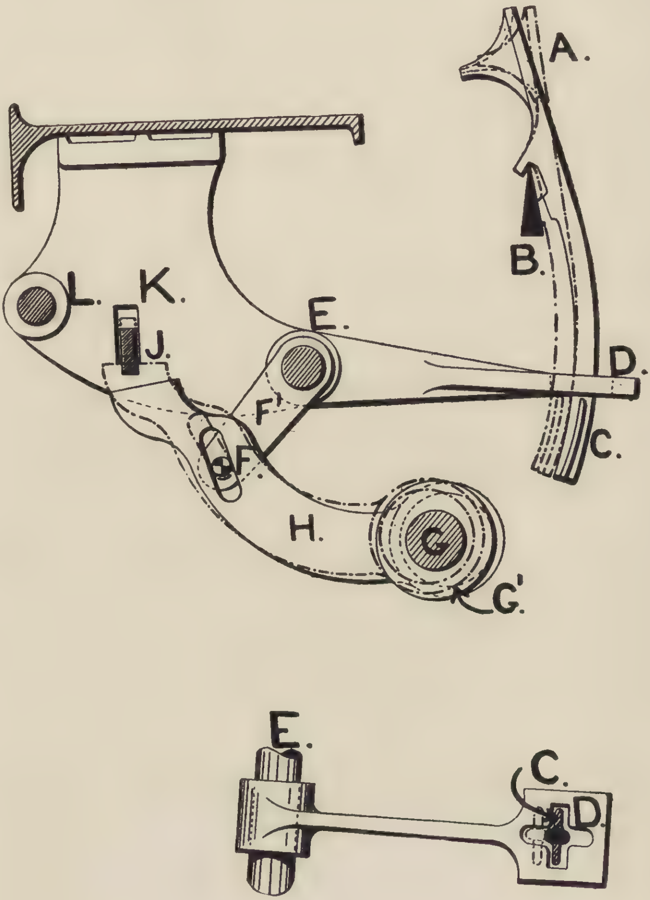


FIG. 74.

shaft, slide bar, and eccentric lever as for the front stop motion previously described, and such common parts are lettered the same in Fig. 75 as in Figs. 72, 73 and 74.

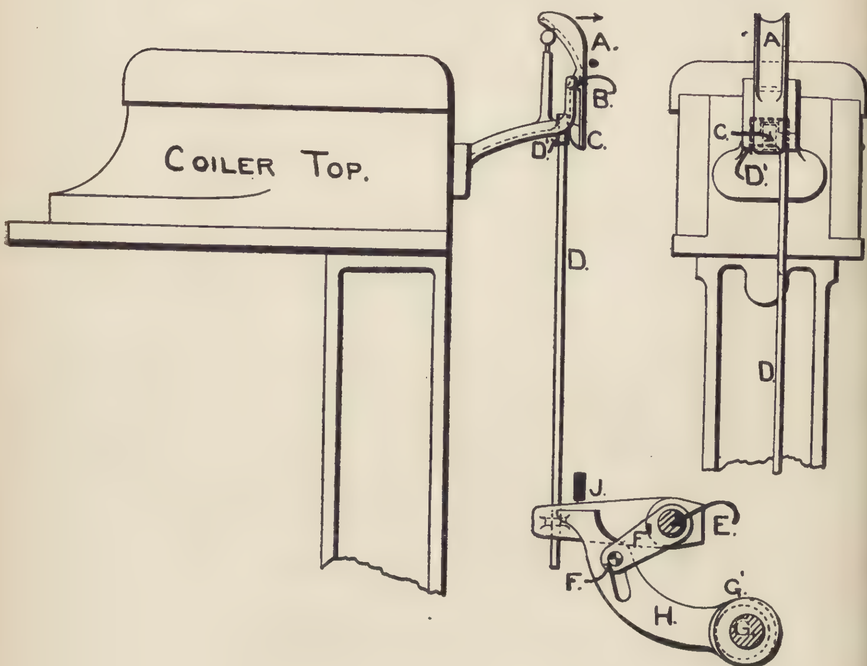


FIG. 75.

Index of Parts.

A Weighted Tumbler.
B Knife Edge for supporting A.
C Hook at bottom end of Tumbler.
D Rod moved up and down from Rocking Shaft, E.
D′ Projection on Sliding Rod, D, engaging with C.
E Rocking Shaft.
F Stud in Lever, F′.
F′ Rock Shaft Lever.
G Cam Shaft.
G′ Eccentric oscillating H.
H Eccentric Lever.
J Knocking-off Bar.

} These parts are used also with Figs. 72 to 74 for the front stop motion and lettered the same.

Action of Parts.

When an end breaks or is not the average weight—due to roller laps in the draw box and other causes—the spoon lever or tumbler, A, yields to its weighted or heavier lower extremity, C, and falls away from the coiler top.

This action brings the hooked portion, C, of the spoon lever into the way of the projection, D′, on the upright rod, D, and stops the down motion of D, and in this way arrests the motion of rod, F′, carrying the stud, F. The stud, F, then acts as a guide for the eccentric lever, H, and the latter mounts the stud and comes directly under the notched rod or knocking-off rod, J, forcing J upwards until it is lifted out of the stop in bracket, K. Immediately J is thus released it is slided by spring, P, and stops the machine by N pushing M as described in Figs. 72 to 74 for the front stop motion.

In reference to the stop motions just described it must be clearly understood that in the ordinary working of the eccentric lever, H, and the lever, F′, with stud, F, the action is so arranged that the combination allows the lever, H, to work up and down without coming into contact with the knocking-off rod, J. It is only when one of the tumblers, A, acts and arrests the rocking shaft and keeps stud, F, fixed that the eccentric lever, H, is guided with its slotted portion up the stud so as to lift up the knocking-off rod and stop the machine.

Measuring Motion.

Previously in this chapter we have sketched and described a motion as made by Messrs. Dobson for automatically stopping the comber when a certain length of cotton has been put into the can.

Such motions are used when firms require all the cans to contain an equal length of the combed sliver.

In Messrs. Hetheringtons' comber there is placed on the bottom of the front calender roller a bush with a small projection working in connection with a lever. Every revolution of the calender shaft moves this lever and thereby moves two small pawls or catch levers fixed to a changeable ratchet wheel. The movement of the ratchet wheel is accompanied by the movement of a worm and worm wheel. On the worm wheel is a peg or snug which comes in contact with the knocking-off rod.

The peg or snug lifts the notched rod or knocking-off rod out of its notch, when it is immediately slided along by the charged spring as described with the other stop motions of this firm. The stop rod of course is taken along with the knocking-off rod.

In all the three stop motions just described when the machine is started by moving the stop rod along by hand the notch lever is latched by the same movement. Fig. 75 (*a*) is a small general view of the well-known comber of Hetheringtons' make.

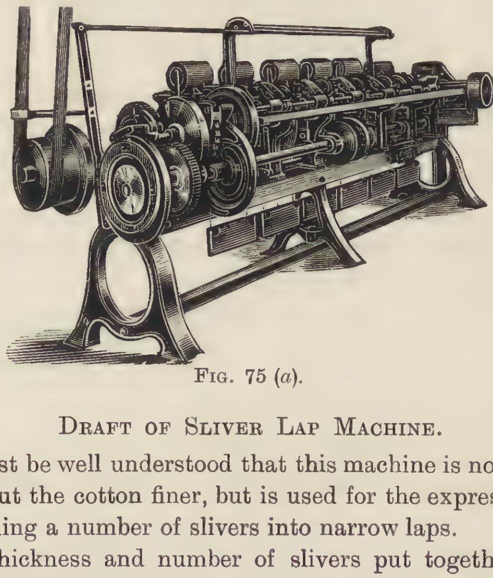


Fig. 75 (*a*).

Draft of Sliver Lap Machine.

It must be well understood that this machine is not intended to draw out the cotton finer, but is used for the express purpose of combining a number of slivers into narrow laps.

The thickness and number of slivers put together do not favour much roller draft, so that about 1·6 to 1·85 draft is generally found sufficient. Of this, perhaps, 1·15 may be between the back and middle rollers.

As a matter of fact, roller draft is not much needed in the machine, while its introduction tends to give roller laps and reduce production.

If there is too much draft in the rollers, or the leathers want varnishing, we may expect a tendency to give a cloudy ribbon or lap. If the slivers fed to this machine are uneven cloudiness is very liable to show up in the ribbons of cotton.

Draft Particulars.

On the lap roller end or wheel . . .	72 teeth.
Wheel on end of front shaft . . .	12 ,,
,, other end of front shaft . .	29 ,,
Calender roller wheel	72 ,,
On the same end of calender roller . .	90 ,,
Back roller wheel	50 ,,
Diameter of back roller	$1\frac{1}{2}$ in.
,, lap ,, ...	12 ,,

$$\frac{1\cdot5 \times 72 \times 29 \times 90}{12 \times 72 \times 50 \times 12} = 1\cdot83 \text{ draft.}$$

Calculations on the Ribbon Machine.

These calculations have been adapted to the ribbon machine as made by Messrs. Hetherington according to the dimensions given in Fig. 76.

There is a long driving shaft, which contains on its outer end the fast and loose pulleys, and which extends nearly the full length of frame, below the drawing rollers. In one specific case the following dimensions are given as being actual working conditions :—

(1) The driving shaft makes 280 revolutions per minute, and contains a 72 wheel, which drives, by means of an 80 carrier, a 68 wheel on the front roller. From this ascertain the revolutions per minute of the front roller.

$$\frac{280 \times 72}{68} = 296\cdot4.$$

(2) On the front roller is a 25 wheel driving 100 large crown or stud wheel. On same stud is the change pinion of 50 teeth driving a 70 back roller wheel. The diameters

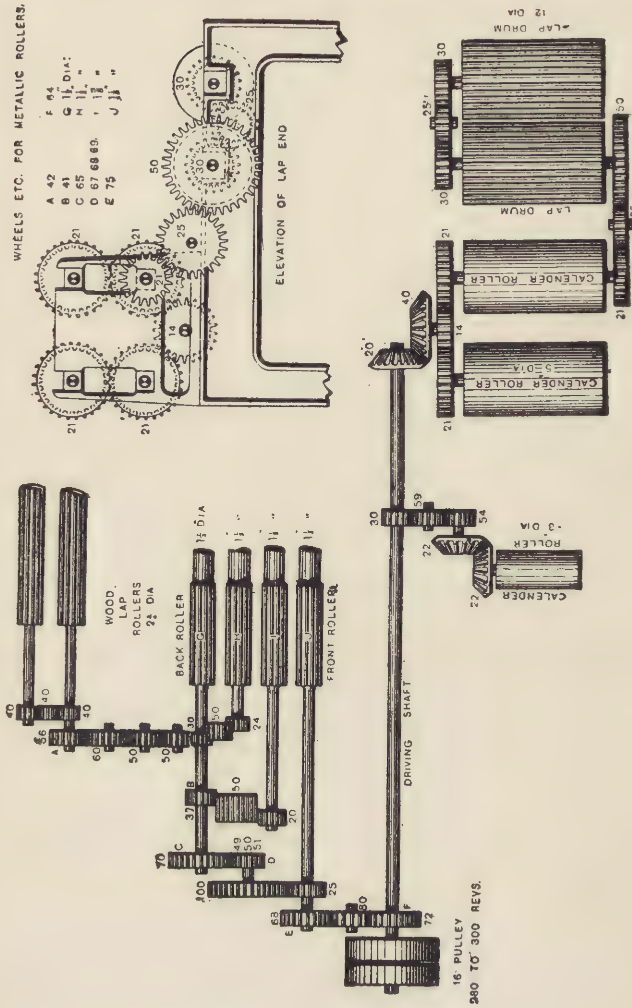


Fig. 76.

of front and back rollers are both $1\frac{1}{2}$ in. Find total roller draft.

$$\frac{100 \times 70}{25 \times 50} = 5{\cdot}6 \text{ draft.}$$

Note.—By leaving out the change pinion in above we get a draft constant of 280.

(3) On the back roller is a 37 pinion driving—by means of a carrier—a 20 pinion on the second roller from front. In this case also the diameters of the two rollers are alike. Ascertain draft between back roller and second roller from front.

$$\frac{37}{20} = 1{\cdot}85 \text{ draft.}$$

(4) On the back roller is a second pinion which contains 30 teeth and drives, by means of a carrier, a 24 wheel on the third roller from the front. The rollers are alike in diameter. Ascertain draft between these two rollers.

$$\frac{30}{24} = 1{\cdot}25 \text{ draft.}$$

(5) From the foregoing drafts it is required to ascertain the draft between third and second rollers from the front.

Rule.—Divide the two middle drafts, the larger by the smaller.

$$\frac{1{\cdot}85}{1{\cdot}25} = 1{\cdot}48 \text{ draft.}$$

(6) From the foregoing drafts ascertain the draft between the front roller and the second from front.

Rule.—Divide the total draft by the draft between back roller and second from front.

$$5{\cdot}6 \div 1{\cdot}85 = 3{\cdot}027 \text{ draft.}$$

(7) Ascertain total draft from the three intermediate drafts as found above.

Note.—It must be remembered in this case that the three drafts are multiplied together, and not added as students and others often imagine.

$$3{\cdot}027 \times 1{\cdot}48 \times 1{\cdot}25 = 5{\cdot}599 \text{ draft.}$$

It will be noted that this answer is just an almost infinitely small fraction less than the total draft obtained by the previous method, this being due to the decimals not being all quite worked out.

For the benefit of some practical men and students not very conversant with the multiplication of decimal fractions, the full working of this one calculation is given below :—

$$
\begin{array}{r}
3{\cdot}027 \\
1{\cdot}48 \\
\hline
24216 \\
12108 \\
3027 \\
\hline
4{\cdot}47996 \\
1{\cdot}25 \\
\hline
2239980 \\
895992 \\
447996 \\
\hline
5{\cdot}5999600 \text{ Ans.}
\end{array}
$$

8. On the back drawing roller there is a 30 pinion driving by two carrier wheels of 50 teeth each, and one of 60 teeth, a 56 wheel on the first fluted wooden lap roller, the latter being $2\frac{3}{4}$ in. diameter.

Find draft between the wooden rollers and the back drawing roller.

$$\frac{1\frac{1}{2} \times 56}{2\frac{3}{4} \times 30} = \frac{3 \times 4 \times 56}{2 \times 11 \times 30} = \frac{56}{55} = 1{\cdot}018 \text{ draft.}$$

9. It is required now to find the draft between the front drawing rollers and the fluted lap drums or rollers at the lap head.

On the driving shaft is a wheel of . .	72	teeth.
This drives a wheel on front drawing roller	68	,,
Also on the driving shaft is a bevel of .	20	,,
This drives calender roller bevel wheel .	40	,,
On same stud as this bevel is a wheel .	14	,,
This drives a wheel on calender roller .	21	,,
On other end of calender roller is a wheel .	21	,,
Driving a wheel on the first lap drum .	50	,,

The lap drums have a diameter of . .	12	in.
The drawing rollers have a diameter of .	$1\frac{1}{2}$	,,

In this case we can place the diameter of the lap drum above the line and the diameter of the front drawing roller below the line. We may place the 50 wheel on the end of the lap drum below the line and place with it every alternate wheel. The other wheels must all go above the line.

$$\frac{12 \times 21 \times 14 \times 20 \times 68}{1{\cdot}5 \times 50 \times 21 \times 40 \times 72} = 1{\cdot}06 \text{ draft.}$$

10. From the last two drafts and the total roller draft as before found, it is required to ascertain the real total draft over all.

$$1{\cdot}06 \times 1{\cdot}018 \times 5{\cdot}6 = 6{\cdot}042 \text{ draft.}$$

11th calculation:—

On the driving shaft there is a wheel of .	72	teeth.
Driving a wheel on front drawing roller .	68	,,
Also on the driving shaft there is a wheel of	30	,,
Driving a stud wheel of	54	,,
On same stud there is a bevel wheel of .	22	,,
Driving a bevel on end of first calender roller	22	,,
Diameter of calender roller	3	in.
,, front roller	$1\frac{1}{2}$	,,

Ascertain draft between front roller and first calender roller.

$$\frac{3 \times 22 \times 30 \times 68}{1{\cdot}5 \times 22 \times 54 \times 72} = 1{\cdot}049 \text{ draft.}$$

12. In the foregoing calculation the particulars are given relating to the driving of the first calenders.

The second calenders are driven as follows:—

Also on the driving shaft there is a bevel of	20	teeth.
This drives a bevel on stud of	40	,,
On same stud is a wheel of . . .	14	,,
Driving a wheel on end of second calender of	21	,,
Diameter of second calender . . .	5	in.

Find draft between first and second calender rollers.

$$\frac{5 \times 14 \times 20 \times 54 \times 22}{3 \times 21 \times 40 \times 30 \times 22} = 1 \text{ draft.}$$

On the second calender roller is a wheel of . . 21 teeth.
Driving a wheel on end of lap drum . . . 50 ,,
Diameter of fluted lap drum . . . . 12 in.

Ascertain the draft between second or last calender rollers and the fluted lap rollers or lap drums.

$$\frac{12 \times 21}{5 \times 50} = 1{\cdot}008 \text{ draft.}$$

13. Taking the revolutions per minute of the driving shaft at 280, and the particulars as given in above tables, ascertain—

(*a*) revolutions per minute of first calender rollers.
(*b*) ,, ,, of second calender rollers.
(*c*) ,, ,, of fluted lap drums.

Answers.

(*a*) $$\frac{280 \times 30 \times 22}{54 \times 22} = 155{\cdot}5 \text{ revolutions.}$$

(*b*) $$\frac{280 \times 20 \times 14}{40 \times 21} = 93{\cdot}3 \text{ revolutions.}$$

(*c*) $$\frac{280 \times 20 \times 14 \times 21}{40 \times 21 \times 50} = 39{\cdot}2 \text{ revolutions.}$$

14. The roller draft constant may be found as below. On the front roller is a 25 wheel driving a 100 crown stud wheel. On same shed is the change wheel driving a 70 back roller wheel. Taking the back and front rollers at the same diameter, we get—

$$\frac{100 \times 70}{25} = 280 \text{ constant.}$$

15. With this draft constant of 280 find (*a*) the draft which a 48 change pinion will give. The change pinion required to give 5·5 roller draft.

(*a*) $$\frac{280}{48} = 5{\cdot}83 \text{ draft.}$$

(*b*) $$\frac{280}{5{\cdot}5} = 50{\cdot}9 \text{ change pinion.}$$

Taking all the calculations together, it will be seen that we have given all the driving of the calender rollers, fluted lap drums, and back wooden lap rollers. We have found all the several intermediate drafts, and from these obtained the total draft between the back wooden feed lap roller and the front fluted lap drums. This draft can be found also in one operation from the particulars previously given, the calculation being as below:—

$$\frac{4 \times 12 \times 21 \times 14 \times 20 \times 68 \times 100 \times 70 \times 56}{11 \times 50 \times 21 \times 40 \times 72 \times 25 \times 50 \times 30} = 6{\cdot}02 \text{ draft.}$$

By leaving out the 50 change wheel in bottom line of calculation the constant for draft would be found to equal 301.

Proof: $6{\cdot}02 \times 50 = 301$.

The ribbon lap machine may produce from 400 lb. to 500 lb. weight of laps per day of 10 hours, after allowing about 10 per cent. for loss by various stoppages.

As a matter of opinion the writer is quite opposed to running this machine at high speeds. The production, however, may be increased by having the lap heavier per yard. The class of cotton also affects the production and the possible practical limit of speed. The width of the lap also may affect the weight of cotton turned off, this width being from $7\frac{1}{2}$ in. to $10\frac{1}{2}$ in. as may be required.

The weight per yard of the laps may be from 10 to 14 dwt., the lighter weights being for the narrower laps and the finer counts.

As regards power required to drive the machine, this may be from $\frac{3}{4}$ to $1\frac{1}{4}$ i.h.p. according to circumstances, and may be taken at an average of 1.

Stop Motions.

By a modification of the principle of the spoon stop motion, the ribbon lap machine is provided with mechanism by which it is automatically knocked off or stopped when any one of the laps fails from any cause on its passage from the back wooden lap rollers to the drawing rollers. It is sufficient here to state that each ribbon of cotton passes over a balanced iron rail equal in width to the ribbon. When properly working and passing forward the sheet of cotton keeps the balanced rail or wide spoon forward, but when the cotton is not on this stop motion lever it falls backward, and the frame is stopped in just the same manner as by the spoon stop motion of a drawframe.

It is usual also to apply a full lap stop motion. In one arrangement there is an adjustable bracket or finger secured to one of the vertical racks of lap end which knocks the machine off when the lap has become of sufficiently large diameter to lift the vertical rack high enough.

Lap Hardening Apparatus.

As described in chapter i. this is to all intents and purposes the same as on the scutcher, except that it is not deemed necessary to have the double wheel purchase employed on many scutchers and openers in order to get a sufficient amount of resistance to the upward motion of the vertical racks, and thereby to secure harder laps. It will be evident that a narrow lap of from 7½ in. to 10½ in. wide should not need the same resistance and hardening power as a lap of from 37 in. to 45 in. in width.

The majority of practical men who have to do with these ribbon machines prefer to have a considerable amount of weight on the brake lever in order to get laps which are as hard as can be got, and which therefore also contain a good length of cotton and will last longer on the comber. There are a few comber masters, however, who prefer to have only a small weight on the brake lever, and make the laps softer, with the object of preventing lap-licking.

The following calculations are some of them based on Dobson's and others on Hetherington's combers, and the gearing plans of these combers, given in Figs. 77 and 78, should greatly aid in following the calculations.

Drafts of a Comber.

There are two principal positions for draft on a Heilmann comber: (1) between the steel feed rollers and the first calender or condensing rollers; (2) between the back roller of the draw box and the block rollers or second calenders. In either of these positions the amount of draft may be a little more than five, so that the two multiplied together give a little less than a total of thirty. In addition to these two principal positions, there are various other positions where a slight draft is put in just to keep the cotton sufficiently under tension, as shown below:—

1. Between wooden lap rollers and steel feed rollers (negative).
2. Between first calender and back roller of draw box.
3. Between block rollers and the coiler top rollers.

The following particulars are taken from working combers, the wheels marked D going above the line in the draft calculation, and those marked *d* going below:—

	Fig. 77 (*a*). Hetherington's.	Fig. 77. Dobson's.
d Coiler Top Roller Bevel	20 teeth	20 teeth
D Bevel on top of Coiler Upright Shaft	21 ,,	20 ,,
d Bevel on Middle Upright Shaft	20 ,,	22 ,,
D Bevel on Coiler Short Cannon Shaft	20 ,,	22 ,,
d Spur Wheel on Coiler Short Cannon Shaft	60 ,,	59 ,,
D Spur Wheel on end of Cylinder	60 ,,	60 ,,
d Feed Peg on other end of Cylinder	1 ,,	1 ,,
D Star Wheel	5 ,,	5 ,,
d Feed Change Wheel	18 ,,	19 ,,
D Feed Roller Wheel	38 ,,	38 ,,
d Bevel on other end of Feed Roller	23 ,,	21 ,,
D Bevel on Side Shaft for driving Wooden Lap Rollers	22 ,,	20 ,,
d Bevel on other end for driving Wooden Lap Rollers	20 ,,	20 ,,
D Short Carrier Stud for driving Wooden Lap Rollers	55 ,,	55 ,,
d Driving Wheel on same Stud	35 ,,	36 ,,
D Spur Wheel on end of Wooden Lap Roller	47 ,,	49 ,,
d Diameter of Wooden Lap Roller	$2\frac{3}{4}$ in.	$2\frac{3}{4}$ in.
D Diameter of Coiler Top Roller	2 ,,	2 ,,

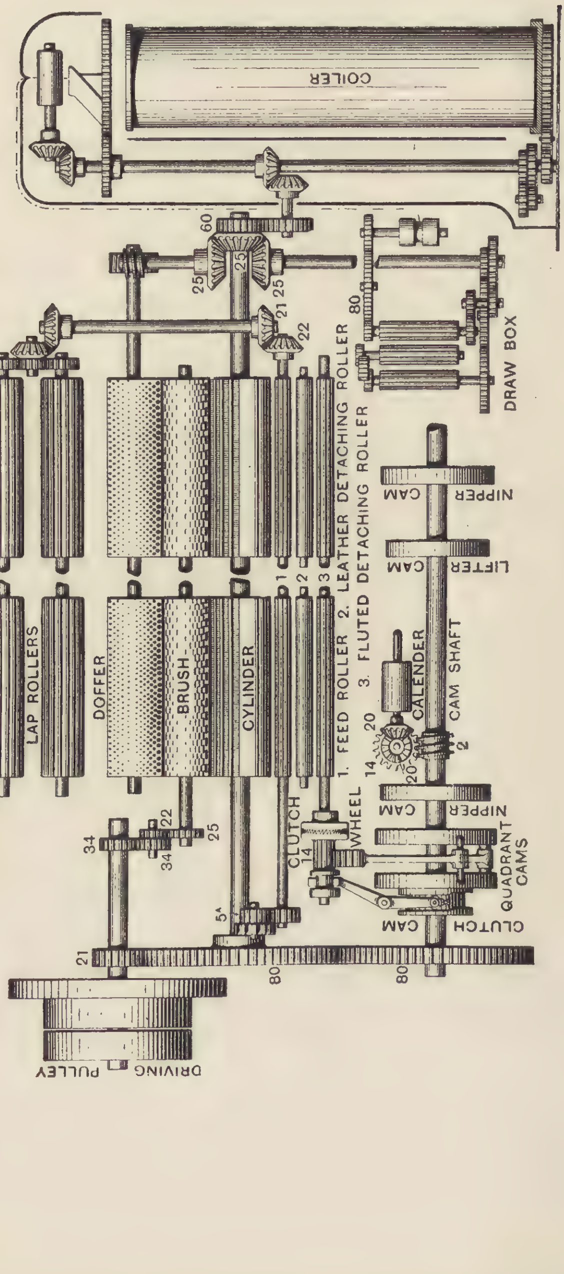

COILER
LAP ROLLERS
DOFFER
BRUSH
CYLINDER
1. FEED ROLLER 2. LEATHER DETACHING ROLLER
3. FLUTED DETACHING ROLLER
DRAW BOX
NIPPER CAM
LIFTER CAM
CALENDER
CAM SHAFT
CLUTCH
WHEEL
NIPPER CAM
QUADRANT CAMS
CLUTCH CAM
DRIVING PULLEY

FIG. 77.

From the foregoing particulars the total drafts in one operation work out as below :—

Hetherington's Comber.

$$\frac{2 \times 21 \times 20 \times 60 \times 5 \times 38 \times 22 \times 55 \times 47}{2{\cdot}75 \times 20 \times 20 \times 60 \times 1 \times 18 \times 23 \times 20 \times 35} = 28{\cdot}47. \text{ Ans.}$$

Dobson's Comber.

$$\frac{2 \times 20 \times 22 \times 60 \times 5 \times 38 \times 20 \times 55 \times 49}{2{\cdot}75 \times 20 \times 22 \times 59 \times 1 \times 19 \times 21 \times 20 \times 36} = 26{\cdot}55. \text{ Ans.}$$

It will be noted that the difference in draft between these two combers is brought about principally by the second comber having a 19 change feed wheel on, as against an 18 on the first comber.

In connection with the drafts of a comber it is important to note that the lap is unrolled from the wooden lap rollers by frictional contact, thus being liable to slippage. At the same time the lap is pulled forward at a positive rate by the steel feed rollers, so that any slippage which may take place on the wooden lap rollers tends to tighten the lap. Because of this particular slippage there is no need to have a draft between the steel and wooden feed rollers, but on the other hand it is useful to have the surface speed of the wooden lap rollers slightly greater than that of the steel feed rollers, in order to compensate for the slippage. The mechanical draft in this position for the above two machines works out as below :—

Hetherington's Comber.

$$\frac{4 \times 3 \times 22 \times 55 \times 47}{11 \times 4 \times 23 \times 20 \times 35} = {\cdot}96 \text{ draft.}$$

Dobson's Comber.

$$\frac{4 \times 3 \times 20 \times 55 \times 49}{11 \times 4 \times 21 \times 20 \times 36} = {\cdot}97 \text{ draft.}$$

In these two calculations the steel feed rollers are taken at $\frac{1}{4}$ in. diameter, and the wooden rollers at $2\frac{3}{4}$, the other sizes being as given in the table.

Cases have been known where the slippage of the lap on the wooden lap rollers has led to breakages of the lap by the wooden lap rollers shaking greatly. The application of steadying rods has cured this evil.

For the benefit of some readers it may be useful to give the rules by which the foregoing draft calculations are found. In the cases of the draft between the steel feed rollers and the wooden lap rollers it must be remembered the feed rollers drive the wooden rollers, and the draft rule is as follows :—

Draft Rule.

1. Place all driven wheels above the line for a dividend, along with the diameter of the steel rollers.
2. Place all the driving wheels below the line for a divisor, along with the diameter of the wooden rollers.

As will be seen above, the finding of the total draft in one operation involves a very long calculation.

In addition to this the coiler top rollers do not drive the wooden rollers, nor *vice versâ*, as both are really driven from the cylinder.

As long as the calculation is, however, it can really be made very simple and clear by the following rules :—

Rule I.

(*a*) For the purposes of this calculation assume that the coiler top bevel wheel is the driver of all the wheels involved, although, of course, it is not really so.

(*b*) Place all driven wheels above the line for a dividend, along with the diameter of the coiler top rollers.

(*c*) Place all the driving wheels below the line for a divisor, along with the diameter of the wooden rollers.

Rule II.

The following is another rule :—

(*a*) Start at the coiler and place the coiler end bevel below the line, and then place with it every alternate wheel.

(*b*) At the same time place all the other wheels above the line.

(*c*) The diameter of coiler top roller will go above the line and that of the wooden lap roller below the line.

Draw Box Draft.—The cylinder drives a short side shaft which extends to the draw box and gives motion to all parts thereof, including also the block rollers. There are usually three pairs of rollers in the draw box of a Heilmann comber, although four pairs have been sometimes experimented with. Taking both a Hetherington and a Dobson comber the draw box drafts will be found as below :—

	Hetherington's.	Dobson's.
d Wheel on Block Roller	43 teeth	40 teeth
D Driven by Wheel on Front Roller	25 ,,	22 ,,
d Wheel on other end of Front Roller.	37 ,,	34 ,,
D Compound Carrier Wheel	45 ,,	40 ,,
d Compound Carrier Wheel	45 ,,	45 ,,
D Wheel on Side Shaft	50 ,,	50 ,,
d Wheel on Side Shaft	16 ,,	15 ,,
D Wheel on Back Roller	46 ,,	50 ,,
d Diameter of Back Roller	$1\frac{3}{8}$ in.	$1\frac{3}{8}$ in.
D Diameter Block of Back Roller	$2\frac{3}{4}$,,	$2\frac{3}{4}$,,

As before, all particulars marked *d* go below the line and those marked D above the line. For the purposes of the draft calculation the particulars are taken as if the block roller wheel was the driving wheel, although it is really the side shaft which drives all the parts. The rule for total draft will serve here, substituting the block roller for the coiler roller and the back roller for the wooden lap roller. The total drafts between block roller and back roller are :—

Hetherington's Comber.

$$\frac{25 \times 45 \times 50 \times 46 \times 8 \times 11}{43 \times 37 \times 45 \times 16 \times 11 \times 4} = 4{\cdot}51 \text{ draft.}$$

Dobson's Comber.

$$\frac{22 \times 40 \times 50 \times 50 \times 2\frac{3}{4}}{40 \times 34 \times 45 \times 15 \times 1\frac{3}{8}} = 4{\cdot}792 \text{ draft.}$$

Whenever any alterations are made in the draw box draft by increasing or reducing the speed of the block rollers and front rollers it must be followed up by a corresponding alteration in the speed of all the coiler motions. There is usually a slight draft of say about 1·05 between the block rollers and the coiler top rollers, and this should be maintained. Usually the best way of altering the speed of the coiler top rollers and other parts of the coiler in such a case is to alter the size of the spur wheel on the coiler short cannon shaft or stud, given at 60 teeth for Hetherington's and 59 teeth for Dobson's in the foregoing tables. This wheel is comparatively easy to change, is made in different sizes to allow for this, and a slot is provided for adjustment of the cannon shaft. Suppose the draw box draft was changed from 4·5 to 5, and there was a 60 coiler cannon wheel on with the 4·5 draft, what cannon wheel would be wanted for the 5 draft? This change wheel is a driven wheel, and therefore a less wheel would be required to speed up all parts of the coiler to meet the increased speed of block rollers.

$$\frac{4{\cdot}5 \times 60}{5} = 54.$$

It may be remarked that there are differences of opinion amongst practical men as to the amount of draw box draft it is best to put in, and it may also vary with the number of heads on a comber, so that Hetheringtons' make this wheel to contain anything from 35 to 75 teeth. In Platt's combers a wheel is now provided which alters both draw box and coiler motion proportionately.

Setting and Weighting of Draw Box Rollers.

The rollers of a draw box are more or less subject to the same rules as those of other machines. As regards the setting for good Egyptian cotton, we might say:—

(1) Between centres of back and middle rollers, $1\frac{11}{16}$ in.
(2) ,, front ,, $1\frac{9}{16}$ in.

These may be taken as a basis, and for Sea Islands cotton or poor Egyptian varied proportionately.

It is usual to weight the leather rollers of the draw box at either end with a dead weight of about 15 lb. on either end of the front roller. The back rollers are bridled together, and a 20 lb. weight hung on each end of the hanger wire, thus giving 10 lb. weight for each end of the back and middle rollers. A recent neat improvement in the weighting of the draw box rollers consists in the application by Messrs. Dobson of lever weighting, in which the one weight is made to do the work of two as used in dead-weighting, and, what is much more important, the arrangement allows of the application of a very effective weight-relieving motion. Another very important advantage is that the amount of weight placed on the rollers can be readily varied at the will of the persons in charge. Providing that the attendant disadvantages of greater liability to breakages and to getting the weights in wrong positions of the lever, and to getting other parts out of order, are not considered too great, it is probable that this lever-weighting may meet with considerable adoption.

In some cases metallic drawing rollers have been adopted for the draw box of a comber, and when any such alteration is made great care will have to be exercised in proportioning the various speeds afresh. The rate at which the slivers are taken up by the back roller, the draft between the front roller and the draw box, will take a good deal of getting right on account of the greater surface speed of the metallic rollers over the other. It is probable, also, that the rollers will require less weighting. For some time these metallic rollers have been made with very deep flutes, but the present tendency appears to be towards making the flutes of only very moderate depth, partly owing to the uneven work some people consider the deep flutes to make.

On a drawframe an advantage claimed for these rollers is increased production, but we can scarcely see how this advantage can be claimed for the application of metallic rollers to the comber, because the production of a comber is not limited by anything about the ordinary draw box. The expense of leather covering is, of course, saved, and opinions differ as to whether the metallic or the ordinary rollers give the least amount of roller laps.

Sometimes four pairs of rollers are used in the draw box, and some contend that four pairs ought to be used here just as on a drawframe, because in both cases the work of the rollers is the same. It is usual, however, to apply only three pairs. It may be noted that good results have been got from the use of metallic rollers in the sliver lap machine.

Draft between Calender Roller and Steel Feed Rollers.

As before stated, the draft in this position is one of the two principal drafts of a Heilmann comber. Particulars are given below for finding this draft both on a single and double nip comber.

	Single Nip.	Double Nip.
Diameter of Table Calender Rollers .	D $2\frac{3}{4}$ inches	D $2\frac{3}{4}$ inches
Diameter of Steel Feed Rollers . .	*d* $\frac{3}{4}$,,	*d* $\frac{3}{4}$,,
Bevel Wheel on end of Calender Roller	*d* 20 teeth	*d* 20 teeth
Bevel Wheel driven by above . .	D 20 ,,	D 20 ,,
Cam Shaft Worm Wheel . . .	*d* 14 ,,	*d* 14 ,,
Driven by Double Worm on Cam Shaft .	D 2 ,,	D 2 ,,
Large Wheel on Cam Shaft . . .	*d* 80 ,,	*d* 80 ,,
Gearing with Cylinder Wheel . .	D 80 ,,	—
Wheel Gearing with the 80 . . .	—	D 42 ,,
On same Stud	—	*d* 21 ,,
Driving Large Wheel on Cylinder . .	—	D 80 ,,
Feed Peg for driving Star Wheel . .	*d* 5 ,,	*d* 2 ,,
Star Wheel	D 4 ,,	D 5 ,,
Feed Change Wheel	*d* 18 ,,	*d* 18 ,,
Feed Roller	D 38 ,,	D 38 ,,

As before, the general rule for drafts applies in this as in all positions, and all particulars marked *d* go below the line in the division, while particulars marked D go above the line in the dividend.

The draft between table calenders and steel feed is as follows :—

Single Nip.

$$\frac{2\frac{3}{4} \times 20 \times 2 \times 80 \times 5 \times 38}{\frac{3}{4} \times 20 \times 14 \times 80 \times 1 \times 18} = \frac{11 \times 4 \times 2 \times 5 \times 38}{4 \times 3 \times 14 \times 1 \times 18} = 5{\cdot}52 \text{ draft.}$$

Double Nip.

$$\frac{2\frac{3}{4} \times 20 \times 2 \times 42 \times 80 \times 5 \times 38}{\frac{3}{4} \times 20 \times 14 \times 80 \times 21 \times 2 \times 18} = \frac{11 \times 4 \times 2 \times 42 \times 80 \times 5 \times 38}{4 \times 3 \times 14 \times 80 \times 21 \times 2 \times 18} = 5{\cdot}54.$$

The differences in the foregoing particulars between single and double nip are brought about by the cam shaft revolving twice as fast as the cylinder, and by two feed pegs being necessary for the duplex.

DRAFT BETWEEN COILER TOP ROLLERS AND BLOCK ROLLERS.

	Hetherington's.	Dobson's.
Diameter of Back Roller . . .	d $2\frac{3}{4}$ inches	d $2\frac{3}{4}$ inches
Diameter of Coiler Top Roller . .	D 2 ,,	D 2 ,,
Coiler Top Roller end Bevel . . .	d 20 teeth	d 22 teeth
Driven by Bevel on top of Upright Shaft	D 21 ,,	D 22 ,,
Bevel on middle of Upright Shaft . .	d 20 ,,	d 22 ,,
Driven by Bevel on Cannon Shaft . .	D 20 ,,	D 22 ,,
Cannon Shaft Spur Wheel . . .	d 58 ,,	d 59 ,,
Spur Wheel on Cylinder end . . .	D 60 ,,	D 60 ,,
Bevel on end of Cylinder Shaft . .	d 25 ,,	d 25 ,,
Driving a Bevel on end of Side Shaft .	D 25 ,,	D 25 ,,
On Draw Box end of Side Shaft . .	d 50 ,,	d 50 ,,
Driven part of Double Carrier . .	D 45 ,,	D 45 ,,
Driving part of Double Carrier . .	d 45 ,,	d 40 ,,
Driven Wheel on Front Roller . .	D 37 ,,	D 34 ,,
On other end of Front Roller . .	d 25 ,,	d 22 ,,
Driving a Wheel on Block Roller . .	D 43 ,,	D 40 ,,

By the general rule for drafts all driving wheels are marked d and go below the line in the divisor, and all other terms marked for the dividend above the line.

Hetherington's Comber.

$$\frac{2 \times 21 \times 20 \times 60 \times 25 \times 45 \times 37 \times 43}{2\frac{3}{4} \times 20 \times 20 \times 60 \times 25 \times 50 \times 45 \times 25} = \frac{2 \times 4 \times 21 \times 60 \times 37 \times 43}{11 \times 20 \times 58 \times 50 \times 25}$$
$$= 1{\cdot}05 \text{ draft.}$$

Dobson's Comber.

$$\frac{2 \times 22 \times 22 \times 60 \times 25 \times 45 \times 34 \times 40}{2\frac{3}{4} \times 22 \times 22 \times 59 \times 25 \times 50 \times 40 \times 22} = \frac{2 \times 4 \times 60 \times 45 \times 34}{11 \times 59 \times 50 \times 22}$$
$$= 1{\cdot}028 \text{ draft.}$$

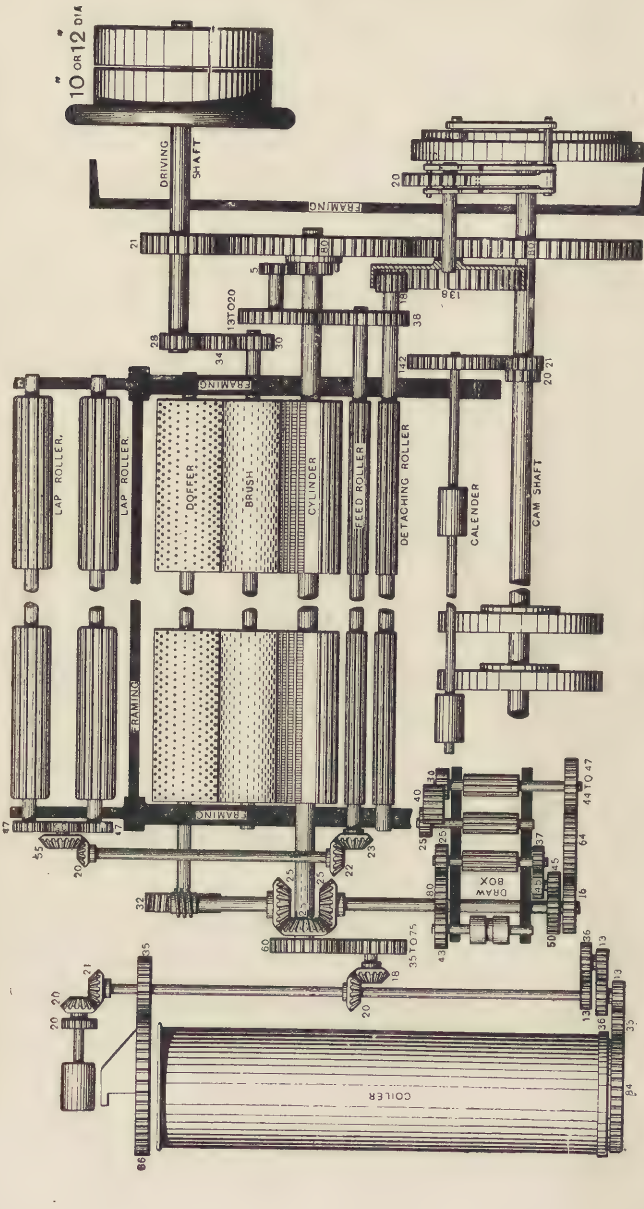

10" OR 12" DIA
DRIVING SHAFT
FRAMING
LAP ROLLER.
LAP ROLLER.
DOFFER
BRUSH
CYLINDER
FEED ROLLER
DETACHING ROLLER
CALENDER
CAM SHAFT
DRAW BOX
COILER

FIG. 78.

Draft between Calender Rollers on Front Table and Back Roller of Draw Box.

As before stated, the best practical way of regulating this is to have the slivers on the table just kept moderately tight, but without straining them.

It is possible to check this draft by passing a thin piece of string—or, better still, a piece of tape—through the calender rollers and the back roller only in the draw box.

It is also possible to check it by a calculation on the same lines as those previously given.

	Hetherington's.	Dobson's.
Diameter of Calender Roller . . .	*d* $2\frac{3}{4}$ inches	*d* $2\frac{3}{4}$ inches
Diameter of Back Roller in Draw Box .	D $1\frac{3}{8}$,,	D $1\frac{3}{8}$,,
Wheel on Back Roller	*d* 46 teeth	*d* 50 teeth
Driven by Side Shaft Wheel . . .	D 16 ,,	D 15 ,,
On other end of Side Shaft a Bevel .	*d* 25 ,,	*d* 25 ,,
Driven by a Bevel on Cylinder . .	D 25 ,,	D 25 ,,
On other end of Cylinder Index Wheel .	*d* 80 ,,	*d* 80 ,,
Driving a large Wheel on Cam Shaft .	D 80 ,,	D 80 ,,
On the Cam Shaft a Double Worm .	—	*d* 2 ,,
Driving the Worm Wheel on Short Upright	—	D 14 ,,
Bevel on top of Short Upright . .	—	*d* 20 ,,
Driving a Bevel on Calender . . .	—	D 20 ,,
On the Cam Shaft a Wheel . . .	*d* 21 ,,	—
Driving a Wheel on Calender . .	D 142 ,,	—

Hetherington's Comber.

$$\frac{1\frac{3}{8} \times 16 \times 25 \times 80 \times 142}{2\frac{3}{4} \times 46 \times 25 \times 80 \times 21} = \frac{11 \times 4 \times 16 \times 142}{8 \times 11 \times 46 \times 21} = \frac{4 \times 142}{23 \times 21} = 1{\cdot}17 \text{ draft.}$$

Dobson's Comber.

$$\frac{1\frac{3}{8} \times 15 \times 25 \times 80 \times 14 \times 20}{2\frac{3}{4} \times 50 \times 25 \times 80 \times 2 \times 20} = \frac{21}{20} = 1{\cdot}05 \text{ draft.}$$

To Ascertain Waste Percentage.

It is frequently necessary in mill practice to ascertain how much per cent. of waste a comber is taking out. The usual method of doing this is to stop the comber, and thoroughly clean all the waste away from the back of the machine, breaking the waste off quite level and close to the doffer combs. Then run the comber for a certain number of nips, say 30, 40 or 50; the more nips there are taken the better the average got, just as in wrapping counts.

If too many nips are taken variations in short lengths of lap are not as easily detected.

The sliver must be broken clean off up to the block rollers at the same time that the waste is cleaned out.

For the given number of nips taken all the good cotton must be carefully collected, and all the waste made in the same time, and the two must be carefully and separately weighed.

The rule for finding percentage then is: Add the weight of waste and cotton together for a divisor. For a dividend add two cyphers to the weight of waste, which, of course, is equal to multiplying it by 100. Both waste and good cotton should be brought to grains.

Example.—In a certain number of nips a Heilmann comber gives out 16 dwt. 7 grs. of good cotton, and a total of 3 dwt. 7 grs. of waste from all the heads together: what is the percentage of waste being made?

There are 24 grains in a pennyweight, therefore the good cotton.

	Good Cotton. Dwt. Grs.		Waste. Dwt. Grs.		
(*a*)	16 7	(*b*)	3 7	(*c*)	391
	24		24		79
	71		79 grs.		470)7900(16·80 per cent. *Ans.*
	32				470
	391 grs.				3200
					2820
					3800
					3760
					400

Note.—It is a common mistake with students and others to find the per cent. of loss on the good cotton, and not on the weight of laps passed through as above.

Production of a Comber.

In estimating the production of a comber it is very important that due allowance be made for the large percentage of waste made.

The production of a comber will be increased—

(1) By speeding up all the machine.

(2) By putting on a larger change feed wheel.

(3) By taking out a less percentage of waste.

(4) By feeding it with a heavier weight of lap per yard.

Example 1.—A single nip comber takes a lap $8\frac{1}{2}$ in. wide, weighing 10 dwt. per yard. The comber makes 80 nips per minute and contains 8 heads, and the feed rollers give out ·223 in. per nip. The working week is $56\frac{1}{2}$ hours, but four hours are lost by various stoppages. Find (1) production in pounds of good cotton per week; and (2) the production of waste, the machine taking out 18 per cent.

$$\frac{\cdot 223 \times 80 \times 60 \times 52{\cdot}5 \times 240 \times 8}{12 \times 3 \times 7000} = 428{\cdot}16 \text{ lb.}$$

This includes both good cotton and waste.

If 100 lb. of laps give 18 lb. of waste, how much waste will 428·16 lb. of laps give?

$$\begin{array}{r} 100 : 428 :: 18 \\ 18 \\ \hline 3424 \\ 428 \\ \hline 77{\cdot}04 \text{ waste.} \end{array}$$

Neglecting decimals: 428 − 77 = 351·12 lb. of good cotton.

Note.—In the first calculation the pennyweights (dwt.) are brought to grains, the hours to minutes in the dividends, and in the division 12 × 3 is used to bring inches to yards, and 7,000 to bring grains into pounds.

Example 2.—A duplex comber of 6 heads makes 125 nips per minute, and takes a lap $10\frac{1}{2}$ in. wide, weighing 12 dwt. per yard. The feed rollers deliver $\frac{1}{4}$ in. of cotton per nip, and the comber is actually working in the week 52 hours. Seventeen per cent. of waste is taken out. Find production in lb. of good cotton.

$$\frac{1 \times 125 \times 60 \times 52 \times 12 \times 24 \times 6 \times 83}{4 \times 12 \times 3 \times 7000 \times 100} = 555 \text{ lb. practically.}$$

Note.—The ·25 is represented here as $\frac{1}{4}$, and the good cotton is taken at $\frac{83}{100}$ of the weight of laps used, so that the

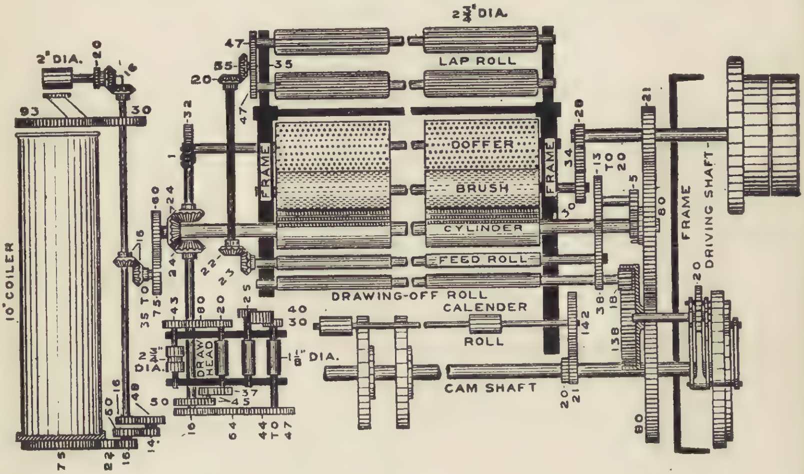


FIG. 79.

calculation can be worked in one operation and without decimals. The foregoing are the methods preferred by the writer. Messrs. Hetherington say: "In estimating the production of a comber it is convenient to deduct the percentage of waste from the lap, and then consider all as passing through. To get the actual production approximately it is usual to deduct $7\frac{1}{2}$ per cent. from the speed." If we call the speed, after taking off $7\frac{1}{2}$ per cent., S, the feed wheel, F, and the weight of lap in grains per yard, G, after deducting the waste, then the actual production in pounds per 10 hours will be very approximately—

For six heads $\frac{S \times F \times G}{5649}$

For seven heads $\frac{S \times F \times G}{4842}$

For eight heads $\frac{S \times F \times G}{4237}$

For ordinary work the $10\frac{1}{2}$ in. lap may weigh 14 dwts. per yard for the single machine and 12 dwt. per yard for the double machine. In each case a 16 or 17 feed wheel may be used. Under these circumstances the production of a double machine with 8 heads at 125 beats and 17 per cent. of waste would be :—

$$\frac{115\frac{1}{2} \times 16 \times 239}{4237} = 104 \text{ lb. in 10 hours.}$$

It will be seen from the gearing plan of the Whitin comber in Fig. 79 how closely English and American combers resemble in details of driving.

Speeds of Coiler Parts.

Revolutions of cylinder per minute	80
Spur wheel on cylinder	60 teeth.
Driving cannon wheel	58 ,,
Also on the cannon shaft a bevel	20 ,,
Driving a bevel on vertical coiler shaft . . .	20 ,,
On upper extremity of vertical coiler shaft a bevel .	21 ,,
Driving a bevel on coiler top roller	20 ,,
Near the top of vertical shaft a spare wheel . .	35 ,,
Driving the eccentric plate or tube wheel . .	86 ,,
On the lower extremity of vertical shaft . . .	13 ,,
Driving a wheel on first stud	36 ,,
Also on this first stud	13 ,,
Driving a wheel on second stud	36 ,,
Also on second stud	13 ,,
Driving can bottom wheel	84 ,,

Note.—There is a 35 carrier between the 84 and 13, but this is ignored in the calculations.

Find (1) Revolutions per minute of vertical coiler shaft.
,, (2) ,, ,, of coiler top rollers.
,, (3) ,, ,, of tube or plate wheel.
,, (4) ,, ,, of coiler can.

(1)

$$\text{Revolutions of vertical shaft} = \frac{80 \times 60 \times 20}{58 \times 20} = 82{\cdot}75.$$

(2)

$$\text{Revolutions of coiler top rollers} = \frac{82{\cdot}75 \times 21}{20} = 86{\cdot}887.$$

(3)

$$\text{Revolutions of tube wheel} = \frac{62{\cdot}85 \times 35}{86} = 33{\cdot}67.$$

(4)

$$\text{Revolutions of can} = \frac{82{\cdot}75 \times 13 \times 13 \times 13}{36 \times 36 \times 84} = 1{\cdot}67.$$

The diameter of the coiler top calender roller is 2 in., and its revolutions 87. The revolutions per minute of the tube wheel in coiler top are 34. Find the twist per inch put in the sliver.

$2 \times \frac{22}{7} \times 87 =$ inches of sliver passed through coiler top per min.

$= 546\frac{6}{7}$ in., or say 547.

Then $\frac{34}{547} = {\cdot}062 =$ approximately $\frac{1}{17}$ of a turn of twist per inch of sliver, *i.e.*, there is one turn of twist to about 17 in. of sliver.

From the wheels previously given find the number of coils of sliver placed in one revolution of the can, *i.e.*, find the revolutions of tube wheel for one of can.

$$\frac{1 \times 84 \times 36 \times 36 \times 35}{13 \times 13 \times 13 \times 86} = 20{\cdot}1, \text{ say } 20.$$

This can be checked by dividing the revolutions per minute of the tube wheel by those of the can bottom wheel, as previously found. This is done as follows :—

$$\frac{33{\cdot}67}{1{\cdot}67} = 21{\cdot}1, \text{ or say } 20, \text{ as before.}$$

Find the revolutions per minute of the front roller of the draw box from the following particulars:—

Revolutions per minute of cylinder . .	80 teeth.
Bevel wheel on end of cylinder shaft . .	25 ,,
Driving a bevel on side shaft . . .	25 ,,
Near other end of side shaft . . .	50 ,,
Driving double carrier wheel . . .	45 ,,
Another wheel on double carrier . .	45 ,,
Driving a wheel on front roller . .	37 ,,

$$\frac{80 \times 25 \times 50 \times 45}{25 \times 45 \times 27} = \frac{80 \times 50}{37} = 108{\cdot}1.$$

On Covering the Doffers.

On a comber there is a doffer to each head, and these doffers are covered with rather strong filleting having somewhat coarse teeth. In starting new combers it is necessary to make calculations for the amount of filleting required to cover the doffers. This is done in the same way that filleting is found for a new card.

It is customary to cover the doffers at the mill as in the case of card cylinders and doffers, and the filleting may be ordered either through the machine makers as an extra or directly from card clothing manufacturers.

The procedure of covering the doffers of the comber is much the same as on carding engines, but the diameter and widths of the doffers are very small, and necessitate the frequent making of tail ends, there being, of course, 16 tail ends in an 8-head comber. It is not common to have a tension machine in clothing these doffers, as on a carding engine, and the required tension may be got by passing the filleting once round the body, a leather belt being used to allow of this. The doffers are fixed in position on the doffer shaft prior to covering, and it is necessary to have them slowly turned by hand during covering, some kind of leverage being provided to assist the person turning the doffer shaft.

Suppose the doffers of a 6-head comber are $5\frac{1}{2}$ in. diameter and $10\frac{1}{2}$ in. wide, how much filleting will be required of $1\frac{1}{4}$ in. width?

$$\frac{5 \cdot 5 \times 3 \cdot 1416 \times 10 \cdot 5 \times 6}{1 \cdot 25 \times 12} = 65 \cdot 973 \text{ ft., say 66 ft.}$$

Each doffer is keyed to the cylinder, and there may be four plug holes for the clothing tacks at each end of each doffer, each plug being $\frac{1}{2}$ in. or $\frac{3}{8}$ in. diameter. It may not be necessary to put a tack in every plug, but sometimes it is advisable to put two tacks in the same plug. The operation of covering all the doffers of a comber may occupy approximately about four hours, but this, of course, is subject to variation with the number of heads, etc.

To the above calculation it may be necessary to add a little fillet for the loss in tail ends, although it is difficult to cover absolutely all the doffer surface at the ends. The actual clothing of the doffers is a somewhat unpleasant task.

Speed Calculations.

The line shaft of a comber room makes 252 revolutions per minute, and contains a driving pulley 13 in. diameter. The driven pulleys on the end of the comber driving shaft are 10 in. diameter. On this shaft is a wheel of 21 teeth driving the index wheel of 80 teeth on the cylinder shaft. Find the nips per minute, allowing 2 per cent. for slippages of the driving belt.

$$\frac{252 \times 13 \times 21 \times 98}{10 \times 80 \times 100} = 84 \cdot 2 \text{ nips.}$$

It is required to start a single nip comber to make 80 nips per minute. The line shaft makes 260 revolutions per minute. The comber end pulleys are 10 in. diameter, and there is a 21 wheel on same shaft driving the 80 index wheel. Find diameter of pulley required on line shaft.

$$\frac{80 \times 80 \times 10}{21 \times 260} = 11 \cdot 72 \text{ in., say } 11\tfrac{3}{4}.$$

There are 10 in. fast and loose pulleys on the comber short driving shaft driven by a line shaft making 280 revolutions per minute, and containing a 12 in. driving pulley. Find revolutions per minute of driving shaft.

$$\frac{280 \times 12}{10} = 336.$$

On the short driving shaft of the comber is a 28 spur wheel driving by a 34 carrier a 30 wheel on the doffer brush. Find revolutions per minute of this brush.

$$\frac{28 \times 336}{30} = 313\tfrac{3}{5}.$$

On the cylinder shaft of a comber making 80 nips per minute there is a 25 bevel driving another 25 on a side shaft. On other end of side shaft is a single worm driving a 32 wheel on the doffer. Find revolutions per minute of doffer.

$$\frac{80 \times 25 \times 1}{25 \times 32} = \frac{80}{22} = 3{\cdot}6363.$$

Feed Change Wheel.

As on all spinning machines the size of this wheel largely controls the amount of draft.

By putting on a larger driving feed change wheel the feed rollers or back rollers are made to have a greater surface speed during any given time without the rate of delivery being altered.

A more important thing to remember is that the amount fed per nip—as controlled by the feed wheels—exercises an important effect on the amount of the combing.

A larger driving wheel causes the fringe of the lap to advance more through the nippers at any one time, and really means that the fibres will be taken fully through the nippers in a shorter time, and so be acted upon less by the cylinder needles.

Also, as explained in the article under "Heads and Tails" in this book, the leading ends or "heads" of the fibres must be combed more than the parts last held by the nippers.

In any case it is likely that a cotton fibre of $1\frac{1}{4}$ in. length is not acted upon more than about three times at its leading end, on account of the difficulty of getting the needles quite close to the grip of the nippers, allowing the leading $\frac{1}{4}$ in. of a fibre to be combed three times, then the second $\frac{1}{4}$ in. would be only combed twice, and the third $\frac{1}{4}$ in. only once by the cylinder needles. This is taking the amount of feed to be $\frac{1}{4}$ in. per nip. But if the rate of feed were increased to be $\frac{3}{8}$ in. per nip, then the third $\frac{1}{4}$ in. would probably be only combed twice.

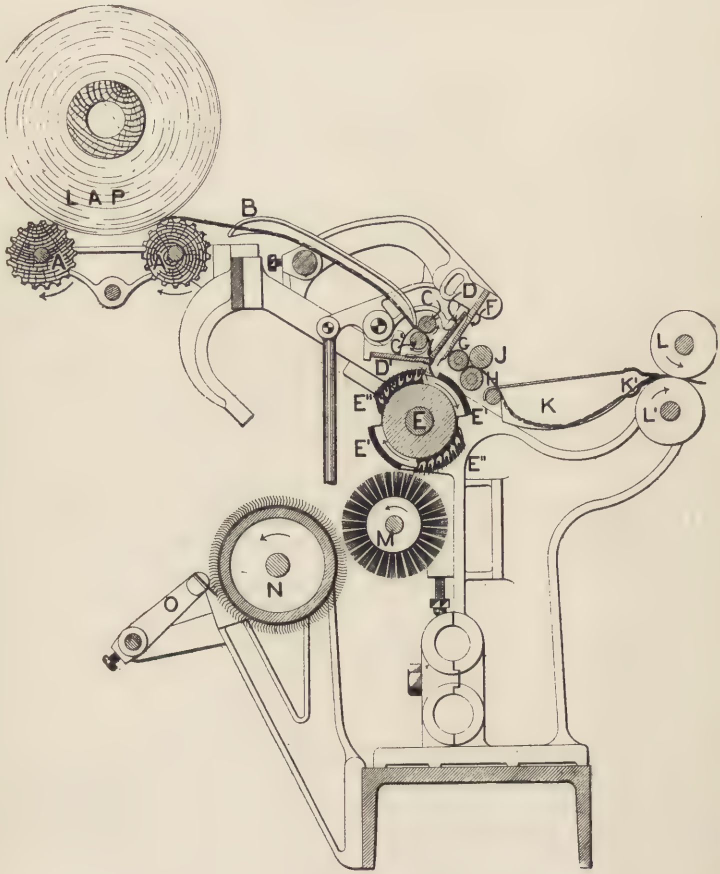


FIG. 80.

It is quite clear therefore that a less driving feed change wheel (on the same stud as the star wheel) would give more combing to the "heads" of the fibres.

It is difficult to use a very heavy lap on the Heilmann comber because of the difficulty of getting the needles to attack it and penetrate it with sufficient force and thoroughness.

A fair draft is 25 to 30, while the amount of feed may vary from ·19 in. to ·26 in. per nip.

In order to aid a little in comprehending the calculations, a section is given in Fig. 80 of Hetherington's double nip comber.

The lap is shown resting on the two fluted wooden feed rollers, A, A. The sheet of cotton, B, passes from the lap down a convex guide plate and then through the top and bottom feed rollers, C, C. Afterwards through the nippers, D, D′, of which D is the nipper knife and D′ the cushion plate, these parts being shown nipping or holding the cotton. E is the cylinder and E′, E′ are the fluted segments of the cylinder, while E″, E″ are the needle segments. Because there are two needle segments and two fluted segments it is a duplex comber. The top comb, F, is shown lifted up while the cylinder needles act. C is the leather-covered detaching roller, H the long steel detaching roller, and J the top piecing roller. K is the sliver tin shown with the sliver slack in the tin, the funnel or outlet being at K′. L, L′ are the calender rollers. M is the waste brush, N is the doffer.

Doffer and Revolving Brush of Comber.

There is a very great difference in speed between these two cylindrical parts of a comber, although both are connected with the proper stripping and disposition of the waste made at the comber.

The particulars for both the following calculations were taken from an actual working comber by the writer:—

Cylinder, 85 revolutions per minute.

On the cylinder shaft is a 25-toothed bevel.

Driving a side shaft bevel 25.

On same side shaft is a single worm 1.

Driving doffer worm wheel 32.

$$\frac{85 \times 25 \times 1}{25 \times 32} = \frac{85}{32} = 2\tfrac{21}{32} \text{ doffer revolutions.}$$

$$\frac{252 \times 13 \times 4 \times 34 \times 32}{39 \times 34 \times 25} = 295 \cdot 68 \text{ brush revolutions.}$$

The very rapid revolution of the brushes is required in order to render their action in cleaning the needle segments more effective, but it causes the brush bristles to wear soon unless they are of good material.

To make the cleaning action of the brushes still more efficient, and to cause uniformity of wear in the brushes, it is the practice in some cases to apply a brush traverse motion. The brushes should also be set quite parallel to the cylinders, and slots are provided for adjustment in case of wear of the bristles. In the brush traverse motion referred to (as made by Messrs. Hetherington) the brushes have a slight longitudinal motion in addition to their circular motion.

Everything should be done to make the action of the brushes in cleaning the needles as effective as possible, as dirty needle segments will interfere with the combing and cleansing action of the needles. The brushes clean the needles, and the doffer cleans the brushes, and the doffer is itself cleaned by the doffer comb. It is necessary that the cylinders, brushes and doffers be very well cased in by the back tins to keep the waste in its proper place. Sometimes the sheet or fleece of waste appears at the back with thick stringy portions in it, but this need not necessarily be a sign of bad work, as it may be that the waste is catching on the insides of the back covers. To allow of the free and uniform passage of the fleece of waste the insides of the back tins or covers may be kept well cleaned.

CHAPTER VIII.

VARIOUS NOTES AND DISCUSSIONS.

Double and Treble Combing.

It is well known that most firms who comb at all only favour and practise single combing. Even single combing is an expensive process, but when double combing is resorted to both the additional expense and trouble are much greater than for single combing. The firms who practise treble combing are very few indeed.

Since combing is the most perfect operation known for extracting short fibre, and for cleaning the yarn of its very fine impurities, it is natural to imagine that double and treble combing are likely to give a higher class yarn than single combing.

It is by no means the case, however, that double combing improves the yarn in the same ratio as does single combing, any more than double carding would clean the cotton in the same proportion as single carding.

In other words, the merest tyro can see a vast improvement in slivers and yarns produced with single combing as compared with yarns produced without any combing, while the additional improvement obtained by double combing is by no means as apparent, although some is undoubtedly present.

It has been asked, Suppose we take out 26 per cent. with single combing and a total of 26 per cent. with double combing, is not one as good as the other for the yarn? The answer is, Probably not, because in the latter case we might take out say 19 per cent. at the first combing and 7 per cent. at the second combing, and we should have a total of practically double the quantity of needles or combs acting on the cotton, thus necessarily giving more cleaning.

It will be noticed that out of the total of 26 per cent. with double combing we have put 19 per cent. for the first combing and only 7 per cent. for the second combing, and not as might be imagined by some, about 13 per cent. to be taken out at each combing.

The reason for this is that with practically the same settings at the combers the first combing might be expected to take out 18 to 20 per cent., as against 6 or 7 per cent. at the second combing, simply because in the second combing there is not much short fibre left in the cotton to be extracted.

Suppose, for instance, we were intending to take out 30 per cent. by treble combing the proportions would never be 10 per cent. at each of the combings, but more like 17 per cent., 7 per cent., and 6 per cent. at the first, second and third combings respectively.

The limited quantity of cotton yarn which has had its fibres subjected to treble combing has necessarily to be sold at a very high price on account of the great amount of trouble bestowed upon it, as well as the high price of the raw cotton.

With treble combing the needles of the cylinder, of course, pass practically three times as much through the fibres as with single combing, if the same length of feed be kept.

It is somewhat difficult to take out more than about 8 per cent. of waste at the second combing.

With the practice of even double combing there commences a good deal of trouble to get the slivers to work. The fibres have become so parallel and feel so soft that they stick to almost anything, and the slightest shock or strain is sufficient to break them. Cans with spring bottoms are often used in order to assist the slivers to mount to the top. Any plates or guides that the cotton has to impinge against should be kept perfectly clean and well polished and dry. The cotton in this state is much more susceptible to disturbance by electrical influences, or air currents, than when simply carded.

Heat and Humidity.

It is a fortunate circumstance for cotton spinning in Lancashire that for the most part of the year the climatic conditions are conducive to successful working of the cotton fibre.

Generally speaking, for good cotton spinning we require the two essential conditions of warmth and humidity, and for the most part by the aid of simple steam pipes we can manage in Lancashire very well.

On occasions, however, trouble is caused by dry east winds, dry frosts, or dry, hot summer weather, which are all bad for the satisfactory manipulation of the cotton fibre.

This question of atmospherical conditions is alluded to here because the author is of opinion that no department of a cotton mill is more easily or more detrimentally affected by absence of sufficient humidity than is the comber department; and especially is this the case when the ribbon lap machine is used.

On this account it is here recommended that large stocks of laps for the combers should not be accumulated any more than is absolutely necessary, as the longer they stand the more liable will they be to give trouble.

In cases of continued adverse atmospherical conditions, such as specified above, the author has frequently known great trouble to be caused at the comber by excessive lap licking, curling at the detaching rollers, breakage of slivers on the front table, etc.

In such cases time after time the writer has known great improvement to result from the application of humidifiers, or a good degging of the floor. The worst of humidifiers is that they are so often accompanied by disadvantages which are as bad as the evils they cure.

When cotton is too dry it is rendered very susceptible to the influences of electricity, with the result that mutual repulsion of the fibres is produced, and the individual fibres try to stand out from the body of the fibres.

A moist atmosphere will absorb the electricity produced by the working of the belts and the machinery and so prevent it from affecting the fibres, while a dry atmosphere cannot do this.

The percentage of relative humidity best suited for either good combing or good spinning may range from about 46 to about 53 per cent. according to the height of the dry bulb, and it may be taken that about 50 per cent. of relative humidity, combined with a proper degree of heat, will give as good working results as can be expected.

To aid in checking the atmospherical conditions it is good practice to have a hygrophant fitted up in a convenient position in the comber room. It should not be placed too near a door or wall or humidifier, but in some position that could be expected to give a fair and reliable average.

Hygrometers.

One make of hygrophant or hygrometer is shown in Fig. 81, as supplied by Messrs. Dowson, Taylor & Co., who say on this subject:—

"The instrument which enables us to measure the amount of humidity contained in a cubic foot of air at a certain temperature is known as the hygrometer. There are various types of this instrument, each possessing individual merits. That illustrated in Fig. 81 embodies our most recent improvements and is an advance upon all others.

"The instrument consists of two thermometers as nearly as possible identical, the one marked 'dry,' the other 'wet'.

"The bulb of the wet thermometer is covered with thin muslin, and round the neck of the bulb and over the muslin is twisted loosely, or tied in a loose knot, a conducting thread of lamp wick, common darning cotton, or floss silk.

"This passes to a tube at a suitable distance, kept continuously filled with water from the large bottle reservoir.

"The instrument should be mounted in an open space, with the bulbs raised about 4 ft. above the floor, in the shade, and as far from walls as possible.

"The bottle reservoir should always be supplied with rain or distilled water.

"Before use, the cotton lamp wick should be washed in a solution of carbonate of soda, and pressed whilst under water throughout its length. When in use it should be of such extent that the water conveyed is sufficient in quantity to keep the

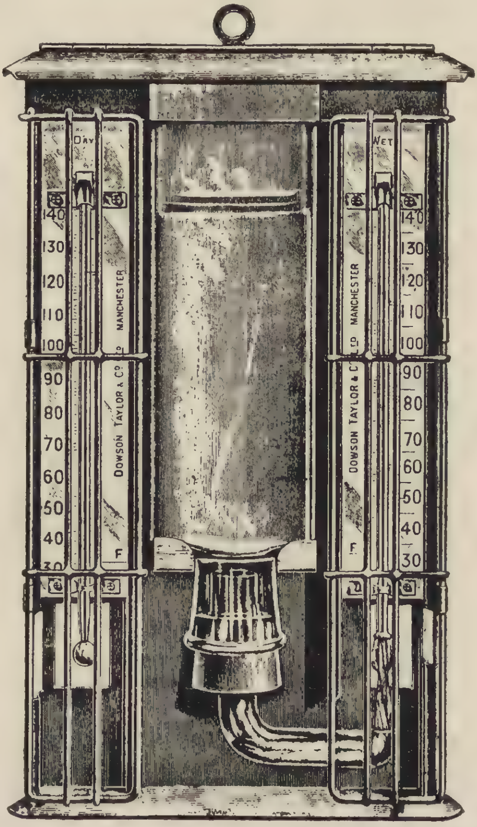


FIG. 81.

muslin on the bulb as moist as when the air is saturated with vapour. The amount of water supplied can be increased or diminished by increasing or decreasing the extent of the conducting thread.

"In observing, the eye should be placed on a level with the top of the mercury in the tube; and the observer should be careful to refrain from breathing whilst taking the observation. Temperatures of the air and of evaporation are given by the direct readings of the two thermometers; and by reference to the hygrometrical tables the exact percentage of humidity can be ascertained."

It should be added that some good authorities consider that the water well should be at least 4 in. from the dry bulb.

Top Combs.

At some large concerns practically all the top combs are quite prevented from lifting at all, and it is argued that this gives better combing, although why this should be so is difficult to see so long as the top combs are always down all the time of detaching.

It would probably be difficult to set these combs with an extremely small angle, even if it were required to do so. If too straight they would catch the leather-covered roller, or else, on the other hand, the top nipper.

Formerly the top combs were lifted entirely by one small cam placed at one end of the cylinder. It is now the practice to have one of these cams at each end of the cylinder, and care should be taken to have them both set exactly alike.

Wide setting of the top comb and small amount of angle would give a less percentage of waste. Some people think that never lifting top comb would give a higher percentage than with lifting, but the author does not agree with this contention so long as the comb gets down in good time.

With a top comb getting down very late, then detaching might be commenced before the top comb did get down, in which case, with very late top comb we might certainly expect a reduction in waste percentage. A very widely set top comb, however, scarcely needs any lifting. Allowing the top comb to stop down with very close setting may prove detrimental to the pins, especially if the cylinder needles are not kept clean from flocks, etc.

The top comb cam at the coiler end may be cast in one piece with a small bevel, and the two fastened to the spur wheel which drives the coiler, the three being then secured to the cylinder shaft.

An endeavour should be made to have the vertical screws for the top combs to rest in a fairly central position on the stands.

Difference in Carding.

It has often been asked whether or not a less percentage of waste should be taken out of the card when it is intended to comb the cotton.

As a matter of fact, in many cases it is the practice to do this, and especially when the counts to be spun are not to be very high, and the cotton is Egyptian.

A reason for this is found in the fact that comber waste commands a better price than card waste, and on this account it is considered better to have 18 per cent. at the comber and 4 per cent. at the card, than to have 17 per cent. at the comber and 5 per cent. at the card.

In some such cases it has been sought to limit the card waste by setting front plate closer, by slowing the flats, by closing the undercasings, and even by putting in blank under-casings.

When, however, we are carding and combing Sea Islands cotton the case is different. This fine and delicate cotton is so highly charged with nep and short fibre, that it is advisable to get as much waste out at the card as can be got in a reasonable manner. We want all the work we can properly get from the card in this respect, and at same time all we can get from the comber.

Different Widths of Combers and Draft.

Cases have existed in which combers have been working with, say, 6 heads taking laps $7\frac{1}{2}$ in. wide, and in the same room on the same sort of work there have been new combers containing 8 heads, and taking laps of $8\frac{3}{4}$ in. or even up to $10\frac{1}{2}$ in.

In such cases it is rather a difficult matter to get the slivers from the small combers to come out the same weight per yard as those from the large combers, as may be sometimes required.

In such cases the laps could be made thinner for the large combers than for the short ones, or the total draft of the 8-head combers could be increased, while that of the short combers could be diminished.

It would probably be still better if the slivers could be allowed to come out of different weight, and compensation made in a later machine.

Calender Rollers.—There is some difference of opinion as to whether the calender rollers on the front table should be plain or fluted, and both kinds are in use.

The fluted ones are thought by some to slightly help in consolidating the slivers; but are perhaps more liable to act in a variable manner on slivers that are thicker or thinner than the average. For instance, in a certain specified case, where the ribbon machine was employed, and an end was broken at the ribbon machine for a short time, the slightly thinner portion of lap thus made was allowed to go on to the comber, since on an 8-head comber it would only make the sliver $\frac{1}{48}$th part too light. When fluted calender rollers were, however, used on the comber, these pressed the thinner sliver out to a greater length, so that it could not hold the spoon of the front stop motion down. The difficulty was quite overcome by substituting plain rollers for the fluted ones.

Dobson's Duplex Comber.

The duplex comber has been somewhat fully discussed in chapter iv. of this book, but an additional note may be given here, as this comber certainly has some advantages, although at the time of writing (August, 1901) it appears to be losing caste in favour of the latest single nip comber of the same firm.

In Dobson's duplex the cam shaft is driven at exactly double the speed of the cylinder shaft, by driving the 80's index wheel on the cylinder shaft from a 21 wheel on the pulley shaft, while the 80's wheel on the cam shaft is driven from a 42 wheel on the pulley shaft, with a carrier wheel between the 42 and the 80.

On the single nip machine it is ensured that the cam shaft and cylinder shaft shall revolve at the same speed by gearing one 80's wheel with the other.

To get a double action of the top combs, the lifting cams for these are simply made duplex, *i.e.*, to have two raised surfaces on the circumference instead of only one.

It is probably true that no more radical change was ever made in a cotton spinning machine, with less real alterations and less change of requisite mechanism, than was the case in making a duplex Heilmann comber on the Bourcart principle. The cams were all made to have proper action in the simple manner above indicated. The other and essential requisite was of course putting two needle segments and two fluted segments on the cylinder instead of only one of each.

In the duplex comber each needle segment and each fluted segment may occupy about 3 in. in the circumference of the cylinder, while in the single nip machine each segment may take up approximately 4 in. of the circumference.

Hetherington's Improved Heilmann Comber.

At this stage a few pages are given referring more especially to the comber as made by Messrs. Hetherington, and to aid a little in this a section of a single nip comber is given in Fig. 82.

For many years this firm enjoyed the monopoly of making this machine, and it may truthfully be said that it was brought to great perfection under their care, for no alteration in principle has been made since it was first constructed by them, and the details have only been slightly modified.

They make the machine of 6, 7 or 8 heads to work laps of $7\frac{1}{2}$ in., $8\frac{3}{4}$ in., or $10\frac{1}{2}$ in. as may be desired, and either single or double nip. The following details are common to both machines :—

Nipper Ends.—Formerly the needle segments were made wider than the lap to be worked, in order to allow the latter to spread in its passage through the machine. The selvedges left much to be desired in consequence. They now apply to the nipper their patent nipper ends which prevent undue spreading of the lap and insure perfect selvedges, thus improving the work and saving considerable waste, and can work the $8\frac{3}{4}$ in. lap without any increase in the length of the machine. This is shown in Fig. 83, in which *d* is the top nipper, b^1 downwardly projecting lip from *b*, *c* front of cushion plate, and *a* is the special nipper end or finger.

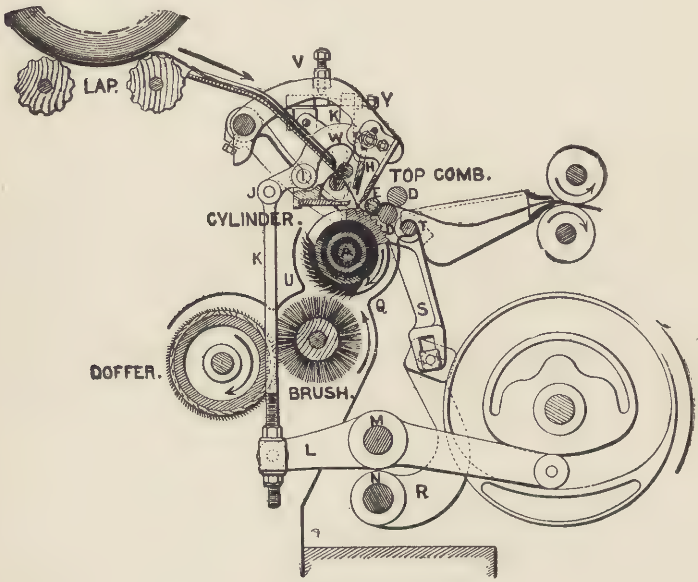


FIG. 82.

These guide pieces project from the plate sufficiently to prevent all spreading beyond a determined width, such width being arranged according to the width of the needles on the cylinder.

An important advantage of the use of such guide pieces is that they permit the use of a wider lap.

These projecting guides sometimes extend in front of and sometimes behind the top nipper, so that the width is maintained until the cotton leaves the nipper.

Other makers have applied devices for the same object, Dobson's consisting of a small finger screwed to the top of each end of the cushion plate.

The cams have been greatly improved in shape, and their action made more smooth; the grooves in them are carefully cut to template by milling cutters, and are of large dimensions so as to ensure smooth running with as little wear as possible. They are placed in the middle of the machine, with the exception of the cam for giving motion to the fluted detaching roller, and in the 8-headed machine they are doubled, and one cam is placed in the middle of each half of the machine

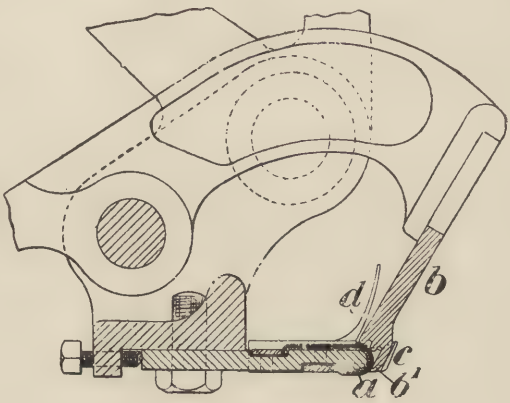


FIG. 83.

thus completely obviating any ill effects arising from torsion in the shafts. The top comb shaft is made unusually strong, and a cam is placed at each end of it.

The feed roller may be either the ordinary fluted roller or the porcupine roller. The latter is used with the object of opening the lap a little and preparing it to be more readily attacked by the comber needles, but where a ribbon lap machine is in use this is hardly necessary.

A stop motion can be applied, if desired, to each sliver as it leaves the collecting tin, and a full can stop motion is also usually applied to prevent the cans being filled too full.

A brush traverse motion is applied so that the brush has a slight longitudinal motion in addition to its circular one, and the needle segments are much better cleaned by this device.

Mica plates are put in the back covers if desired, so that the needles may be always visible to the attendant, without being dangerously exposed.

The needle segments are all carefully made, and each strip can be replaced independently.

In the single nip machine the cylinder has only one needle segment with 17 rows of needles, and one fluted segment, and runs usually at 85 turns per minute, but there are machines running at a higher speed than this.

In the double nip machine of this firm the cylinder has two comb segments, each with 13 rows of needles and two fluted segments, and to this machine are applied two detaching roller cams, which form the subject of a patent. The one cam makes one stroke of the roller, and its neighbour the next one. This organ has always been that which limited the speed of the machine owing to the great strain upon it. By doubling the cams they can run at 130 beats per minute in the double nip machine, for some organs in the machine only make 65 revolutions or strokes in place of 85 in the single nip machine. The detaching roller, although making more strokes per minute, is revolving slower when actually in motion in the double than in the single machine. The time is gained by the pauses between the strokes of the roller being of shorter duration. An increase in the diameter of the cylinder means an increased speed of the detaching roller and a quicker passage of the needles through the cotton. By this double cam arrangement we have time between the passages of the needles to make the piecing, and can thus keep the cylinder the same size in both machines. The needles passing gently through the lap slightly tend to make less waste and perhaps enervate the fibre less than a quicker speed would do.

The slow speed of some of the working parts adds to their durability. While Dobsons' get their double action motion from a double speed of cam shaft, Hetheringtons' prefer to get it from duplicate and oppositely set cams.

WEIGHTS AND DIMENSIONS OF COMBING MACHINES BY THIS FIRM.

Width of Lap.	No. of Heads.	Length.	Width.	Single Nip.			Double Nip.		
				Gross.	Net.	Cubic Feet.	Gross.	Net.	Cubic Feet.
		ft. in.	ft. in.	cwt.	cwt.		cwt.	cwt.	
	6	13 2¼		40	31	100	40	33	
8¾	7	14 8¾	3 5	46	36	112	60	47	
	8	16 2		52	40	125			
	6	14 2¼		46	37				
10½	7	15 10¾	3 5						
	8	17 6		59	46		63	48	

Pulleys 10 in. to 12 in. diameter × 3 in. wide.

Speed.	Revolutions per minute.	Beats per minute.
Single nip	324	85
Double nip	240	125

Combing Machine Calculations: Draft.—Let D = the draft; F = the feed wheel; and C = the change wheel on the coiler cannon, the *total draft* between the lap rollers and the coiler top will be :—

$$D = \frac{47}{35} \times \frac{55}{20} \times \frac{22}{23} \times \frac{38}{F} \times \frac{5}{1} \times \frac{60}{C} \times \frac{20}{20} \times \frac{21}{20} \times \frac{2 \text{ in.}}{2{\cdot}75 \text{ in.}},$$

$$\text{whence } D = \frac{30753}{F \times C}.$$

The wheel, C, depends on the draft in the drawing head, and must be made to take up what the drawing head delivers.

The back roller wheel is altered when necessary so that the roller takes up the slivers properly from the table, and the draft in the drawing head is best altered by changing *only* the wheel on the outer end of the front roller, leaving the compound 45 and the 50 on the cross shaft unchanged.

If b = the back roller wheel, and f = the front roller wheel, the draft in the drawing head is $\frac{6 \times 3{\cdot}125}{f}$.

C will then be $\frac{3 \times f}{2}$, and this will give a draft of 1·05 between the drawing head and the coiler top.

In estimating the weight of counts of the sliver, deduct the waste from the weight or counts of the lap, and consider all as going through them.

$$\text{Hank sliver} = \frac{\text{Hank of lap (reduced)} \times \text{draft}}{\text{No. of laps up}}.$$

$$\text{Or weight of sliver} = \frac{\text{Weight of lap, less waste} \times \text{No. of laps up}}{\text{draft}}.$$

Production.

This depends on the speed, weight of lap, feed wheel, and amount of waste taken out. In estimating the production of a comber, it is convenient to deduct the percentage of waste from the lap and then consider all as passing through. To get the actual production approximately it is usual to deduct $7\frac{1}{2}$ per cent. from the speed.

If we call the speed, after taking off $7\frac{1}{2}$ per cent., S, the feed wheel F, and the weight of lap in grains per yard G, after deducting the waste, then the actual production in pounds per 10 hours will be very approximately—

$$\text{for 6 heads: } \frac{S \times F \times G}{5649}$$

$$\text{,, 7 ,, } \frac{S \times F \times G}{4842}$$

$$\text{,, 8 ,, } \frac{S \times F \times G}{4237}.$$

For ordinary work the $10\frac{1}{2}$ in. lap may weigh 14 dwt. per yard for the single machine, and 12 dwt. per yard for the double machine. In each case a 16 or 17 feed wheel may be used. Under these circumstances the production of a double machine with eight heads at 125 beats and 17 per cent. of waste would be—

$$\frac{115\frac{1}{2} \times 16 \times 239}{4237} = 104 \text{ lb. in 10 hours.}$$

The frame ends of Hetherington's comber have been altered so as to give it a nobler appearance. The ends have been widened and the gearing ends act as a cover to the large cam and notch wheel, thus forming an end similar to a speed frame. This tends to make the machine more substantial as well as improving its appearance.

The creel has also been altered to a better shape. The top comb shaft has been strengthened so as to take away vibration from the top combs. Other alterations in detail have been effected so as to give steadier working and less breakage.

The back tins for waste are about 2 ft. 8 in. long, 12 in. wide, and 2 ft. high, with a partition across for each head. These are sometimes made of wood $\frac{3}{4}$ in. thick for the bottom, and $\frac{1}{2}$ in. thick for the sides.

Sometimes in lieu of the above boxes this firm apply a waste gathering shaft after the style of the one described and illustrated for Dobson's comber in this treatise.

This is simply a very slowly revolving shaft placed at the back of the machine in such a position that the waste is wrapped round it instead of falling on the floor or into tins.

Filled in Specification for Hetherington's Combers and Preparatory Machines, for 30,000 Mule Spindles Spinning 80's.

How many sliver lap machines?—Three. Width of lap to be made?—$7\frac{1}{2}$ in.

Diameter of the rollers?—First, $1\frac{1}{2}$ in.; second, $1\frac{1}{2}$ in.; third, $1\frac{1}{2}$ in.

Are we to supply metallic rollers (extra) or ordinary ones?—Metallic rollers.

Are we to cover the top rollers and clearers?—No (extra).

Diameter of the driving pulleys?—12 in. × $2\frac{1}{2}$ in. Speed per minute?—180 to 200.

How many ribbon lap machines?—Three. Width of lap to be made?—$8\frac{1}{2}$ in.

How many heads per machine?—Six.

Diameter of the rollers?—First, $1\frac{1}{2}$ in.; second, $1\frac{1}{4}$ in.; third, $1\frac{1}{2}$ in.; fourth, $1\frac{1}{2}$ in.

Are we to supply metallic or ordinary rollers?—(Metallic extra.) Ordinary rollers.

If the latter, will you have the top rollers with loose ends?—Yes (extra).

Are we to cover the top rollers and clearers?—No (extra).

Will you have the curved plates covered with sheet brass?—Yes (extra).

Diameter of the pulleys?—16 in. × 3 in. Revolutions per minute?—240.

When facing the table, how many machines with pulleys on the right?—Two.

When facing the table, how many machines with pulleys on the left?—One.

One extra ordinary top roller and three draft wheels are supplied gratis with each of the above machines.

How many combers?—Eighteen. How many heads per machine?—Eight.

Single or double nip?—Single. Width of lap?—$8\frac{1}{2}$ in.

Diameter of the driving pulleys?—10 in. Nips per minute?—85.

When facing the table, how many combers with pulleys on the right?—Nine.

When facing the table, how many combers with pulleys on the left?—Nine.

Diameter of the rollers in the drawing head?—First, $1\frac{1}{2}$ in.; second, $1\frac{3}{8}$ in.; third, $1\frac{3}{8}$ in.

Will you have metallic or ordinary rollers?—Ordinary (metallic extra).

If the latter, are we to cover them and the cushion plates and clearers?—Yes (extra).

Are we to supply filleting for the doffers?—No (extra). Will get it from wiremakers.

Or will you have the doffers clothed with metallic filleting?—No (extra).

Will you have a coiler, or only a can motion?—Coiler.

Dimensions of the cans: height, 36 in.; inside diameter, 9 in.; outside diameter, $9\frac{1}{2}$ in.

Will you have a front stop motion?—No (extra).

Will you have a full can stop motion?—Yes (extra).

Will you have a brush traverse motion?—No (extra).

Will you have a waste creeper and coiler at the back of the machine (extra)?—Yes.

Will you have an indicator showing the number of hours worked (extra)?—No.

Will you have our patent nipper ends?—Yes (extra).

Will you have the needle covers furnished with mica plates?—No (extra).

Comber Draw Box.

The question has been asked, Why should the draw box of a comber be retained, while the draw box of a card is dispensed with?

It may be answered that the draw box on a comber serves a much more useful purpose than it possibly could do on a card. There can be no doubt that certain advantages resulted from the use of the draw box of a card, such as a reduction of the thickness of the sliver, and a tendency towards the parallelisation of the fibres. But on a comber the draw box to all intents and purposes appears to serve as a special head of drawing frame. Not only is there a tendency to improve the parallel order of the fibres, but by the doubling and attenuation of six or eight slivers into one the uniformity of the comber sliver is largely improved. It appears clear to the writer that the manner in which the attaching and detaching of the cotton fibres is performed on a comber, together with the peculiar and combined action of the top and bottom combs, and the nippers and feed rollers, tends to produce a very irregular sliver, which would give bad results if not corrected to some extent by the draw box. It is well known by comber experts that however uniform the back laps are it is difficult to get the same weight of good sliver and the same percentage of waste from each of the several heads of a comber.

On many combers this equalising power is assisted by the provision of automatic spoon stop motions, by which the machine is made to knock off whenever an end fails between the first calender rollers and the back roller of the draw box, although on the other hand many comber masters consider this motion not worthy of application.

Furthermore it is necessary for the operatives to watch combers more closely than cards because of the liability of the cotton going wrong elsewhere than at the drawback. Apart from stripping and grinding and changing the laps and cans cards will often run a considerable time with very little attention and comparatively little risk of anything going wrong. When the draw box was used, however, the cotton often went wrong at the point, necessitating a good deal of extra attention; with the modern quick-running flat cards this evil would be greatly increased, so that it is now very generally conceded that the draw box on a card would do more harm than good. At one time draw boxes were very largely adopted, and twenty years ago the writer personally saw whole card-rooms filled with them. Experience, however, appears to have taught us that it is better in the case of carded yarn to leave the work of the draw box to the drawing frame on which stop motions are always fitted and at which there is always a tenter bustling round. On a card it is probable that the cotton would be more liable to go wrong at the draw box than elsewhere, while on a comber this is not the case.

Draw Box.—Although usually this contains only three pairs of drawing rollers, in some cases four pairs have been adopted. One objection to this course is to be found in the multiplication of wheels that is rendered necessary in the draw box. Even with three pairs of rollers there are many wheels, and the addition of another pair quite crowds the wheels up. Since we require only about five of a draft in this draw box, it looks as if three pairs ought to serve. Some people, however, consider four pairs of rollers here would be an advantage on account of dividing out the draft better, and making it possible to increase the draft more readily.

Making of Waste.

It is very well known that various alterations can be made to take out less waste in addition to feeding sooner. For instance, less waste can be made by :—

(a) Putting less angle in the top combs.

(b) Setting top combs further away from fluted segment.

(c) Closing nippers sooner.

(d) Feeding sooner.

To put it the other way, we may say:—

The greater the angle of the combs .	Greater	the	waste.
Later the nipper closes	,,		,,
Late feeding	,,		,,
Close setting	,,		,,

Now although practical men have generally found alterations in their combers to work out somewhat as per above rules, yet for the most part they do not appear to understand why it should be so. In his capacity of instructor in cotton spinning the author has frequently been asked for such reasons, and hence they are given somewhat fully hereafter.

It should be stated, however, that slight alterations in the nippers and feeding do not always give very visible results.

Another question often asked is, Why should a comber take out short fibre and not long fibre? And this question will be discussed first.

Why should a Comber take out Short Fibre and not Long Fibre?

It is the author's experience that so far few people have been able to give a satisfactory answer to the question put at the head of this article.

There are many points in common with the card and the comber. Each machine takes out short fibre; each takes out fine dirt, nep, etc., and each opens out the fibres, and more or less treats them to a combing process. They are alike also as regards the difficulty of answering the question as to how each machine manages to extract short fibre without at the same time taking the long fibre. Just now we have only to deal with the comber.

It is well known that the nippers hold the fibres while the needles or combs of the cylinder pass through them, and the most frequent explanation and answer given to the question under discussion is, that the long fibres are held firmly while the needles pass through them, while the fibres below a certain length cannot reach up to the nippers, and are therefore taken out by the cylinder combs.

This explanation would be sufficient if there was a difference of about $\frac{7}{8}$ in. or more between the points of nipping of closed nippers and the cylinder comber; but, as a matter of fact, this distance is only about $\frac{3}{8}$ in., so that any fibres $\frac{1}{2}$ in. length can be held by the nippers providing they are not crossed or have not been let go by them, so as to reach far beyond the distance of the cylinder needles.

The amount of short fibre taken out, and the length of the fibre that is taken out, probably depend more upon the distance of the leather detaching roller from the nippers and feed roller than upon the distance of the cylinder needles therefrom. Based upon this statement, the author offers the following explanation of the question under discussion :—

Suppose the point of contact of the centre of the leather detaching roller with the fluted segment of the cylinder be 1 in. from the top edge of the cushion plate. The average length of the good fibre is taken at $1\frac{1}{2}$ in., and $\frac{1}{4}$ in. per nip is supposed to be projected forward by the feed rollers. Each fibre has to be projected from the nippers upwards of $\frac{1}{2}$ in. before it really begins to be acted upon by the cylinder needles, and it will be evident that each long fibre would be acted upon about four times by the cylinder needles before finally liberated by the nippers. It is probable, however, that each fibre is not acted on more than two or three times by the cylinder needles, because when it has been projected beyond the top edge of the cushion plate, say usually about an inch, it is laid hold of by the leather detaching roller and fluted segment of the cylinder, and taken forward as good combed sliver, and the back ends of the fibres are pulled through the needles of the top comb at the same time.

From this explanation it will be evident that under proper working conditions there cannot be much long fibre taken out as waste, since before such fibre has been liberated from the grip of the closed needles it is taken from the open nippers by the detaching mechanism.

Take now the case of short fibre of say $\frac{5}{8}$ in. length. Such fibres may possibly be held by the nippers while the cylinder needles pass through the front ends of the fibres, but the next time the nippers open these short fibres will be projected by the feed rollers beyond the reach of the nippers. At the same time the centre of the bottom leather detaching roller is too far off these fibres to take them forward with the long fibres. When the needles of the cylinder again come up, these short fibres being neither held by the nippers nor by the detaching rollers are taken forward by the needles as waste.

To put the matter briefly :—

(1) The long fibres are taken from the open nippers by the detaching mechanism before they are released by the closed nippers, and so cannot be taken by the needles as waste.

(2) Very short fibres are liberated by the nippers before the leather roller can reach these fibres, and so are combed out by the cylinder needles.

Long fibres never are free from both the nippers and the detaching mechanism at the same time when the cylinder combs are up, but there is always a moment when the short fibres are neither held by the nippers nor the detaching mechanism.

The action here really very much resembles the action of drawing rollers, where there is always a tendency for short fibres to drop out when the rollers are too openly set, and especially so between the front and middle rollers, where the draft is greatest. This principle is improved upon in the comber, inasmuch as the liberated short fibres not only have a tendency to fall out, but they are seized by the cylinder needles, and absolutely pulled out by force.

The net forward or delivery surface speed of the detaching rollers is about five times as large as the net surface forward delivery speed of the feed rollers, so that there is a draft of about 5 in this position.

Top Comb.

It must not be forgot that the top comb plays an important part in taking out waste.

If a top comb is left up for a few nips it will be at once evident that much less waste is being taken out, and the sliver is coming out at the front much thicker.

It is well known that only a comparatively small amount of short fibre can fall out at the drawing rollers of any machine, however far apart the rollers may be, because of the short fibre being sustained by the general body and substance of fibres. The same principle is more or less present on the comber, so that there is a tendency for short fibres to be pulled forward by the detaching mechanism, owing to these short fibres clinging to and receiving support from the long fibres.

This tendency, however, is admirably checked by the needles of the top comb.

Short Fibre Extraction.

The foregoing remarks on the extraction of short fibre were written by the author some two years ago for the pages of a well-known textile journal. Just before going to press with this treatise the author has been favoured with an article by Professor Johannsen on the same subject, and this is reproduced below:—

"In Fig. 84, under the letters *a* and *a′*, are shown the drawing-off cylinders (detaching rollers), which catch the combed beard, L, at the point, C, and pull it through the fix comb (top comb).

"The length of the shortest fibres contained in the combed slivers is determined in the following way:—

"The cylinders, *a*, *a′*, draw off while the fleece is fed forward, and thus they can grasp at the end of feeding (or just before they stop) those fibres whose extremities did not at first reach the finishing point, C.

"Such fibres were at least long enough to be ended in *m* before the drawing-off.

"Indeed, if they had been shorter they would not have been pinched by the grasping point, *m*, and thus would have been taken off by the circular comb and put into the noils.

"Then if during the drawing-off or detaching the fleece is fed of the length, A, forward, the cylinders or detaching rollers, *a*, *a′*, can grasp at the last moment fibres of a length, L, A.

"*Corollary*.—The combed slivers contain only fibres of all lengths included between B and L, A, while B is the maximum length of the fibres in the combed slivers."

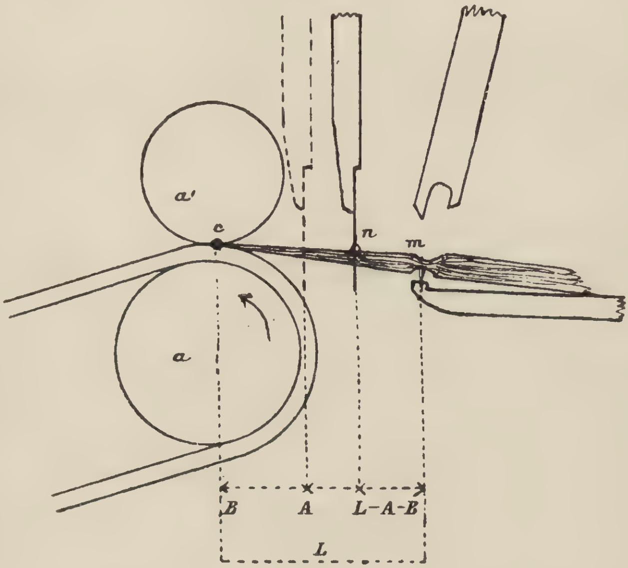


FIG. 84.

Practically all the fibres have to be pulled through the top comb by the detaching mechanism, so that any loose or crossed fibres are caught and held by the top comb needles. As practically all the short fibres are at a certain period in a loose condition, they are kept back by the needles of the top comb. When the top comb lifts up during the succeeding nip, the short, loose or crossed fibres are left on it by the front edge of the body of fibres projecting from the nippers, and are, therefore, immediately taken round as waste. The top comb does not cause long fibres to be taken out as waste, because such fibres are held with sufficient firmness by the detaching mechanism as to be pulled safely through the top comb.

Besides the useful function which the top comb performs as just indicated, it will be remembered that it also assists in combing out the rear or tail ends of all the good fibres. It is impracticable to fully complete the combing of the fibres by the cylinder needles, since in order for those needles to act on the fibres the latter must be held by their rear or tail ends by the nippers, and before the closed nippers release the long fibres the detaching mechanism must take the fibres from the open nippers. As a matter of fact, it is probable that the top comb acts on a much greater length, and the cylinder needles on a much shorter length, of each cotton fibre than most people imagine.

Besides materially assisting in extracting the short fibre, the top comb also performs the important duty of combing out and cleaning all the tails or rear ends of the fibres. During each revolution of the cylinder, and immediately before the leather detaching roller begins to take the last combed tuft of fibres forward, the needles of the top comb descend into these fibres, so that the latter have all to be partially pulled through the top comb.

No fibres have to be pulled twice through the top comb, since the detaching rollers never return to it any fibres they have once laid hold of.

From the foregoing explanation it will be seen why setting the top comb further away from the fluted segment of the cylinder should tend to make less waste. It is because loose and crossed fibres have a better opportunity of being drawn underneath the top comb by the detaching mechanism.

A somewhat similar explanation serves for showing why taking some of the angle out of the top comb causes a comber to take out less waste. With less angle in the top comb the fibres can be pulled through it more freely than with a good deal of angle.

The foregoing explanation of why a comber does not take out long fibre as waste must be modified by the statement that in order for a comber to be effective in this respect it is absolutely necessary to pass the cotton fibres through preparatory machines between the card and the comber. Quite apart from the question of feeding a comber with a uniform lap, it is absolutely essential to present the fibres to the nippers in an approximately parallel condition. Unless this condition is obtained good fibres will be liable to escape from the grip of the nippers before they are reached by the leather detaching roller, and being kept back by the top comb will be taken out as waste with the short fibre.

It may be taken as probably the best and most certain means of preventing a comber from making waste out of good cotton, to effectively prepare the laps for it, by making the fibres parallel and the sheet of cotton uniform.

For Short Staples.—From the foregoing explanation of how a cotton comber manages to take out short fibre instead of long, it will be seen that in order to fit up and set out a comber to act upon short-stapled cotton it ought to be a primary condition to have the centre of the leather detaching roller brought closer to the top edge of the cushion plate than for longer-stapled cotton. This condition does not appear very easy of attainment, owing to the limited amount of space available, and to the top comb having to pass between the leather roller and the nipper, and also to the close juxtaposition of the comber parts generally.

It is the actual experience of the writer that it is a difficult matter to get a comber to work short-stapled fibre satisfactorily, and to take out a small percentage of waste, when it has been constructed and adjusted for long-stapled cotton. Something may be done in this direction by allowing the cushion plate to follow the top nipper a little more in an upward direction than at present, and by any and every way possible getting leather roller nearer to cushion plate.

Feed Roller Wheel.—In some cases where short-stapled cotton is combed it is the practice to put on a less feed roller wheel, because if as much is fed per nip as for long fibre the cotton fibres are projected forward before they have been long enough under the action of the cylinder needles.

The feed roller wheel is, however, practically the draft wheel of a comber, and the wheel which it is usual to alter if the counts of sliver are not coming out right. If, for instance, a comber is taking out less short fibre than usual, on account of the better quality of the cotton or from some other reason, then the counts of sliver will come out too heavy. This may be remedied by putting on a smaller feed roller wheel, which will have the effect of feeding the cotton more slowly, while the delivery remains as before.

The writer has heard it contended that the use of a smaller feed roller wheel would tend to take out more waste, because the thinner the body of cotton held by the nippers and acted on by the needles, the larger the percentage of waste. If this principle be correct, then the use of a finer or lighter lap would have the same effect; on the other hand, some people contend that a longer feed gives more waste.

Why does Late Feeding make more Waste?

It is the usual practice amongst comber fitters and overlookers when the waste percentage is a little too high or low for them to slightly alter the time of feeding. On all combers means are provided by which this alteration can be very simply and easily effected. It is generally agreed amongst practical men that later feeding gives more waste, although it is not wise to attempt to make great alterations in the waste percentage in this manner. It is the writer's experience that scarcely any practical men or others can satisfactorily explain why late feeding should make more waste, and he has very frequently been asked to offer an explanation.

For Egyptian cotton, single nip, the official feeding time is 5, and on the duplex comber $4\frac{1}{2}$. The time for feeding is practically the same for Sea Islands as for Egyptian cotton. It must be remembered that feeding takes place while the nippers are open, and the fluted segment of the cylinder is on the top, and it commences just before the forward motion of any of the three detaching rollers. To take an extreme variation in the feeding, we will suppose it is put to begin at $6\frac{1}{2}$ instead of 5, which is a greater alteration than is likely to be made in actual practice. After the alteration it would probably be 10 or more of the index wheel before feeding was finished, and by this time the nippers would ordinarily be closed, and the late feeding would cause the fibres to curl and cluster up behind the nippers. When the nippers were again opened the cotton would be therefore projected through the nippers in a somewhat confused manner and non-parallel order, and would not pass in a satisfactory manner through the needles of the top comb, and so would be left to be taken by the cylinder needles as waste.

Again, feeding commences just before the leather detaching roller touches the cylinder segment and commences to take the fibres forward. If feeding be delayed, then the leather roller and cylinder segment cannot lay hold of the fibres sufficiently well, and more of them are left for the cylinder needles to take round as waste. By late feeding the fibres are not projected through the nippers sufficiently soon for the leather detaching roller to lay hold of the fibres as well as with soon feeding, and feeding does not finish before the nippers close.

These reasons then are given by the writer as an explanation of why late feeding should make more waste.

As a typical case of the use of the feed peg, we may suppose that the percentage of waste comes out as 18 per cent. instead of as 19. Providing we are not already feeding late, we may now do so, and it may be reasonable to expect such an alteration to increase the waste percentage as required. It would be quite impracticable to attempt to reduce the waste say from 20 to 16 per cent., or on the other hand to increase from 16 to 20 per cent. by alterations in the time of feeding alone.

Why does Late Nipping give more Waste?

It is generally conceded that later nipping usually tends to give a greater percentage of waste, and the question is often asked why this should be so.

When any answer at all is forthcoming to this question, it is usually to the effect that the needles of the cylinder get into the fibres before they are fully held by the nippers, and, therefore, the needles pull more fibres from the nippers as waste than would otherwise be the case.

While there is probably some truth in this explanation, the author is inclined to think a more likely explanation is as given below, although he has never in any case known any one else to advance the same reason.

The detaching rollers draw and detach the combed cotton from the open nippers, and pass it forward towards the collecting tin, and the end of the combed tuft of cotton should be passed out of the way of the cylinder needles before the latter come round again. So long, however, as the nippers remain open there will be a tendency for the fibres being drawn forward by the leather roller to exercise a frictional contact on the surrounding fibres lying loose on the cushion plate, and in this way to drag some of the loose fibres forward, and to leave them in the path of the needles when the latter come round. Later the nipping and greater the tendency to produce this detrimental effect. By closing the nippers comparatively early, and allowing detaching to continue a little later, the detaching is cleaner and more thorough, and almost all the detached fibres are passed forward by the rollers out of the way of the cylinder needles. The late nipping tends to give imperfect detaching in the manner just pointed out. The author has heard the question put in public discussion, Is it wise or true combing to nip before the forward motion is finished? His answer to such a question would be in the affirmative, for the reason just given.

Touching this question as to why should later nipping give more waste, it may be remembered that detaching is also proceeding during the time the nippers are opened, and is not usually finished when the nippers are closed. It is probable that really effective detaching or separation of fibres does not take place until after the nippers are closed. If the nippers are closed very late it may happen that a number of loose fibres are dragged forward by the detaching rollers into the path of the cylinder needles, and out of the grip of the nippers, instead of either being left within the hold of the nippers, or, on the other hand, taken forward by the detaching rollers out of the range of action of the needle segment.

By closing the nippers at 9, and continuing the forward motion of the rollers a fair amount of time after the nippers are closed, and well before the needle segment comes up, a less number of loose fibres are left for the needle segment to take round as waste.

Take now the closing later of the nippers. Although this is an official instruction, and generally understood as a legitimate thing to do, it is probable that it is by no means as frequently resorted to as feeding later to take out a little more waste. The writer has been frequently asked, Why should later closing of the nippers make more waste? In addition to the foregoing and principal reason, we may say that it is probably also in part because the nippers do not hold the cotton so firmly when the latter is first attacked by the needles of the cylinder, and hence the needles extract more fibre. The top nipper should touch the bottom one or cushion plate at 9 for Egyptian and $9\frac{1}{4}$ for Sea Islands, so that the principle of later nipping for more waste is here recognised. It is not likely, however, that just one tooth later of the index wheel will have a very appreciable effect on the amount of waste made or on anything else. Although the top nipper touches the cushion plate at 9, yet the nippers are not properly down, and have not got a thoroughly good grip of the fibres until a good deal later number of the index wheel; but it may be upwards of 14 or so of the index wheel before the cylinder needles attack the cotton, so that the writer may repeat it as his opinion that it is useless trying to make a very great difference in the amount of waste by altering the time of nipping. Suppose, for instance, the nippers be made to close at 10, there will still be about 4 marks = 16 teeth of the index wheel before the needles attack the cotton, and it may be fairly presumed that by this time the nippers have as firm a hold on the fibres of cotton as they are likely to have. Excessively early closing of the nippers would interfere with the work of detaching.

It is very probable that a variation in the distance between the long steel roller and the front edge of the cushion plate will affect the amount of waste made more than a variation in the time of nipping. In some cases it is the practice to have this distance $1\frac{3}{16}$ in. for good Egyptian cotton, and $1\frac{7}{16}$ in. for long Sea Islands. There are many firms, on the other hand, who use the same gauge in this position for both Sea Islands and Egyptian cotton, and profess to be unable to find any difference in the working. If the change be from long Egyptian to short Sea Islands, then it may be quite unnecessary to put the nipper further from the detaching rollers, but if the change be from say moderate Egyptian to long Sea Islands, it is the opinion of the writer that the setting in this position should be more open. On the same principle, if a comber were to be changed from Egyptian to American cotton—a most unusual procedure in England—the writer would recommend that the distance between the long steel rollers and the front edge of the cushion plate be diminished by nearly the length by which the Egyptian cotton fibre exceeds the length of the American fibre.

In the opinion of the writer good working distances between the long steel roller and front edge of cushion plate would be as follows :—

Good Sea Islands	$1\frac{3}{8}$ in.
,, Egyptian	$1\frac{3}{16}$,,
Poor Egyptian	$1\frac{1}{8}$,,
Good American (not Peelers, etc.) . .	$1\frac{1}{16}$,,

With such settings as these there would be a better chance of taking out a sufficient amount of waste for the Sea Islands than by sticking to the $1\frac{3}{16}$ in. setting. On the other hand, there would be less liability of taking out too much waste when using poor Egyptian and good American if the closer settings were adopted as above recommended. With very close setting it is difficult to find room for the top comb, nippers and leather roller.

"Heads" and "Tails" in Combing.

It is convenient to term the leading or front portions of the cotton fibres as they pass through the comber the "heads" of the fibres, while the rear or following portions may be termed the "tails" of the fibres.

In the combing machine we are quite unable to comb the "heads" of the fibres with the same apparatus as the "tails" are combed.

It is quite essential that both the "heads" and the "tails" of the fibres should be combed in order to get the most perfect cleaning action, and the more nearly we can comb the full lengths of the fibres the more perfectly is the work done.

The combing of the fibres is obliged to be divided into two principal periods, each represented by different mechanism. In the first place, while the "tails" of the fibres are held by the nippers—and in a much less degree by surrounding fibres—the needles of the cylinder pass through the "heads" of the fibres.

Afterwards the "heads" of the fibres are grasped by the detaching mechanism and the "tails" pulled through the needles of the top comb.

In the Heilmann comber, therefore, it is important to remember:—

1. The "heads" of the fibres are combed by the cylinder needles.

2. The "tails" of the fibres are combed by the needles of the top comb.

As regards other types of combing machines, some of them—probably most—have to work on much the same lines, while others adopt different lines.

Importance of Top Comb.

It may be given as an additional note that the writer has once or twice heard first-class comber men contend that the top comb exercises a more important effect on the combing of the fibres than many people are aware of, and his own investigations fully support this contention.

Since there are 17 rows of needles in the needle segment of a single nip Heilmann comber, and 13 rows in that of a duplex Heilmann, while there is usually only one row of needles in the top comb (in a few cases there are two), it is very natural indeed to imagine that the cylinder needles do nearly all the work.

As a matter of fact, the author is prepared to contend that in many cases something like one-half the length of the fibre is combed by the top comb, and the other half by the cylinder needles. According to the settings and constructions it is probable that this half may be either increased or diminished somewhat.

There are two or three reasons for the anomaly just pointed out :—

1. The cylinder needles cannot reach within a certain distance of the point where the fibres are held by the nippers, some constructions of nippers being more faulty in this respect than others.

2. The extreme front ends of the "heads" of the fibres are acted upon by the needle segment more than any other portion of the fibres, the amount of cleaning by the cylinder needles diminishing towards the nippers.

3. The "tails" of the fibres have necessarily to be pulled through the top comb, so that this comb acts like a filter and will not allow any neps, crossed fibres or impurities to pass forward.

4. The "tails" of the fibres are held by the surrounding fibres, which set up a resistance to the forward motion of such fibres ; and this frictional resistance is of great service in straightening and cleaning the "tails".

From the above statements two important corollaries may be made :—

(1) To get the "heads" of the fibres perfectly combed we must get the nipping point as close to the cylinder needles as possible, set the needles so that if one row misses the fibres another will catch them, and have as many rows of needles as are convenient.

(2) To get the "tails" of the fibres combed as perfectly as possible we must drop the top comb as near to the detaching rollers as possible, lift the fibres resting on the cushion plate as well behind the top comb needles as possible, and have the lap as heavy as it is convenient to have.

It is the opinion of the author that better results could be obtained by a reconstruction of the nippers, so as to have the nipping point closer to the cylinder needles.

Further, if the cylinder needles could be made to stand it, it is probable that heavier laps would give better combing. Against this it may be argued that the use of an 8-head Heilmann comber already necessitates either an excessively large draft, or else very light back laps.

Better combing would also be produced if the top comb could be made to follow the leather-covered detaching rollers slightly.

Suggested Heilmann Comber.

In view of the foregoing remarks it has occurred to the author that it might be quite profitable to arrange Heilmann combers somewhat on the following lines :—

1. Place the headstock in the middle like that of a self-actor mule.

2. Provide from 3 to 6 laps or heads (say 4 or 5 preferably) on either side of the headstock.

3. Place a coiler can at either end of the machine so as to be filling two cans at the same time.

4. Use thicker laps so that the slivers will issue from the machines about the same dimensions as at present.

It might naturally be expected also that in such a comber there would be less torsion and loss of motion in the various shafts owing to the driving being from the centre. Since penning the above note an expert has informed the author that some such idea was tried many years ago.

Action of Cylinder Needles.

The needles of the cylinders are, of course, each carried to a fine sharp point, so that each is really somewhat of a cone shape.

An effect of this is that fibres or portions of fibres which can be acted upon by the bottoms or bases of the needles are likely to be better cleaned and straightened than are fibres or portions of fibres that are acted upon only by the points or

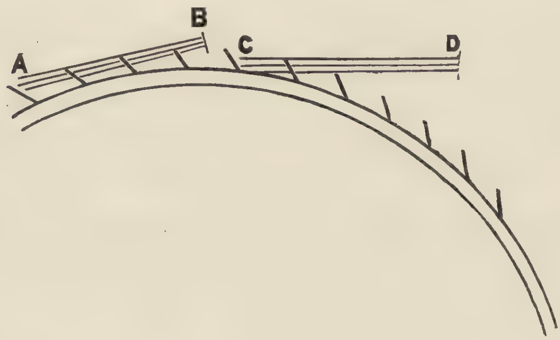


Fig. 85.

apices of the needles, since there is far less space between the needles at their bases than at their apices.

It appears to the author that in order to secure the greatest efficiency from the cylinder needles a great deal depends upon the exact position in which the nippers hold the fibres in relation to the centre of the cylinder.

If the fibres are held too far back it is impracticable to comb even all the "heads" or front portions of the fibres.

For instance, referring to Fig. 85, if the fibres, C, D, were held at D by the nippers, it would be impossible for the cylinder needles to reach much more than the front extremities of the fibres at C.

If, however, the fibres, A, B, are held by the nippers at B, or even more to the left still, a much greater proportion of the length of the fibres can be combed.

It should be noted that in most Heilmann combers this point is now kept well in mind.

Waste Gathering.

It will be readily understood that in a large set of combers the waste or fly takes a good deal of gathering. In some cases a strong young person has to do this work twice a day, and attend to about eighty combers, and might also give a little assistance with such work as taking out the long detaching rollers, etc.

It does not pay to drive the picking of the fly too long, as it becomes then more difficult to gather than what time has been saved in missing a picking.

In some cases a good deal of time is taken up in picking flocks from the cylinder needles and in straightening needles.

It is well known that comber waste is an addition to the waste taken out in a mill which simply makes carded yarn, and is much too good to be classified with the ordinary waste, which is used up in the production of Billey spun yarns. Some cotton spinning mills use a large proportion of comber waste mixed with American cotton, in spite of the differences in colour, etc. In such cases it is difficult to make out the nep, and it is a good practice to mix the two kinds of cotton on the finisher scutcher. In addition the range of counts spun does not reach very high excepting the proportion of waste used be very small.

It is, of course, impracticable to use the comber waste up in the same mill as it is made in, and for the same class of work, as the combers have been used for the express purpose of sorting it out, and rejecting it from among the longer fibres. It may, however, be used up in the same mills for lower and carded counts of yarn. It must be remembered that the quantity of comber waste made is very great, say about 2,000 lb. per week in a mill consuming between 10,000 lb. and 11,000 lb. of raw cotton weekly, and taking out about 20 per cent. of comber waste.

Use of Screw-key.—A word of caution should be uttered to any who may have to do with the erection, resetting or alteration of combers as regards the screwing up of the multitude of small screws and bolts that are to be found about a Heilmann comber. As stated elsewhere, it is important that these be screwed up firmly.

On the other hand, in very many cases reckless and injudicious screwing up of the smaller screws has led to the heads of the set screws being twisted off, and it is very annoying and troublesome to have to contend with these broken screws when making subsequent alterations.

Waste Alteration.—In some cases if the percentage of waste is not right alterations are made in the following order in trying to get right:—

(1) The time of feeding.

(2) The time of nipping.

(3) The top comb setting.

It is difficult, however, to control the amount of waste as fine as say to ½ per cent., and practically impossible for any man to set every head of the same comber to work exactly alike as regards waste percentage.

Half-combed Slivers.—In cases of actual practice a kind of superior card of yarn is obtained by only taking out a very low percentage of waste at the combers, while in other cases practically the same effect is produced by mixing a certain number of combed slivers with other slivers that have been only carded.

Scouring and Cleaning.—It is the case with the comber as with other machines, that the times between scouring and thoroughly going through each comber vary at different firms. In some cases such thorough going through work is done once in every twelve months, so that a firm having 100 combers would scour two every week.

In some cases such scouring takes place on an average every six months for the same comber, while a good cleaning of the sliver tins, cleaning detaching rollers and guide plates, etc., and pulling draw box to pieces, may be done at shorter intervals.

A thorough scouring would imply going through practically all the settings as described in the section on that subject.

All the leather-covered rollers should be at the same time put into thoroughly good condition.

Needle Segments.—In some instances the seventeen rows of needles on the cylinders are made up as follows:—

First six rows	32 per in. and	24's wire gauge.
7 to 9 ,,	40 ,, ,,	26's ,, ,,
10 and 11 ,,	48 ,, ,,	27's ,, ,,
12 ,, 13 ,,	64 ,, ,,	29's ,, ,,
14 ,, 15 ,,	72 ,, ,,	30's ,, ,,
16 ,, 17 ,,	88 ,, ,,	33's ,, ,,

Coiler Gearing.—In very many cases, as shown in the gearing plans of Dobson's (Fig. 77) and Hetherington's (Fig. 78) combers, the coiler is driven directly from the cylinder shaft, while in other cases the coiler is driven more indirectly from the draw box, as shown in the gearing plan of Messrs. Platt's comber (Fig. 34). Although perhaps the former method is rather neater, and in many cases is very seldom required to be altered, yet in other cases the latter or indirect method has been found most suitable, and some combers have been altered to it. In some cases it is required to keep the sliver from the comber at something like a given standard, and every time a new full set of laps have been got coming full weight down the front table and through the draw box the sliver has been wrapped. If required then the draft of the draw box has been altered by changing one of the wheels, and with the indirect driving such alteration also alters the speed of coiler in proportion. With the indirect driving if the draw box be made to deliver the cotton at a different rate of speed, it is necessary to alter a separate wheel to keep the coiler speed right, this wheel being rather heavy and inconvenient to get at.

It must be understood that alterations of draw box draft cannot be very well made by altering the speed of the back roller as on other machines, since this would slacken or else tighten the slivers on the front table, according as to whether the back rollers were reduced or increased in speed. On all combers there is a wheel by which the speed of front roller can be readily altered, and the block rollers are kept right in speed in such cases by being driven from the front roller.

Extra Cams.—To facilitate the taking out of the quadrant for repairs and alterations, with the new double quadrant cam there are provided round holes in the face or side of each cam through which the stud for the cam bowl can be knocked out of or pushed into position inside the bowls. The bowls being thus released it is easy to take out the quadrant.

The multiplication of cams on the cam shaft may certainly be expected to lead to some practical difficulty in any circumstances which may need the stripping or partial stripping of the cam shaft, such, for instance, as having from any cause to change the worm on the cam shaft which drives the calender roller shaft. Even with the less number of cams employed on the cam shaft, there has often been plenty of trouble with the cam shaft in times past. A remedy for this could easily be found by making the cam shaft in two or more parts, connected by couplings.

Improvements.—There can be no doubt that the new double frame ends or headstock foundations should greatly aid in the perfect working of a Heilmann comber. If well and harmoniously adjusted, the direct coupling up of the lifters and the use of the extra lifter cams should be a considerable improvement. The duplication of the nipper cams can scarcely fail to mend the operation of the nippers, while the duplication of the quadrant cam is also as great an improvement as any. It is becoming the practice to mill the cams with the greatest care, using well constructed he and she templates, which can be occasionally put on the cams if necessary to check the shaping of the cams.

Both the studs and the bowls which work in the cams are carefully turned, and then afterwards hardened and tempered and practically made into steel.

Oil holes are now also being put in the studs on which the cam bowls work.

There can be no doubt that formerly enough care and skill were not always put into the construction of these bowls and studs, and it is easy to see that wearing and sticking of these parts will soon prove disastrous to the correct working of the principal parts of the comber.

In some cases for all the cams on the cam shaft a uniform standard has been adopted of making the cam bowls 1 in. wide, and to fit nicely and exactly in grooves of $1\frac{5}{8}$ in. diameter in the faces of the cams.

It must be added that practical men are most decidedly of opinion that it will be a difficult matter to keep so many cams working perfectly together.

Mica Plates.—In a very few cases some of these have been applied as back covers to the brushes and cylinders, but this material is so brittle and withal so expensive that few people care to adopt it. Its advantage is that it permits the brushes and cylinders to be seen without taking the covers off.

Combing American Cotton on Heilmann Combers.

As stated elsewhere, the Heilmann comber is certainly not seen to its best advantage when combing American cotton of ordinary inch staple. It can, however, do fairly well with very good American cotton reaching say $1\frac{1}{8}$ in. staple on an average.

Such cottons are often combed on the Heilmann comber, and their spinning capacity in this manner vastly improved.

If we get below this length of staple it is difficult to set sufficiently close with some of the principal settings, and yet find room for the top comb, the nippers and the leather-covered roller between the long steel detaching roller and the bottom feed roller.

With cotton averaging $1\frac{1}{8}$ in. staple good settings would probably be :—

Long steel detaching roller from bottom feed roller . $1\frac{11}{16}$ in.
Front edge of cushion plate from long steel detaching roller . . . . $1\frac{1}{16}$,,

Providing it is desired to comb American cotton of ordinary inch staple, the following distances would probably work well, providing we could set this close and yet find room for the working parts:—

Long steel detaching roller from bottom feed roller . $1\frac{9}{16}$ in.
,, ,, ,, ,, ,, front edge of cushion plate . . . . 1 or $\frac{7}{8}$,,

As stated, however, at any rate in many cases this very close setting could not be got. Possibly a kind of compromise could be effected by entirely discarding the use of the top comb, if this could be made practicable.

Ribbon Machine.

Although the ribbon machine is not in favour with many practical men, cases exist where it has been proved, by repeated and careful testing and comparison, to give as good results in the yarn, while taking out in some cases upwards of 2 per cent. less waste at the comber. This, however, is when the ribbon machine has been working at its best advantage, and the worst of it is that in many cases the loss in waste by the cotton not going properly over the curved web conductors, and by the comber laps licking more owing to their softer character, has been deemed a greater evil than the greater percentage of waste at the comber. In some cases attempts have been made to give a corresponding advantage to that claimed for the ribbon machine by applying four pairs of drawing rollers to the draw box of the sliver lap machine.

The ribbon machine would probably be improved if an electrical stop motion could be applied to act satisfactorily when one of the thin fleeces of cotton broke at the front of the machine.

It is possible also that some method could be devised by which the doubling of the laps could be done before the cotton wends through the drawing rollers, instead of after, and in this way the whole machine got to work better. In such a case possibly an application of the American railway head principle could be made to the machine.

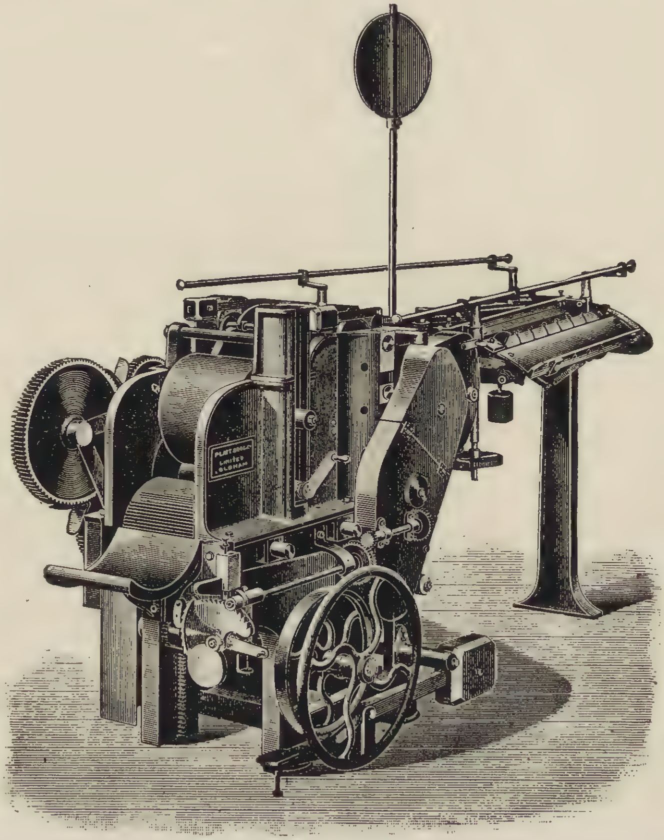


Fig. 86.

It might prove, however, very difficult to get the drawing rollers to act on such a heavy body of cotton, metallic drawing rollers being the most likely to serve.

As showing the trouble sometimes experienced with this machine, it may be stated that in one case the cotton could not be got to travel properly down the curved web conductors and along the front table no matter what was done. Finally it was discovered that one of the weight hooks for the drawing rollers was not acting properly on its roller, and the slight difference this made in the ribbon of cotton stopped the latter from travelling along properly.

In another case a much similar effect was found to be produced by a slight binding in one of the calender rollers on the front table.

In yet another case a similar effect was produced by the front table getting a little out of the level.

In numberless cases variations in the atmospherical conditions have produced similar effects on this machine.

Sliver Lap Machine.

It is contended by some that putting four pairs of drawing rollers in the sliver lap machine instead of only three will permit of more draft and give a more uniform lap, and in this way give the same effect as using a ribbon machine. Some such machines have been got to work, but there is a difference of opinion as to their merits. If it is done it is probably that the use of metallic rollers would be best as giving less lap licking.

A general view of the sliver lap machine as made by Messrs. Platt Bros., of Oldham, is shown in Fig. 86.

Weight of Lap.—It may be stated that some people prefer at the comber a light lap and a long feed, whereas others prefer a shorter feed and a heavier lap, and there are differences of opinion as to the relative merits or demerits of either practice.

Spring Weighting of Detaching Rollers.

In Fig. 86 (*a*) is shown a method of spring weighting that has been applied in a few cases by Messrs. Dobson, but dead weighting is preferred.

Collecting Tins.

Often small holes are formed in the bottom of these to let dirt drop out. Some contend that these permit small currents of air to interfere with the sliver. To remedy this one firm sometimes puts a false bottom in the tin which has holes in it, but has the other and blank bottom beneath it.

Nipping on Combers.

A well-known comber master of Bolton some time ago wrote the author as follows:—

"Just a word with regard to nipping on combers. I cannot think it was the intention of the inventor that nipping should

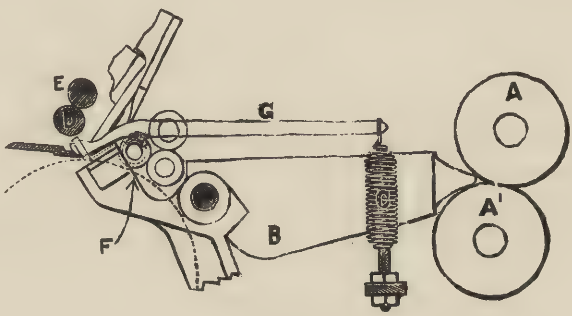


Fig. 86 (*a*).

A, A^1	Calender Rollers.	D, E	Feed Rollers.
B	Collecting Tin.	F	Leather Roller.
C	Spring.	G	Lever.

commence while detaching is going on, or why the space between the segment and the circular comb? Surely this space was intended for the closing and getting into position of the nipper bar. If you nip while detaching, the fibres are struck out of the top comb, letting more go to the front and less to the back. It is only when you are nipping too early that you can get more waste out by nipping later. Were you to nip after detaching has finished, it would make no difference in the waste to nip later, always providing that the nipper bar is down when the circular comb is combing. As you are aware, the greatest factor in taking out the waste is the top comb, and it is to set the top comb lower in taking out a medium percentage that nipping has to take place earlier. When an employer insists on having his top combs as close to the segment as possible, and still only wants a medium percentage of waste, you are then compelled to nip while detaching, and release the friction of the top comb by the nipper bar. You thus have to compensate for the more waste taken out, in having the top comb set close to the segment, by nipping while detaching, which, I should think, is not true combing."

CHAPTER IX.

COTTON COMBING MACHINES OF CONTINENTAL MAKE.

It is highly probable that the different rows of needles on the needle segment of a Heilmann comber are too close for getting the very best results, but it would be difficult to put them wider.

At the same time it is difficult to find proper space for the eather-covered detaching roller.

In some of the more recent comber inventions abroad attempts have been made to overcome these difficulties by fixing practically the whole of the cylinder periphery with needles, and applying very different detaching mechanism.

In the new comber of the Société Alsacienne, as described a little further on, it may be noted that it is arranged to be fed with laps about $4\frac{1}{2}$ times as heavy per yard as those fed to the Heilmann comber. It is quite possible to feed this machine with slivers. The feeding fleece can be composed of sixteen slivers or of two narrow laps made on the ribbon lap machine, or on the sliver lap. As in the case of the Heilmann comber, they have found it best to pass the slivers through either a ribbon lapper or a drawframe before going to the comber.

In addition to the very heavy lap they place the rows of needles on the cylinder somewhat widely apart, and fix twenty-two rows of needles in all.

On the Continent it would appear that constant efforts have been put forth for very many years, either to radically improve the Heilmann comber, or else to invent combers of different construction altogether. Most of the leading types of these machines are briefly described in this chapter.

Hübner Comber.

In the construction of this comber the following principle was laid down :—

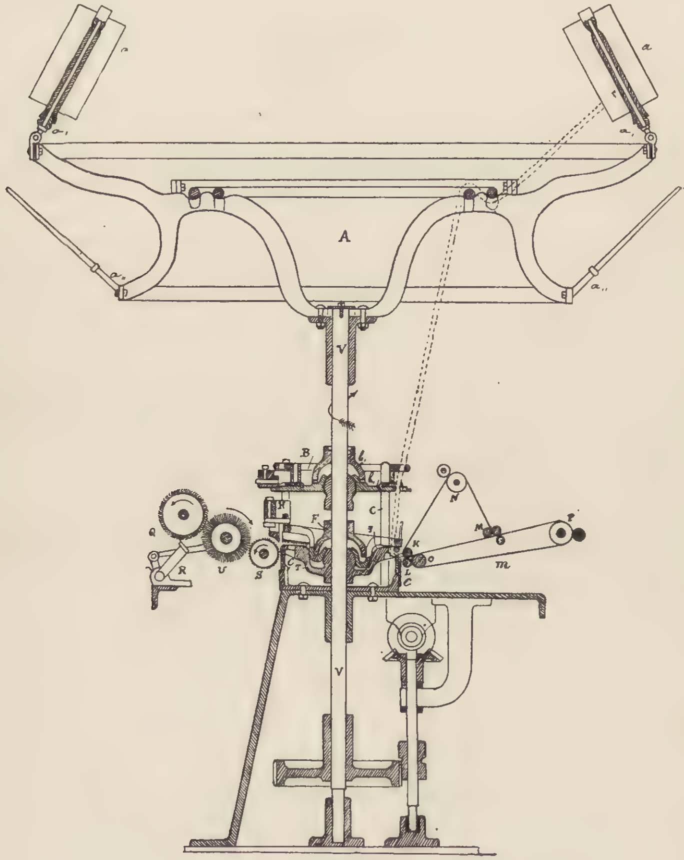


Fig. 87.

That fibres held between a highly polished (metallic) surface and a rough surface like that of leather will follow the rough surface when this is moved round the other.

The principal feature of this comber is that it is continuous in its action, so its production is greater than that of the Heilmann comber.

Other special features are :—

1. The *Creel*, A (Fig. 87), which is made to hold bobbins of sliver instead of laps. It is circular in construction, and it is supported by the vertical shaft, V, with which it moves round. There are two rows of skewers, the total number of which is fifty-six. The skewers of the top row are hinged so that they can take any angular position with respect to those of the lower row, which are held fast to the creel. This is to prevent entanglement of the slivers.

2. The *Feeding Plates* or *Dishes*, B (Fig. 87), which are circular in form, and move round by means of a clutch, one part of which, C, is fixed to the vertical shaft, V, and the other part, O″, is cast in one piece with the lower plate. There are two distinct dishes held fast together. The upper disc is drilled with fifty-six holes in two rows, while the holes of the lower disc, though equal in number, are all drilled in one row.

The two dishes are placed in such a way that a space or groove is left between them, in which groove a leather ring, C (Fig. 90), is placed, just overlapping the holes of the lower plate.

The slivers after passing through the holes of the upper plate are taken through those of the lower plate. A very highly polished iron or brass wire, *w* (Fig. 90), fixed at one extremity, passes into the groove just opposite the leather ring, and after going round $\frac{3}{5}$ of the circumference of the groove it is hooked at the other extremity to a spring, by which its tension is regulated. The feeding dishes, besides the rotary motion mentioned above, have also an angular motion upwards and downwards given to them by rod, *c* (Fig. 87). In this way any of the sliver nipped between the leather ring and wire, in their motion downwards will unwind a certain length of sliver from the bobbins. This length depends on the amount of inclination of the plates, which inclination can be regulated.

But these movements are not sufficient to take the slivers forward, so another organ is employed for that purpose. This is a pulley, P (Fig. 91), covered with leather and held at an angle. This pulley is also enveloped for part of its circumference by a polished metallic band, having the same function as that before-mentioned. When the cotton is detached it passes to the inclined plane and climbs up this plane, and is taken between the metallic band and leather pulley. This pulley then draws the slivers out in the proportion of their unwinding.

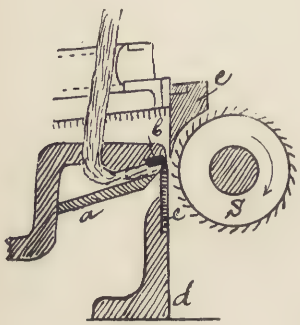


FIG. 88.

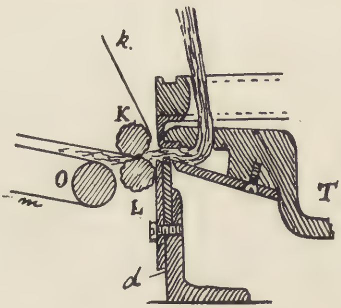


FIG. 89.

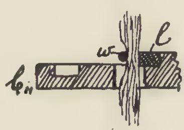


FIG. 90.

3. *The Turbine*, T (Figs. 87 to 91). The slivers after leaving the feeding dishes pass into another circular plate or disc, T, which has fifty-six holes drilled in it, as shown in Fig. 91, and forming by means of plates, *a* (Fig. 88), channels, which when looked at from the inside have the appearance of the orifices of a *turbine*, wherefore this disc is often called by that name.

At the extremity of this plate on the underside a leather ring, *b* (Fig. 88), is attached, and it is between the rough surface of this ring and the highly polished surface of an iron ring, *c*, fixed on the table of the machine that the slivers are nipped when combing or detaching takes place. The turbine is fixed to the vertical shaft, with which it moves round, thus carrying with it the slivers which in the form of lap are taken through the needles of the combing cylinder and afterwards are detached.

4. *The Combing Cylinder*, S (Figs. 87, 88, 91). The combing cylinder is provided with needles, which are of different counts, the finer counts being at the end where the turbine leaves the cylinders.

The axis of the cylinder can be adjusted to the turbine to suit different lengths of fibre.

The shape of the cylinder is such that the fibres in meeting the cylinder are only combed at their extremity. According as they approach the centre of the cylinder they are combed to a greater depth till the combing reaches the nipping point. From this point they gradually recede as they approach the fine needles, and at the point where the fibres leave the cylinder the needles penetrate the lap a certain distance from the point where it is nipped. A guard, *e* (Fig. 88), is placed over the cylinder to force the fibres into the needles of the comb. This guard must be adjusted as near to the cylinder as possible, and to prevent any damage to the needles the underside of the guard is made of soft wood. The cylinder is cleaned by a brush, U, a doffer, Q, and a doffing comb, R (Fig. 87), as in the Heilmann comber.

5. The fibres after being combed and before they are detached pass before a disc, *x* (Fig. 91), covered with plush, the duty of which is to straighten the fibres which have by the relative movement of the turbine combing cylinder taken an oblique position, so that they may be in the best form for detachment.

6. *Top Comb*, J (Fig. 87). There is also a top comb, which is circular in form, and the duty of which is to separate the combed fibres from the uncombed, and at the same time to comb the tail ends of the fibres when they are detached. This comb has an angular movement by means of guides, H (Fig.

87), which engage into circular grooves on its upper part. It has also a rotary movement imparted to it by means of a clutch similar in construction to that described in the paragraph on the feeding dishes.

7. *Detaching Rollers, etc.*—At the opposite end to the

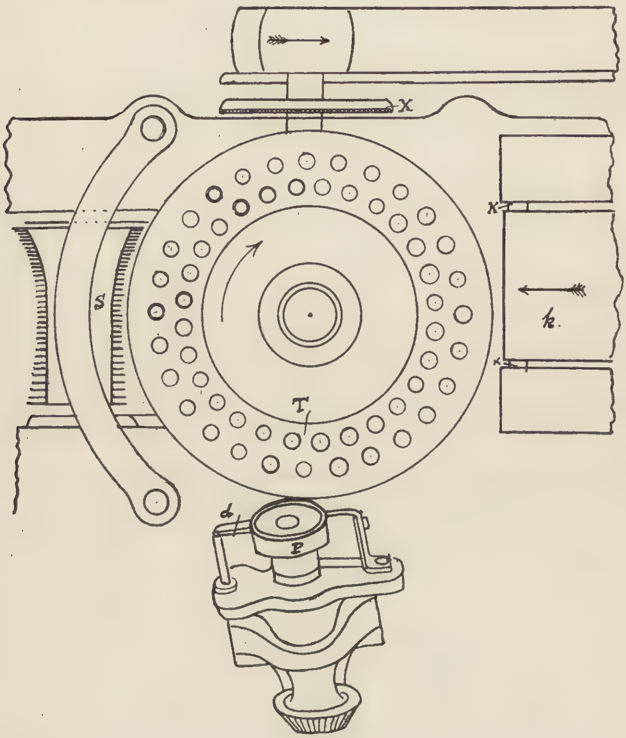


Fig. 91.

combing cylinder are the detaching cylinders, K, L (Figs. 87 and 89), which are fluted in their length and weighted by means of levers and weights. Round the top cylinder an endless strap or apron, *k*, of leather passes and is supported by two other cylinders, M and N, of which N is movable. Another apron, *m*, of leather is held between the cylinders, O and P. The cotton after being detached is taken forward by those aprons in the form of a very thin lap, and in its passage meets a wooden finger which rests on the lower apron, *m*, and is rolled round it. It then passes through a funnel, which has a rotary motion sufficient to impart a little twist to the sliver, and thus prevent it from breaking. From this it passes between two calender rollers and then to the coiler can.

Imbs' Combing Machine.

For many years Mr. Imbs has had patent combers working, and the descriptions below refer more especially to improvements on his first patents.

The improvements of his well-known combing machine, recently patented by Mr. Imbs, are mainly intended to make the machine more suitable for short-stapled fibres, the combing of which has hitherto presented many difficulties as far as the regularity of the combed sliver is concerned. One of these occurs in the gathering together of the combed fleece into a ribbon or sliver possessing strength enough to be coiled into a can. For this purpose a fixed guide plate and funnel are used, through which the combed fleece is conducted to the delivery rollers, and condensed. This suffices where the fleece has no great breadth, and if the fibres are long and cling sufficiently together. But if the fibres are short, or are smooth and have little adhesion, and especially if the combed fleece is very broad, and thus has to be drawn together in a short distance from a great breadth to the funnel, the usual method does not answer, because the several parts composing the fleece place themselves together in an irregular manner, while the friction on the edges of the guide plate disturbs the position of the fibres and causes the sliver to become irregular. As a remedy for these defects, the improved machine shown in sectional elevation in Fig. 92, and in plan on a reduced scale in Fig. 93, has been devised by Mr. Imbs. In these figures A denotes the nipper, and *a* a roller mounted on the same, which carries the combed fleece forward with an intermittent motion. Behind this roller a first guide plate, with turned-over edges, or, as it might be called, an open topped funnel, x, is placed, which moves with the

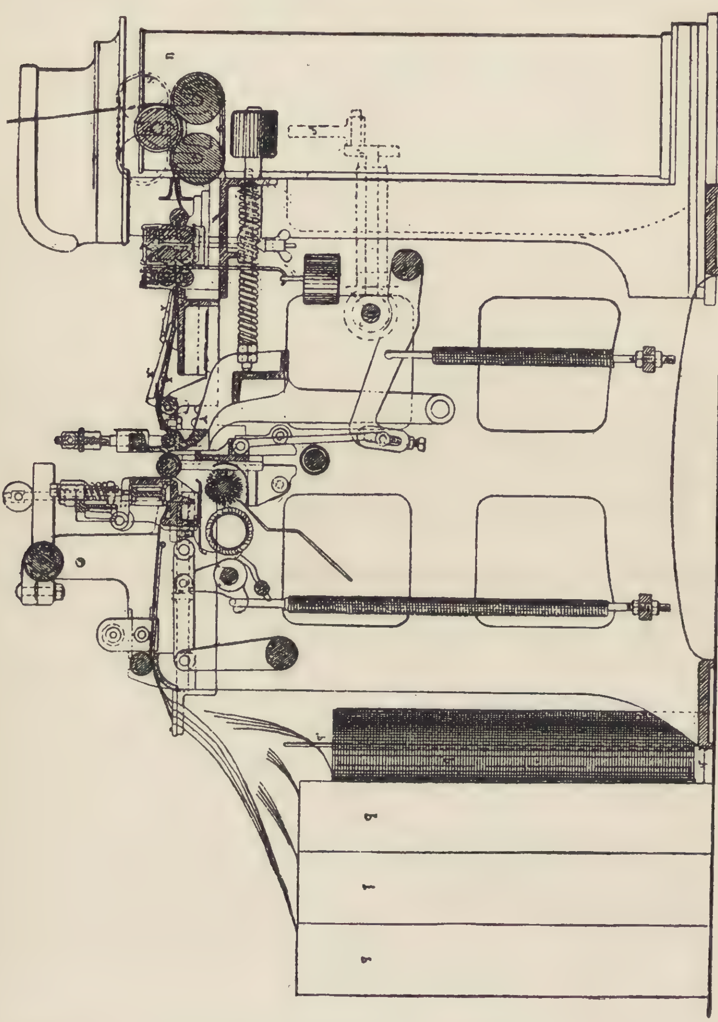


Fig. 92.

nippers and serves to draw the fleece partially together to a narrower width. The fleece, in passing over this plate, is not drawn by the delivery rollers, *m*, but pushed forward by the roller, *a*, so as to slide over the plate, *x*. The edges of the fleece being under no pull or stretch, encounter the curved edges, *x′*, of the plate, and mount up and fall over the central parts of the fleece, and regularly cover the same. The fleece leaves the plate, *x*, reduced to about $\frac{1}{3}$ of its width, and lapped round on the edges without the fibres being disarranged. It then passes through a second funnel plate, *y*, of ordinary size, being drawn forward by rollers, *m*, and is further drawn together by its first size.

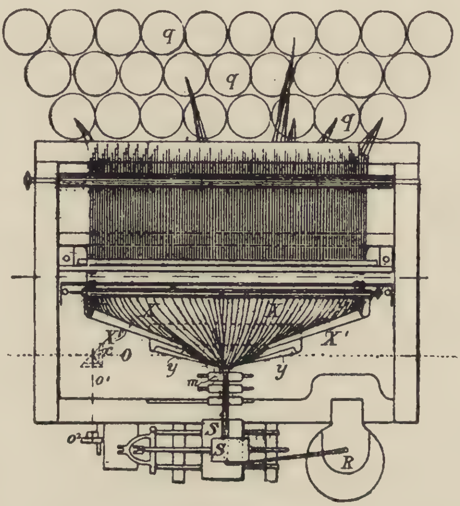


FIG. 93.

In combing machines to which the material is supplied as a thin fleece, ordinary drawing frames are first used, and the thin slivers combined on a Derby doubler, and wound on spools. For short fibres this has the advantage that the different layers stick together and run off irregularly, so that the combed sliver is also irregular, and produces irregular yarn. In joining a fresh spool to one that is running out, the piecing is frequently done without sufficient care, and thick or thin places are then produced in the sliver. These disadvantages Mr. Imbs proposes to overcome by dispensing altogether with the Derby doubler for such material. Instead of using an ordinary drawing frame followed by a doubler, the sliver from the cards is drawn on a machine delivering fine slivers suitable for coiling into cans. Each can contains several fine slivers—for instance, four—placed side by side without being twisted together, and capable of being drawn out separately, which is produced by using drawing frames with rubbers. These cans, *g* (Fig. 93), are then placed directly before the combing machine, and the four slivers from each can drawn separately through holes in a guide plate. There are thus from 25 to 30 such cans, 100 to 120 slivers lying close side by side, and forming a uniform fine fleece without such a derangement of fibres as is common with slivers wound on spools. If a can is emptied, only four out of the 100 or 120 slivers have to be pieced at one time, and even

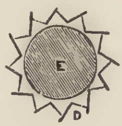


FIG. 94.

if this is unskilfully done the uniformity of the combed sliver will not be sensibly affected by it. The doubling is thus dispensed with. Instead of cans, spools, *g′*, placed in the draw-frame cans, and formed of a bottom plate and central peg, can be used, being drawn out together with the coils on them when the can is filled, without derangement of the fibres.

In order to secure the fibres in the combed sliver when transferred to the next machine, and prevent their becoming deranged by rubbing on the can, a rubbing apparatus, consisting of one leather and one roller, or of two leathers, is placed on the machine between the funnel and the delivery roller, by which the sliver is rolled and condensed.

The rubbing apparatus is arranged in the usual way. It is contended that very regular slivers can be obtained in this way.

A further improvement consists in the construction of the combs. In Imbs' machine these are of small diameter placed upon a shaft with needles inserted into bars, like gill bars. For very fine materials and perfect combing, needles soldered to the rollers are preferred, as these can be taken finer and put closer together. Fig. 94 shows a section of the improved combing roller, which is star-shaped in section, with suitable inclinations of the sides, to which the needles are soldered. In this way the combs can be made of very small diameter. These stars of short length are then combined by placing them on a shaft and fixing them by washers and nuts.

Staub & Monfort's Combing Machine.

This is one of the new and novel combing machines which have received a good deal of attention and consideration on the part of combing experts during the last few years. Patents were applied for in England in 1894, and since that time improvements in detail have been effected. According to information received from an old student of the author's—who at the time of writing is working on cotton combers in America—a number of these Monfort combers have been got to work in Massachusetts, but have not been working sufficiently long to enable their capabilities to be fully determined.

The invention consists in a process intended to give greater production, and to give wider scope in treating different lengths of fibres, than can be obtained in the Heilmann comber.

In order that the difference between their method of combing and other methods may be clearly understood, the inventors make a somewhat original comparison by letters. The inventors give the following table and explanation. Let a represent the combing of the front portion or half of the tuft whilst it is still in combination with the fleece; a^1, the combing of the front portion or half of the tuft when detached from the fleece; b, the combing of the rear portion or half of a detached tuft; c, the detachment of the tuft from the fleece; and d, the combination of the tuft with previously combed tufts to form another fleece; then different processes of combing may consist in the combination of these various operations in the manner represented by the following expressions, in which the simultaneous occurrence of two operations is indicated by bracketing together the corresponding letters :—

(1) . . .	a	$(b\ c)$	d	
(2) . . .	a	c	d	b
(3) . . .	a	c	b	d
(4) . . .	$(c\ b)$	a^1	d	
(5) . . .	$(c\ b)$	d	a^1	
(6) . . .	$(c\ b)$	b	a^1	d
(7) . . .	$(c\ b)$	b	d	a^1
(8) . . .	c	a^1	b	d
(9) . . .	c	a^1	d	b
(10) . . .	c	b	a^1	d
(11) . . .	c	b	d	a^1

The processes represented by the expressions 8, 9, 10 and 11 are included in the Monfort improved method.

According to this invention the tufts of fibre are detached from the fleece *before* the commencement of the combing operation proper, and the detaching devices are arranged independently of the combing device.

The output of a combing machine depends, first, on its effective or working width ; secondly, on the number of strokes of the comb per unit of time ; and thirdly, on the length and thickness of the tuft that can be treated during one stroke of the comb. The first two points depend solely on the construction and arrangement of its parts and mechanism, and have been subjects of much consideration in the design of combing machines heretofore known, but the last point, that is to say, the treatment of a larger or smaller quantity during each stroke of the comb, depends on the method on which the process employed is based.

For the purpose of treating the maximum quantity of material during each stroke of the comb without damaging the material or the working parts, according to this invention detaching devices are employed which enable the aid of the hitherto generally used top comb to be dispensed with. The tufts of fibre are detached from the fleece without the use of a top comb or similar intermediate device, and before the commencement of the combing proper, so that there is no impediment to obtaining very thick tufts of fibre from a thick fleece, and both halves of each of the tufts of fibre are combed separately and uniformly by a number of combs of increasing fineness, the combing of the maximum quantity of fibrous material at each stroke of the comb is thus rendered possible.

Now according to this invention the combed tufts of fibrous material are laid one on another at intervals of distance corresponding to the lengths of the fleece fed forward during the several strokes of the comb, whereby a scaly fleece is produced which has its fibres arranged with the same uniformity as the fleece fed in, and, leaving the noils out of account, approximately the same width and thickness. On account of this manner of producing the fleece of combed material the fibres are arranged therein with the utmost uniformity, and this quality will also be possessed to the same extent by the sliver ultimately produced. This uniformity of arrangement in the fleece thus produced enables the same, before it is condensed into a sliver, to be drawn out uniformly throughout its entire width, so that it is converted into a thin, supple and continuous fleece in which the fibres are arranged in a perfectly uniform and parallel manner, the loose scaly nature of the fleece being thereby caused to disappear. This thin supple fleece can now be readily condensed into a sliver capable of being subjected to further spinning processes.

The method or process forming the subject of this invention consists therefore in detaching tufts of fibre from a fleece of any desired thickness before the commencement of the combing proper, and without the aid of a top comb or the like, then treating the detached tufts singly and on both halves in a uniform manner by a number of combs, and afterwards combining the combed tufts by laying them one on another like the scales of a fish, so that the fleece produced can be converted into a thin fleece the fibres of which are arranged in a uniform, parallel and cohesive manner, by means of mechanism which draws out the said fleece throughout its entire width and before the latter is condensed into a sliver.

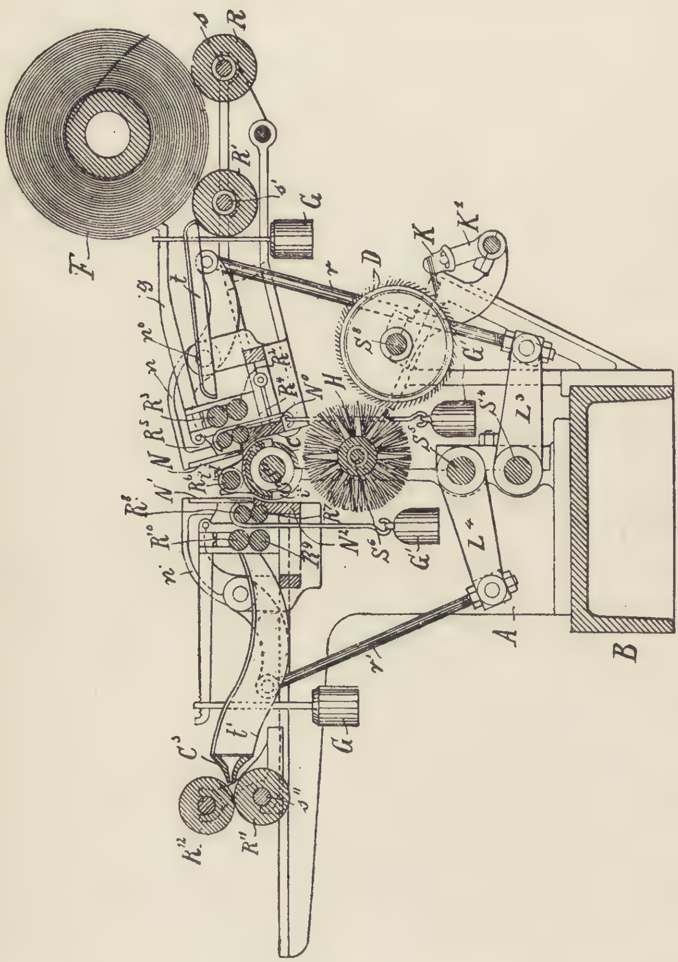


Fig. 95.

A description of the action of this comber may now be given with the aid of sketches, followed by a verbal explanation.

The succeeding general description of the method of combing on Staub & Monfort's comber may be understood with the aid of Figs. 95 and 96.

The lap, F, containing the fleece to be combed is carried by a pair of rollers, R, R^1, and passes thence over a guide plate, *t*, and then consecutively between two pairs of rollers, R^2, R^3, and R^4, R^5, which together constitute a detaching device, and are termed detaching rollers. This detaching device is operated in such a manner that when the two pairs of rollers have rotated sufficiently in a forward direction to draw in a certain length of fleece, the direction of rotation of the rear pair of detaching rollers, R^2, R^3, is reversed, whilst the front pair of detaching rollers, R^4, R^5, continue to revolve in the forward direction. The fleece caught between the rear detaching rollers, R^2, R^3, is thereby drawn back and detached from the fibres that have moved out of the reach of the said rollers, and are now caught between the front detaching rollers, R^4, R^5. The detached tuft of fibres constituted by the last-mentioned fibres is now pushed under an upper nipping jaw, N, which has at this time been brought into position, and, at the instant the front detaching rollers, R^4, R^5, cease to rotate, the said tuft is caught by the said nipping jaw in its descent, and is pressed firmly against a lower and stationary nipping jaw, N^0.

During the time that the nipping jaws, N, N^0, which are termed rear nipping jaws, hold the tuft, the forwardly projecting end of the said tuft is combed by a segmental comb, C, mounted on a cylinder, this being termed the comb cylinder. The nipping jaws, N, N^0, now open again, and a fluted segment, C^1, also mounted on the comb cylinder, with the aid of a bearing roller, R^6, resting freely on the said fluted segment, and of the simultaneously renewed rotation of the front detaching rollers, R^4, R^5, carries the tuft along, and conveys it between a pair of front nipping jaws, N^1, N^2, which are now open, and are situate in front of the paths of the fluted segment, C^1, and segmental cones, C, and onwards to a pair of rollers, R^7, R^8, which are termed receiving rollers.

The rotation of these receiving rollers, R^7, R^8, moves the tuft forward until the rear uncombed portion remains within the reach of the segmental comb, C. At this moment the receiving rollers, R^7, R^8, are stopped, the upper front nipping jaw, N^1, moves down upon the lower and fixed nipping jaw, N^2, and nips the tuft, and the segmental comb, C, then combs the rear portion of the tuft.

By repeating the operations just described there is formed between the receiving rollers, R^7, R^8, a scaly fleece which is gradually moved onwards towards a pair of drawing rollers, R^9, R^{10}, by the step-by-step rotation of the receiving rollers, R^7, R^8.

But since the drawing rollers, R^9, R^{10}, rotate simultaneously with, but with a greater peripheral velocity than, the receiving rollers, R^7, R^8, a drawing action is produced, by which the thick fleece is converted into a thin supple fleece.

This fleece is now condensed by means of a guide plate, t^1, a trumpet, C^3, and a pair of delivery rollers, R^{11}, R^{12}, into a sliver suitable for further treatment. Instead of the said pair of drawing rollers, R^{10}, R^{11}, two or more pairs of drawing rollers may be employed.

Under the general denomination of Fig. 96 the series of operations just described are illustrated diagrammatically by Figs. 1*a*, 1*b*, 1*c*, 1*d* and 1*e* of the accompanying drawings, which represent the parts of five successive times. In all the figures radial arrows indicate that the corresponding rollers are stationary.

Fig. 1*a* corresponds to the position illustrated in Fig. 95, in which the last portion of the segmental comb, C, is entering the end of the tuft presented to it by the rear nipping jaws, N, N^0. The rear end of the preceding tuft is being simultaneously combed, and the rear detaching rollers, R^2, R^3, are beginning to rotate in a forward direction, the front detaching rollers, R^4, R^5, the receiving rollers, R^7, R^8, and the drawing rollers, R^9, R^{10}, being stationary. Both pairs of nipping jaws, N^0, N, and N^1, N^2, are closed, and the bearing roller, R^6, is raised.

Fig. 1*b* represents the position of the parts when the last portion of the segmental comb, C, has passed the nose of the front nipping jaws, N^1, N^2, and the fluted segment, C^1, is

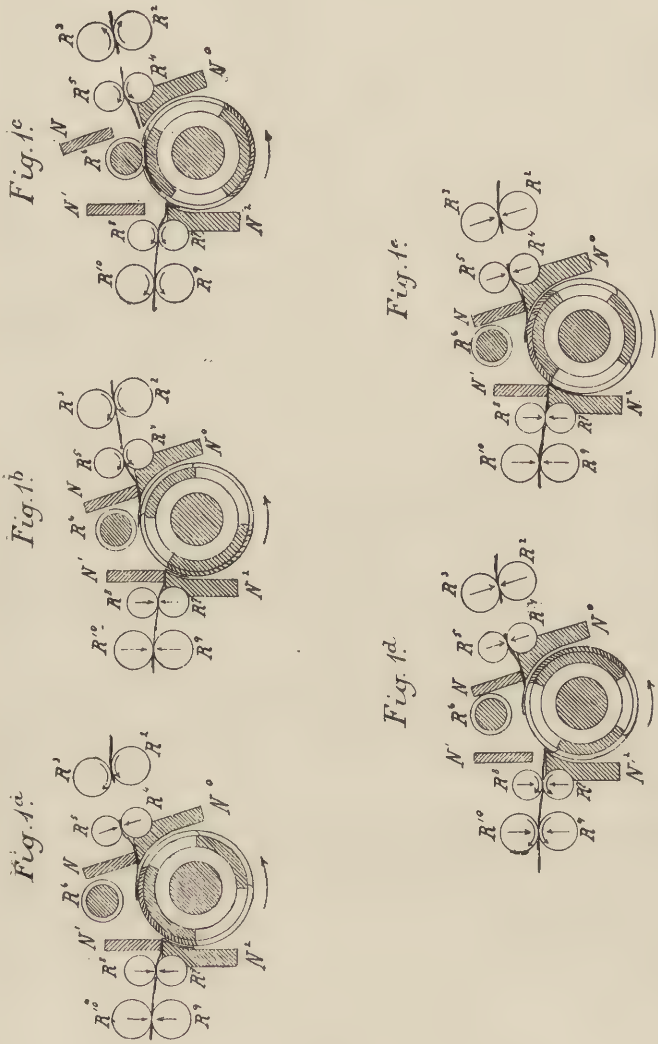


Fig. 96.

moving under the bearing roller, R^6. The rear detaching rollers, R^2, R^3, are still revolving in a forward direction, and have advanced the fleece until it is near to the front detaching rollers, R^4, R^5. These rollers are beginning to revolve and to push forward between the rear nipping jaws, N, N^0, which are now opening, the rear end of the previously detached tuft, which is now being combed on its forward end. The bearing roller, R^6, is now beginning to descend. The combing of the rear portion of the preceding tuft will now be completed, the front nipping jaws, N^1, N^2, and the rollers, R^7, R^8, R^9, R^{10}, having retained, without alteration, the position shown in Fig. 1*a*.

In the position shown in Fig. 1*c* the comb cylinder has rotated until the fluted segment has arrived at the nose of the front nipping jaws, N^1, N^2. The rear detaching rollers, R^2, R^3, have meanwhile reversed their rotation and now complete the detaching of the fleece from another tuft which is carried along by the further forwardly rotating front detaching rollers, R^4, R^5, and is pushed out to the fully opened rear nipping jaws, N, N^0. The segmental needle comb, C, is situate out of the reach of the new tuft. The bearing roller, R^6, has descended upon the fluted segment, C^1, and, together with the latter, has caught the preceding tuft, which so far is combed on one end only, and is about to convey it between the open front nipping jaws, N^1, N^2. The receiving and the drawing rollers have commenced to rotate.

After further rotation of the comb cylinder the parts assume the position shown in Fig. 1*d*, in which the first row of needles of the segmental comb, C, is entering the freshly introduced tuft last detached from the fleece. The rear nipping jaws, N, N^0, have now just closed, and the front detaching rollers, R^4, R^5, have completed their partial rotation. The rear detaching rollers, R^2, R^3, have meanwhile finished their rearward rotation and are stationary, the bearing roller, R^6, has ascended, the nipping jaws, N^1, N^2, are closing, and the pairs of rollers, R^7, R^8, and R^9, R^{10}, are terminating their rotation.

When the parts are in the position shown in Fig. 1*e* the combing of the rear end of the tuft by the segmental comb is commencing. The rear detaching rollers, R^2, R^3, are still stationary, and the other parts are resuming the positions shown in Fig. 1*a*.

The front detaching rollers, R^4, R^5, may have a continuous instead of a step-by-step motion.

The following supplementary remarks and descriptions may be made in reference to Staub & Monfort's combers.

At the instant the last portion of the segmental comb is entering the end of the tuft presented to it by the rear nipping jaws, the rear end of the preceding tuft is also being combed. The rear detaching rollers begin to rotate in a forward direction, the front detaching rollers, the receiving rollers, and the drawing rollers being stationary. Both pairs of nipping jaws are closed, and the bearing roller is raised.

At the instant when the last portion of the segmental comb has passed the nose of the front nipping jaws and the fluted segment moves under the bearing roller, the rear detaching rollers are still revolving in a forward direction and have advanced the fleece until it has moved near to the front detaching rollers.

These rollers begin to revolve and push forward the rear end of the previously detached tuft, which is now being combed on its forward end, between the rear nipping jaws, which are now opening. The bearing roller now begins to descend. The combing of the rear portion of the preceding tuft is now completed, and the front nipping jaws, the bearing roller and the receiving and the detaching rollers have retained without alteration the position they have assumed.

At the instant when the comb cylinder has rotated until the fluted segment has arrived at the nose of the front nipping jaws the rear detaching rollers have reversed their rotation and now complete the detaching of the fleece from the tuft, which is carried along by the further forwardly rotating front detaching rollers, and is pushed out to the fully opened rear nipping jaws. The segmental needle comb is situate out of the reach of the tufts. The bearing roller has descended upon the fluted segment, and, together with the latter, has caught the tuft, which so far is combed on one end only, and has conveyed it between the open front nipping jaws. The receiving and drawing rollers have commenced to rotate.

At the moment when the first row of needles of the segmental comb enters the freshly introduced tuft last detached the rear nipping jaws have just closed, and the front detaching rollers have completed their partial rotation. The rear detaching rollers have meanwhile finished their rearward rotation and are stationary, the bearing roller has ascended, the nipping jaws close, and the receiving and the drawing rollers finish their rotation.

When the combing of the rear end of the tuft by the segmental comb begins the rear detaching rollers are still stationary, and the other parts assume again the position set forth at the commencement of this detailed description.

The front detaching rollers may have a continuous instead of a step-by-step motion. In that case the rear nipping jaws are closed as soon as the front detaching rollers have pushed forward the requisite length of tuft towards the said rear nipping jaws. Whilst the tuft is being tightly held by the rear nipping jaws its rear end is being gradually released by the continued rotation of the front detaching rollers. When the rear nipping jaws are opened the bearing roller has descended upon the fluted segment of the comb cylinder, and it draws the tuft that lies loose between the rear nipping jaws out from between the said jaws.

The detaching devices adapted to be employed in the improved method of combing are of two kinds, *viz.*, first, the hereinbefore described two pairs of nipping rollers; and secondly, one pair of nipping jaws and one pair of nipping rollers. In both cases the said devices are adjusted to a distance corresponding to the length of the fibre. In the second of the two cases just specified the front one of the fleece is pushed in between the nipping jaws and then nipped between the said jaws and held by them during the rearward rotation of the pair of nipping rollers. The fibres lying loose between the nipping jaws and the nipping rollers share in the rearward movement of the fleece produced by the nipping rollers, and are gradually seized and carried along by the said nipping rollers whilst the detaching operation is taking place. In the other case the detaching operation takes place as hereinbefore described, and the loose fibres lying between the two pairs of rollers are seized by the pair of rollers that is the nearer to the said fibres. The detachment is in this case effected in a more rapid and even manner than when a pair of nipping jaws and a pair of detaching rollers are employed.

The aforesaid machine is provided, as is usual in machines for combing cotton, with a number of comb cylinders constituting so many working places mounted on the same shaft. These comb cylinders are mounted in standards fixed to a base plate or frame.

This comber is built by August Monfort of Munchen Gladbach in Germany.

We understand the machine is built at present with 2-feed laps only, instead of 6 or 8 as in the Heilmann. Each head is fed with a lap $12\frac{3}{4}$ in. wide, and it is *claimed* that a 2-head machine can deliver from 100 to 110 lb. of clean cotton per day of 10 hours.

A "set" of combing machines under this system might consist of one sliver lap machine, one ribbon lap machine, and eight combing machines.

Delette's Comber.

The improvements which form the object of the present invention relate to combing machines of Heilmann's kind for textile materials, and have for their object to obtain a better combing of the material whilst reducing the waste and increasing the production.

The material to be combed is brought by means of a feed arrangement on to a trough bearing against the grooved cylinder, which in the case of longer materials may be replaced by a carding comb or roller. The trough and the cylinder, which have for their object to cause the lap to advance at the desired moment, are moved by a star wheel operated by a pin carried on the side of a disc. This star wheel actuates the cylinder by a train of wheels.

A grip or nippers formed of two jaws holds the fibres during the combing of the head of the fibre by the circular comb. This comb receives an alternating rotary motion by means of a toothed pinion engaging with a toothed sector actuated by means of a rod from an eccentric, or by a combination of eccentrics, or by any other suitable arrangement. A circular brush is mounted near the circular comb and receives a longitudinal reciprocating displacement by means of a cam, a projection on which engages in a circular groove of a driving pinion; this brush receives at the same time a rotary motion by wheel and pinion gear with the object of cleaning the circular comb. The final comb which falls into the proper part of the head of the fibre serves to comb the tail of the fibre, and to retain all impurities by means of a blade passing between the two jaws of the nippers, and having a reciprocating movement from levers on a shaft which receives its movement from an arm and roller and cam. This blade is further intended to assume a position near the final comb during the dragging through, and thus to force the fibres to pass across the teeth of this comb.

The dragging through is produced by a group of four cylinders mounted on a frame which is oscillated on a shaft by means of a cam and a roller arm. These four cylinders act in the following manner. One cylinder is grooved and receives an alternating rotary motion from a cam operating an arm having a roller, which arm actuates a ratchet or notched wheel by a pawl. The ratchet is mounted on a shaft which transmits its movement to the said cylinder by a train of four wheels, the last of which is keyed on the shaft of the cylinder. At each dragging of the material the pawl rises and springs one tooth of the ratchet, so that the rotation forward of the system is stronger than the rotation backward, which has for its object to cause the combed fleece to move forward to a variable extent according to the number of teeth of the ratchet employed.

Another of said cylinders is coated with an elastic or flexible substance, and is revolved by the rotation of the said grooved cylinder, on which it is pressed by means of springs or counter weights. Another of said cylinders is

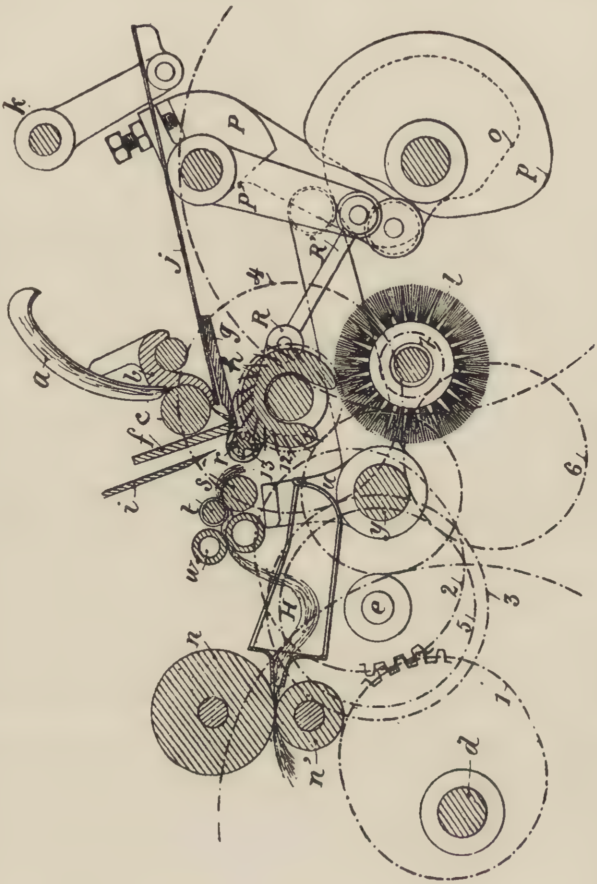


FIG. 97.

grooved and operated by the aforesaid grooved cylinder by means of three toothed pinions. Finally, the last cylinder is grooved and is free and may be revolved by the rotary movement of its related grooved cylinder.

The two first cylinders are dragging or drawing cylinders, and the two last are detachers.

In addition to the alternating rotary movement hereinbefore mentioned the whole of these four cylinders have further a simultaneous forward and backward movement transmitted to the frame by an arm having a roller operated by a cam.

The dragging is produced in the following manner :—

At the commencement of the dragging the cylinders are at the furthest distance from the final comb. Whilst they approach the final comb they receive a rotary forward movement which has for its object to seize the fibres of the substance to be combed. When they arrive in proximity to the final comb the rotation ceases, then the cylinders retire in order to complete the dragging. The pawl rises, springs a tooth, falls again immediately into the succeeding notch, and the cylinders then revolve in an inverse direction in order to release the fleece and attach it to the head of the following lap. The fleece thus formed falls into a hopper and is converted into a band or sliver which is drawn to the outside by delivery rollers.

As may be seen in Fig. 97, the material to be combed is brought by means of a feed arrangement, *a*, on to a trough or tray, *b*, bearing against the grooved cylinder, *c*, which cylinder in the case of longer materials may be replaced by a carding comb or roller. The trough or tray, *b*, and the cylinder, *c*, which have for their object to cause the lap to advance at the desired moment, are moved by a star wheel operated by a pin carried on a disc. This star wheel actuates the cylinder, *c*, by a train of wheels not shown.

A grip or nippers formed of two jaws, *f* and *g*, holds the fibres during the combing of the head of the fibre by the circular comb, *h*, which is mounted on a fixed spindle. This comb receives an alternating rotary motion by means of a toothed pinion keyed on its spindle and engaging with a toothed sector actuated by means of a rod from an eccentric, or by a combination of eccentrics, or by any other suitable arrangement. It is, however, generally preferable to actuate this comb by means of a series of eccentric toothed wheels. This movement is transmitted to the comb, *h*, in such a way that the combing of the sliver is effected whilst the comb revolves at its greatest speed, and the cleaning of the comb by the brush is effected, on the contrary, whilst these parts are revolving more slowly with the object of reducing the formation or production of dust.

In order to prevent any part of the material to be combed escaping the action of the circular comb, *h*, a pressing-in cylinder, *r*, having a certain number of parallel longitudinal grooves arranged regularly over its surface is employed. This cylinder revolves on itself and is operated by the circular comb, *h*, by means of toothed wheels, 12 and 13, keyed on their spindles in such a way that the ribs or bars of the said cylinder gear with the rows of pins of the comb by a movement similar to that of two gear wheels, but without it being possible for these pins to come in contact with these bars. The application of a pressing-in roller of this kind to combing machines has already been made by Messrs. Heilmann & Ducommun, but in their system the spindle of the pressing-in cylinder is fixed as regards that of the circular comb, and the whole of these two parts receives at the end of each combing an alternating rising and descending movement with the object of releasing the head of the fibre and of allowing it to be gripped by the dragging arrangement.

In the present arrangement, on the contrary, the spindle of the circular comb, *h*, remains fixed as hereinbefore stated. The pressing-in cylinder mounted on two cheeks, R, is pivoted on this spindle and receives an alternating oscillating movement from a cam, *p*, by means of a rod, R^1, lever, P^1, and a roller arm, P. The final comb, *i*, which falls into the proper part of the head of the fibre, serves to comb the tail of the fibre and to retain all impurities by means of a blade, *j*, passing between the two jaws, *f* and *g*, of the nippers, and having a reciprocating movement from levers on a shaft, *k*, which may receive its movement from an arm and roller and cam, or by other suitable means. This blade, *j*, has for its object to raise at the desired moment the combed fibres in order to present them to the dragging apparatus. It is also intended to prevent the material felting on the face of the jaw, *g*, and is further intended to assume a position near the final comb, *i*, during the dragging of the fibres through said comb, and thus to force the fibres to pass across the teeth of this comb.

The detaching or dragging through is produced by a group of four rollers or cylinders, *s*, *t*, *v*, *w*, mounted on a frame, U, which is oscillated on a shaft, Y, by means of a cam and roller arm.

The cylinder or roller, *s*, is grooved, and receives an alternating rotary and reciprocating motion from a cam.

The roller or cylinder, *t*, is covered with an elastic or flexible substance, and is revolved by the rotation of grooved roller, S, on which it is pressed by springs or counter weights.

Another cylinder or roller, V, is grooved and operated by the cylinder, S, by means of three pinion wheels not shown.

Finally, the last cylinder, *w*, is grooved and is free, and may be revolved by the rotary movement of the cylinder, *v*.

The first two rollers, *s* and *t*, are dragging or drawing cylinders, and the last two, V and W, are detachers.

In addition to the alternating rotary movement of these four rollers, they have further a simultaneous backward and forward movement.

Action of Parts.

A brief description of the action of these parts is as follows: At the commencement of combing of the head of the fibre by the circular comb, *h*, the cylinder, P, which is at a little distance from the point of the jaw, *f*, progressively approaches the said jaw, *f*, of the gripping device, in order to progressively force the fibres into the teeth of the comb, *h*, so as to produce the pressing-in of the fibre as near as possible to the grip, as shown in Fig. 97, without injuring the fibre, and without allowing any part to escape the action of the circular comb.

Towards the end of the combing the pushing-in cylinder oscillates towards the bottom with a speed equal to that of one of the last rows of teeth of the comb, and places itself in a different position in order to allow the dragging rollers to approach the jaw.

The blade, j, then passes between the jaws, f and g, in order to raise the fibres and present them to the rollers, drawing them through the final comb, i.

At the commencement of the dragging the cylinders are at the furthest distance from the final comb, i. Whilst they approach the final comb they receive a rotary forward motion, which has the action of seizing the fibres of the substance to be combed. When they arrive in proximity to the final comb the rotation ceases, then the rollers or cylinders retire in order to complete the dragging.

For very short fibres there are special constructions of the pressing-in cylinder.

The Gegauff Comber.

During recent years no new cotton comber appears to have attracted more interest than the one briefly described below, in an address delivered by Mr. E. W. Atkinson before the New England Cotton Manufacturers' Association, 18th October, 1900.

The address is reprinted by kind permission of Mr. Atkinson, who says :—

About two and a half years ago I had brought to my attention a new combing machine made in Germany which had been for several years in its experimental stage, and at that time, in 1898, had become a practical success in the cotton manufacturing districts of the Continent. It was, however, little known in England or the United States.

The machine was at once so unique in its design, and such a marked further development of the Heilmann principle of combing, that it had created a great interest in the cotton combing industry of the Continent. Its creation and development had been accomplished by the united efforts of its inventor, Mr. Charles Gegauff, and the large works of the *Société Alsacienne de Constructions Mecaniques*, both of Mulhouse.

Since the invention of the original Heilmann comber years ago, and its practical development by English machinists, there have been a great number of new inventions in combing brought

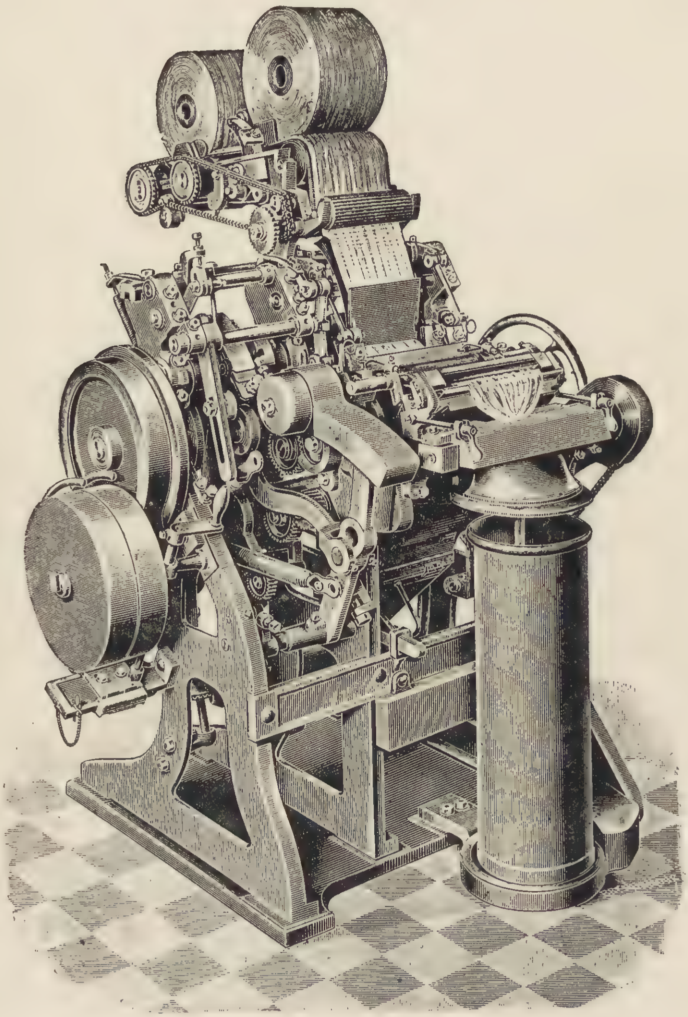


Fig. 98.

forth, all of which have differed radically in principle from the Heilmann comber. While appearing well in theory, they have all failed in actual practice, and have after considerable trial been finally abandoned in favour of the original Heilmann machine.

The Gegauff machine, while being radically different in design and construction from any Heilmann comber yet produced, still embodies all the original principles of Heilmann. To these Gegauff has added many new and most important ideas, the application of which has produced truly remarkable results and entitles the inventor to a high rank. That the Gegauff comber differs from the Heilmann will at once be seen by reference to the illustration.

A general view of this machine is given in Fig. 98.

In a floor space of 20 sq. ft. it produces a weight of sliver which would require Heilmann machines occupying 60 sq. ft. to equal.

I shall confine myself to a very brief description of the theories embodied in the Gegauff comber and the practical results obtained by it. Mr. Gegauff has worked always with one main point in view, *viz.*, to produce a comber which would turn out the cleanest, most even, and most valuable sliver possible, and the dirtiest and least valuable noil possible; also the greatest production of sliver and the least production of noil consistent with the very best work. He has also built upon the well-known fact that the top comb is a most important factor in the proper combing of the cotton in a Heilmann comber. Although this really has only one row of needles—or at the most two—it does more real combing than any other organ in the machine, as all practical comb-fixers know.

The reasons for this will be referred to.

For the purpose of this short paper, Figs. 99 and 100 will suffice to explain the working of this machine.

Fig. 99 shows the feed stopped, the nippers closed, and the circular comb acting.

Fig. 100 shows the nippers open, the top comb down, and the detaching commenced.

It will be noticed that the axis of the circular comb is stationary. This also applies to the detaching rolls and lap. All the remaining essential parts of the machine have, however,

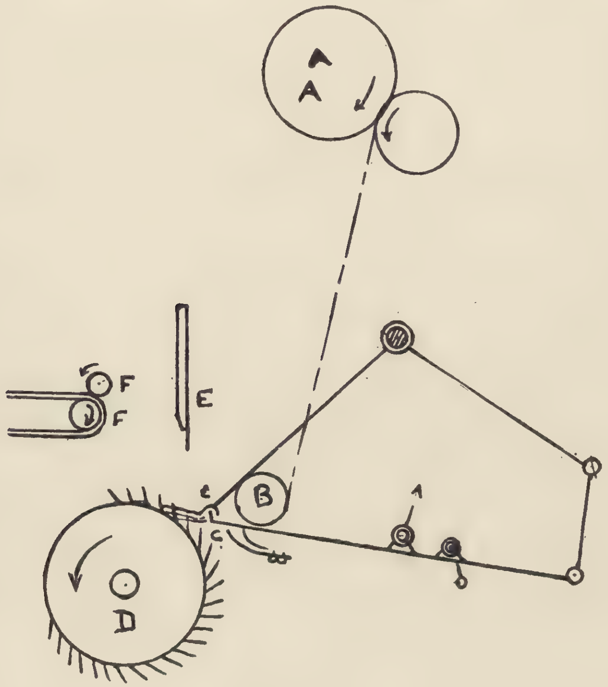


Fig. 99.

Reference Letters for Figs. 99 *and* 100.

A Lap.
B Feed Roll.
C, C Nippers.
D Circular Comb.
E Top Comb.
F, F Detaching Rolls.

independent of their separate motions, an oscillating motion altogether forward and back from the circular comb to the detaching rolls and *vice versâ.* The details of the mechanism operating the several motions of the machine I will not enter into; suffice it to say that they are very easy motions, free from complication and most practical in their working.

The designers of this combing machine claim many advantages which may be briefly enumerated.

1. By separating the detaching rollers from the cylinder,

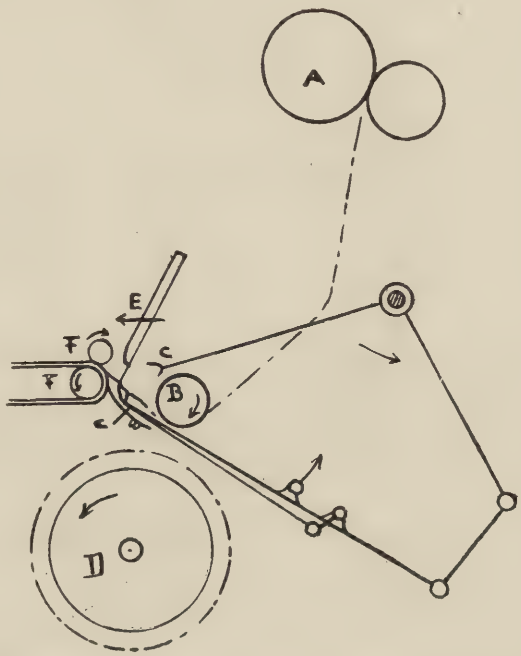


Fig. 100.

and avoiding the fluted segments, the cylinder can have a circular comb upon it with many more rows of needles than is possible upon any other machine.

2. When the top comb falls the beard is free from the cylinder, and the top comb falls clear through it. On the Heilmann machine it has to stop before the end of the needles reach the segments, and thus there are always some fibres in

the tail on the Heilmann comber that do not pass through the top comb or get properly cleaned.

3. Moreover the top comb does not have to wait before falling. As a matter of fact, it falls through the fibres as near to the front end on the German comber as it does to the tail end on the Heilmann machine.

Thus the fibres are in a large proportion actually double combed, first by the cylinder and then by the top comb.

4. The above described arrangement enables the use of an extremely heavy lap, 2,000 grains per yard, or $6\frac{1}{2}$ times as heavy as can be used on any Heilmann machine.

5. Mr. Gegauff maintains, and with correctness, that in any machine which is capable of handling it the heavier the lap the better will be the combing, as the weight and thickness of the lap is itself a great advantage in the combing process. This is really one of the most interesting points developed in this comber.

No doubt every one familiar with cotton has many times noticed that when he desires to get a correct and clean staple of a sample in the usual way, the thicker the bunch of cotton held between the thumb and finger in one hand the cleaner will be the staple drawn from it by the other hand. This is due to the natural combing of the small amount of staple drawn off by the one hand from the thick mass of cotton in the other hand, and this combing is produced by the rubbing of one fibre against its several neighbours.

This idea is put into practice in the Gegauff comber, the lap being of such a heavy weight, and so firmly held when the detaching takes place, that there is a very large amount of what may be termed natural combing of the detached web done by the fibres of the lap itself. The impurities thus left behind in the front portion of the lap come forward on the next feed motion, and are most thoroughly combed out by the great number of rows of needles in the circular comb.

6. A further great advantage of no little moment is the fact that the arrangement of this comber permits the detaching rollers themselves to be made with a slightly spiral fluting (an impossibility on the Heilmann comber).

This enables a very wide lap to be worked with success, inasmuch as by this means there is at any one time only a portion of the web being actually detached. On the Heilmann comber it all has to be detached at once, the fluting being necessarily straight, and this makes the use of very heavy weights on the detaching rollers unavoidable. Also, as the diameter of the detaching rollers is limited by the length of the staple of cotton, it has always been a great difficulty on the Heilmann machine to work the wider laps up to $10\frac{1}{2}$ and 11 in., because no detaching roller could be found that would stand the strain of the weighting without deflection. There have been many make-shifts to get over this point on the

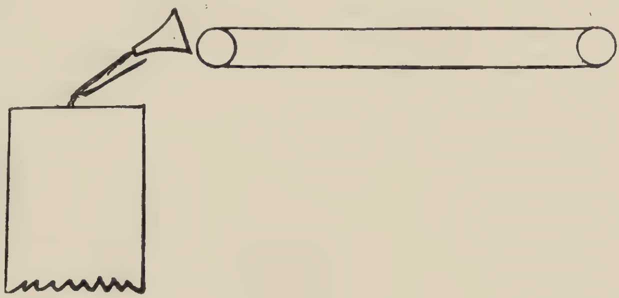


FIG. 101.

Heilmann comber, and none knew the weaknesses of these so well as the machine makers themselves.

On the Gegauff machine, owing to the spiral fluting, there is only one point of the web being acted upon at a given moment, as stated above, therefore only comparatively light weights are needed at the ends of the roller, which can be made also of a very small diameter.

7. A further advantage of this detaching roller, and one of great importance, is the manner in which it lays the web on the apron. It does this in such a way that the piecing is absolutely even and the usual breaking back when coming out of the can is avoided.

Figs. 101 and 102 show the detaching rollers in plan and elevation. By referring to the plan you will note the manner in which the web is laid upon the apron, so that when the same is condensed into the trumpet to go into the coiler, the even result will be readily seen without further explanation.

8. Owing to the fact that the nippers are not opened until the oscillating motion away from the circular comb toward the detaching rollers has taken place, it will at once be seen that it is absolutely impossible for any long fibre to be carried around with the circular comb and be taken off in the noil, and

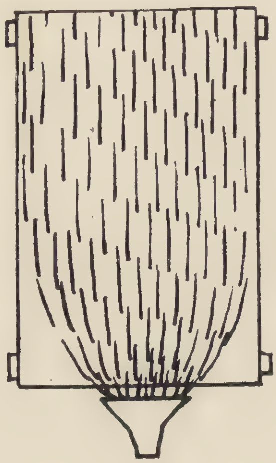


Fig. 102.

one of the very marked characteristics of the working of this machine is the entire absence of long fibres in the noil.

Such in brief is the general description of the Gegauff comber. The advantages *claimed* for it by its makers and inventor are as follows :—

A saving of two-thirds, at least, in floor space per lb. of sliver produced.

A saving in labour, as one hand will mind as many of these combers as she will of the Heilmann.

Large product per machine : for instance, Egyptian 500 lb. per week, and other qualities accordingly.

Ability to comb the shorter staples of cotton with success.

More perfect combing with a minimum of noil.

Less preparatory machinery needed: for instance, one set of preparatory machines are required for eight Heilmann combers, producing 2,400 lb. per week. One set of the same machines suffices to feed twelve Gegauff combers, producing 6,000 lb. per week.

No breaking back of the sliver when leaving the can after combing.

No breakage of the sliver on the sliver plate in dog-day weather (there being no such plate).

Such being the advantages claimed, it remains for practical manufacturers to determine whether or not they are justified. Such radical departures from existing and well-established practices are naturally looked upon with some doubt by conservative people, who always demand full practical proof of the facts before a general adoption of the principles involved.

It is not my purpose to endorse all the claims made for this machine. The various styles and makes of machines must always speak for themselves, and will be adopted or rejected according to their actual merits. There has been, however, such a large number of these combers brought into the country during the past year as to create no little interest in the machine by manufacturers.

It may be added that the author of this treatise has for some time had in his possession an excellent German treatise on the Gegauff comber, by Professor Otto Johannsen, Director of the Technical Spinning and Weaving School at Reutlingen.

In this treatise Professor Johannsen describes this comber in a most able and complete manner, but exigencies of space have prevented fuller treatment in the present book.

The following table will show the way of garnishing the combs in the Gegauff comber:—

1.

Number of the Bars.	Number of Needles per cm.	English Number of the Needles.	Length in inches.	Length of Needles in mm.
1–2	4	18	1–2	7
3	5	18	1–2	7
4–5	6	20	1–2	7
6	8	20	1–2	6
7–8	10	22	7–16	6
9	12	24	7–16	6
10–11	14	24	7–16	5
12–13	16	26	7–16	5
14–15	19	27	7–16	4
16–17	22	27	7–16	4
18–19	25	28	7–16	4
20–22	30	29	7–16	3, 5
Fix Comb	23	27	11–16	7

2.

Number of the Bars.	Number of Needles per cm.		English Number of the Needles.	Length in inches.	Length of Needles in mm.
1–2	4	Flat Needles.	14–20	1–2	7
3	5		14–20	1–2	7
4–5	6		14–20	1–2	7
6	8		16–22	1–2	6
7–8	10		16–22	1–2	6
9	12		18–24	7–16	5
10–11	14		18–24	7–16	5
12–13	16		20–26	7–16	5
14–15	19		21–27	7–16	4
16–17	22		22–28	7–16	4
18–19	25		23–29	7–16	4
20–22	30	Round Needles	29	7–16	3, 5
Fix Combs	24 26	Flat Needles	22–28 23–29	11–16 11–16	7 7

In the table 1, at the bottom, the combs are composed of ordinary round needles, but those most in use have flat needles, as per table 2 on the top. They are more difficult to solder, but last four or five times longer.

To be able to garnish a great surface of the combing cylinder with needles, the drawing-off organ has not been made as a fluted quadrant, fixed on the mandrel of the circular comb, as it stands in the Heilmann comber. This motion is completely separated, and placed on a special bracket called the drawing-off table. With this disposition it is necessary to have an oscillating motion of the carriage carrying the jaws of the clip.

Alterations in Heilmann's Combing Machine.

The production of Heilmann's combing machine is materially diminished by the reciprocating motion of the doffing arrangement, as in consequence of this motion the machine cannot be run above a certain speed. A firm in Alsace a few years ago claimed to have removed this objection by a doffing arrangement which has no reciprocating motion in the direction in which the combing cylinder revolves. Figs. 103 to 105 illustrate this apparatus.

In this arrangement a detaching roller, D, works together with a fluted roller, C, which only revolves at intervals, and a movable cheek, O, which presses the combed lap against the detaching roller in such a way that on the cheek moving downwards the detaching roller rests on one of the fluted portions of the combing cylinder, the cheek moving away from the detaching roller, and thus permitting the union of the tuft which has been taken from the lap and the combed fleece; whilst, on the cheek moving upwards, the tuft after being joined to the fleece is held between the detaching roller and the cheek, the former being removed from the combing cylinder in order to allow the following combing segment of the cylinder to comb the tuft of fibre. In the foregoing operation it will be seen that the detaching roller serves at the same time the purpose of tearing off the tuft, but this may also be accomplished by introducing one or more tearing-off rollers between the detaching rollers and the nippers. The whole of the detaching arrangement is, therefore, sufficiently simple, enables the machine to run at a much higher speed, and, finally, renders it possible to unite a larger or smaller length of tuft to the fleece, according to the length of the staple.

Fig. 103 shows the essential parts of the detaching apparatus in connection with the remainder of the principal parts of the machine, whilst Figs. 104 and 105 show the arrangement in two different positions. There is nothing remarkable either about the combing cylinder, with its combing segments, B, and its fluted or leather-covered segments, S, or the feed apparatus with the nippers, M, $M,^1$ and the comb, F.

The essential parts of the detaching arrangement are the detaching roller, D, the cheek, O, and the fluted roller, C. At one end of the cheek, O, is a trough-shaped cavity which surrounds the fluted roller, C, and is carried on fixed bearings, being turnable round the shaft of the roller, C. The detaching roller, D, is guided concentric to the fluted roller, C, so that the two rollers are always in contact with each other. By means of a weight or spring the roller, D, is constantly pressed in the direction of the arrow, 1, against the surface, X, of the cheek, O, so that it forms a pair of nippers with the latter, which open when the cheek turns in the direction of the arrow, 2, and the detaching cylinder sinks on to one of the sectors, S, of the combing cylinder, the cheek having meanwhile revolved a little farther (Fig. 104).

Between the detaching roller, D, and the comb, F, one or more tearing-off rollers may be introduced, which must be so guided that they can approach or recede from the circumference of the combing cylinder. One way in which this motion can be produced is by letting the studs of the roller, D, slide in slits running from the axis of the combing cylinder, and arranging eccentrics on the latter, against which the roller, A, is pressed by springs or weights. The fluted roller only revolves at intervals, and this may be accomplished by any suitable arrangement, such as, for instance, a clutch, a toothed segment, a star wheel, etc., which is thrown in and out of gear at the right moment by a coupling. The friction of the roller, C, and the sector, or

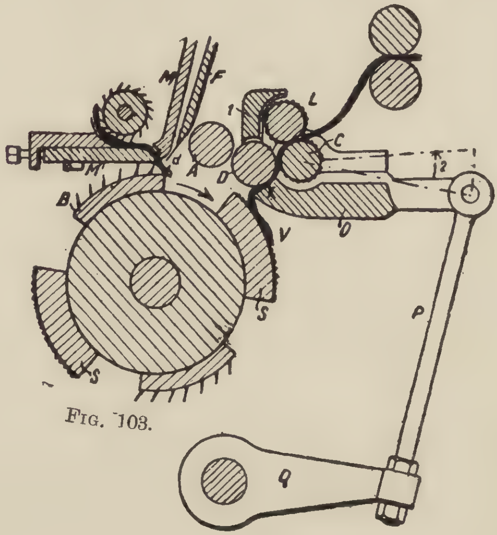


FIG. 103.

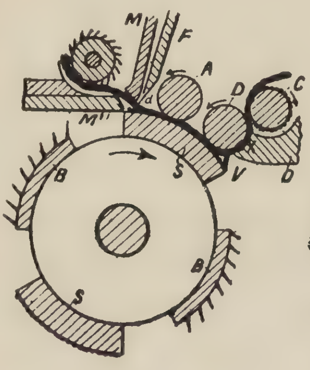


FIG. 104.

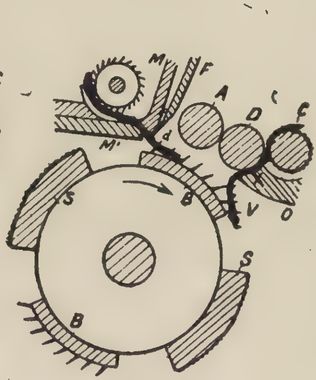


FIG. 105.

fluted segment, S, causes the revolution of the roller, D, which is brought into contact with S (Fig. 104). From this it will be seen that the speed of the circumference of C must correspond to that of the sectors, S, and that C will revolve as long as D and S are in contact with each other.

The cheek may receive its swinging motion from any suitable arrangement—as, for example, the connecting rod, P, lever, Q, and eccentrics. It is not absolutely necessary, however, that this cheek should be turnable round the cylinder, C, as it may be guided in any other way. The roller, A, may be made to revolve either by the friction of S or by a separate set of wheels.

The combing of the tuft, *a*, held by the nippers, M, M^1 (Fig. 103), calls for no particular remark ; whilst this operation is proceeding neither the tearing-off roller, A, nor the detaching roller, D, is in contact with the combing cylinder. The fluted roller, C, is at rest, and the cheek, O, presses the previously combed fleece, *v*, against the roller, D. The tuft projecting from the nippers formed by the roller, D, and the cheek, O, is now combed by the combing segment, B, on the combing cylinder revolving farther (Fig. 105). As soon, however, as the fluted sector, S, following the segment, B, arrives at a position opposite to the roller, A, the latter descends and seizes the front end of the tuft, *a*, projecting from the nippers, M, M^1 (Fig. 104), by pressing it against the fluted sector, S. In consequence of this the combed tuft, *a*, is drawn through by the lowered comb, F, when the combing cylinder continues its revolution, whilst the noil remains behind. At the same time the cheek, O, turns in the direction of the arrow, 2 (Fig. 103), so that the detaching roller, D, falls on to the sector, S; the surface, X, of the cheek, O, however, simultaneously moves out of contact with the roller, D (Fig. 104). As soon as the roller, D, comes into contact with the sector, S, and the cheek, O, sets the fleece, B, free, the fluted roller, C, and detaching roller, D, commence to revolve, and thus bring about the union of the fleece, *v*, with the tuft, *a*, which has been torn off by the roller, A.

New English Comber.

It may be stated that at the time of going to press with the final proofs of this treatise, certain gentlemen connected with the firm of Messrs. John Hetherington & Sons are working hard at the production of a new comber which contains certain important principles which are different to any in the Heilmann. One of the principles appears to be a forward motion of either the nipper or the top comb, or else both, to the extent of, say, 1½ in. or more.

Three or four of these new combers are being put to practical trial in different fine spinning mills, but the invention is not yet sufficiently matured for a description in these pages.

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