Worsted Preparing and Spinning.

(Wool Combing.)

BY

FRED BRADBURY.

WORSTED PREPARING AND SPINNING.

(WOOL COMBING.)

PUBLISHED BY
F. KING AND SONS LIMITED,
HALIFAX.

WORSTED PREPARING
AND
SPINNING.

(WOOL COMBING.)

VOLUME II. *(Second Edition).*

BY

FRED BRADBURY,

PROFESSOR TEXTILE INDUSTRIES, MUNICIPAL COLLEGE OF TECHNOLOGY, BELFAST; 8½ YEARS HEAD DEPT. TEXTILE INDUSTRIES, TECHNICAL COLLEGE, HALIFAX;
AUTHOR OF "CARPET MANUFACTURE," "JACQUARD MECHANISM AND HARNESS MOUNTING," "CALCULATIONS IN YARNS AND FABRICS," "FLAX CULTURE AND PREPARATION," "WORSTED PREPARING AND SPINNING," Vols. I, II, and III., ETC.

PRICE 6/6 NET.

TO BE OBTAINED FROM
F. KING & SONS, LTD., PUBLISHERS, HALIFAX.
AND ALL BOOKSELLERS.

1923.

Preface.

IN the preparation of Volume II., *Worsted Preparing and Spinning*, I have included on the nineteen pages, 273-282 and 316-324, the subject matter originally written by the late Mr. M. M. Buckley, though both these sections have been re-written and the diagrams relating to the same, re-drawn.

For the remainder of the book—practically the whole volume—the writer is alone responsible.

As in former publications I have followed my natural inclination for treating somewhat exhaustively one definite section of textile work. This volume is confined to wool combing and its subsidiaries—back-washing and finishing gills or top making.

Of the various types of wool combing machines in use to-day, the author has devoted the most time and space, and given priority to the *Noble Comb*, because of its extensive use and adaptability to all kinds and qualities of wool.

In a period of 20 years, 1891-1910, at least 75% of the patents applied for on combing related exclusively to the Noble Comb, which fact incidentally demonstrates the great practical and commercial importance attached to this machine by makers and users as compared with all other types.

During recent years an increased amount of attention has, however, been directed to the various types of the Heilmann model.

An enormous amount of attention to detail has been expended on the Noble Comb by an equally large number of persons either engaged in its production or its application to the purpose for which it was designed. The combined result has been the production of a machine of great efficiency.

It is only when the various details of the comb are considered that it is possible to appreciate its mechanical value and the immense amount of ingenuity expended upon it. In the more important sections of the Noble Comb where several ways or means of clothing the same principle are employed, more than one method has been supplied by the author for purposes of comparison, by which means only it is possible to truly estimate the value of any mechanism. All the essential principles of combing will be found discussed under the Noble

Comb, the treatment of which in this volume is probably the most exhaustive yet published.

In the description of other combs my object has been to explain the chief principle, functions and points of difference together with the specific use of each particular machine and not to amplify every detail of mechanism, nor unnecessarily repeat factors common to the Noble Comb.

The subject matter relating to the Noble, Lister and Heilmann combs is the product of many years practical acquaintance and experience in teaching the principles of these machines, in addition to which the writer has inspected almost every patent specification from the Cartwright era to the present time.

Incidentally, there are many very good inventions buried in the patent records which have never yet experienced the light of practical application.

Very considerable importance is attached to the necessity of obtaining a complete understanding of any machine employed, on the principle, that the more thoroughly the mechanism is understood the more completely will all its possibilities of production be utilised. An imperfect or superficial knowledge frequently leaves the owner or user stranded and virtually the slave of the machine.

In illustrating and describing the different mechanisms, the plan has been adopted of giving a general introductory description of the variety and complexity of the parts in relation to the object and action of each machine. The illustrations are likewise first introduced in perspective and afterwards prepared in detailed sections. This method of treatment is primarily helpful to those who desire to study the consecutive details from the feed to the delivery end of the machines. It is also useful for reference to practical men who desire to consult the specific sections.

Attention has been given to improvement in the details of mechanism, since it is the details which chiefly contribute to produce perfection. In every attempt to bring a technical work up-to-date there is always the risk that such sections may be short lived, hence, in this treatise, they are necessarily few. Visits to machine works and combing sheds have been made for the purpose of examining any modified or improved detail of mechanism before its inclusion in this volume.

There are frequently examples of mechanism which, though not meeting with immediate favour and popular approval, nevertheless possess very many points of mechanical merit, which render them worthy of a permanent record, if only to form the basis for further research.

No time, thought, labour or expense has been spared to make this treatise, not only justify its title, but thorough in its detail, adapted to the requirements of modern practice and helpful to the reader and student who seek for a consecutive knowledge of the principles, theory and general practice. Incidentally, the author has endeavoured to make the work suggestive and generate thought. The knowledge or conveyance of a simple practical fact has little value until clothed in theory. The chapters on the Set Over and Theory of Pinning and the defects of dabbing mechanism are examples to wit.

It is only by meditation that a subject really becomes known. An appeal to practice is not always a very satisfactory way of assessing the value of any principle or movement.

To Mr. John Robinson, Mill Manager, Denholme, who has rendered invaluable service in the preparation of this volume, my thanks are especially due.

F. BRADBURY.

BELFAST.

CONTENTS.

CHAPTER XXI.

PAGES.

Intermediate Processes between Carding and Combing 273–288

CHAPTER XXII.

Wool Combing 289–301

CHAPTER XXIII.

The Noble Comb 302–324

CHAPTER XXIV.

The Modern Noble Comb 325–344

CHAPTER XXV.

Feeding the Noble Comb 345–361

CHAPTER XXVI.

Dabbing Mechanisms 362–390

CHAPTER XXVII.

Drawing-off Mechanisms 391–415

CHAPTER XXVIII.

Sliver Funnels, Can Coiler, Circle Cleaning and Stop Motion 416–438

CHAPTER XXIX.

The Set Over and Theory of Pinning ... 439–455

CHAPTER XXX.

Cooper's Noble Comb 456–468

CHAPTER XXXI.

The Nip or Lister Comb 469–483

CHAPTER XXXII.

The Square Motion or Holden's Comb ... 484–493

CHAPTER XXXIII.

The Heilmann Comb (Schlumberger Model) 494–518

CHAPTER XXXIV.

Finishing Gill Boxes 519–535

CHAPTER XXXV.

Material and Productive Costs ... 536–544

CHAPTER XXI.

INTERMEDIATE PROCESSES BETWEEN CARDING AND COMBING.

Gilling after Carding and Preparatory to Combing.

WHEN the wool which has been carded comes from the carding engine, it is passed through one or two gill boxes for the purpose of straightening out the fibres which may be lying across the sliver. This is a comparatively easy task, as complete separation of the fibres having taken place on the card it is only a matter of drawing them through the combs of the gill box, and of ensuring by suitable drafts that they shall take their places along with the others in a position ready for the ultimate combing.

In the treatment of short wools, however, it is frequently necessary to pass them through the additional operation of "backwashing," an operation which, incidentally, is seldom required for prepared wools.

Backwashing.—Its Necessity, Object, and Principle.

During the passage of the wool through the carding process and other operations subsequent to the wash bowl, it becomes more or less soiled, owing to the accumulation on the fibres of oil and fine metallic dust from the card pins.

The cleanliness and colour of the wool are matters of the utmost importance to the top maker, when the material has to be sold in the top or dyed in the slubbing. It is, therefore, frequently necessary to re-cleanse the wool before passing it forward to the combing process. This operation is designated *backwashing*. So far as the spinner is concerned, the process is of very doubtful utility, because back-washed wool never spins so well as when it has not been so treated, nor can as high counts be obtained. The amount of waste at the subsequent processes is also increased materially. To the top maker or comber, on the other hand, it is of great value, since it enables him to get a better colour and more lustre. These qualities materially influence the market value of the top; and no doubt he would immediately assert that unless he did backwash his carded wool he would find some difficulty in selling it. Dyed slubbing is generally backwashed in order to remove any loose colour which may be adhering to the fibres. In the case of white wools or those which exhibit a yellowish tint, the opportunity is often taken at this stage to tint them with some aniline dye, such as indigo purple, methyl violet, or any suitable acid violet, which optically combining with the yellow, results in a very light grey being produced, much less apparent to the eye. It is obvious that the effect thus produced will be fugitive and will disappear when the cloth or yarn is scoured.

As an alternative to neutralising the natural tint of the wool, it is frequently permanently destroyed altogether by the process of bleaching. This consists in passing the slivers through a solution of chemical substances which oxidise the pigmentary matter present, the effect produced being permanent. For this purpose, hydrogen peroxide, sodium peroxide or sodium thiosulphate is available. Of these, the first is most extensively used. To bleach the wool perfectly by these agents is a somewhat lengthy operation, requiring generally from six to twelve hours, according to the character of the fibre ; but very good results have been produced by passing the sliver through a dilute solution after it has been well scoured in the first and second sud bowls. In this case additional substances were added in order to render the action more rapid.

In a pure state, hydrogen peroxide is a colourless fluid of a syrupy consistency, and yields, on decomposition, about half its weight of oxygen, which is the agent by which the bleaching is performed. It readily mixes with water, and is obtained commercially as a weak solution of from 3 to 6 per cent. As sold, it frequently contains impurities which influence its stability, but this may be reduced by storing in a cool, dark room.

Sodium peroxide is a yellowish solid which is soluble in water with evolution of oxygen and heat. If kept perfectly dry it is comparatively stable, but when moistened it readily parts with its oxygen. This substance requires careful storing, as it absorbs moisture, and in this condition its action is such that it easily ignites paper, a circumstance which may produce serious results.

Briefly the process of backwashing consists in passing a number of slivers as they come from the previous operations through a trough containing a sud of hot water and soap, and since the fibres are in a loose state, this sud removes all impurities as well as the oil which may have been used before to assist the working of the wool. As the wool is fed into the machine it passes through this sud trough and over heated cylinders. These cylinders are made of copper, and their temperature and speed are so regulated that the wool shall come off them dry, after which it passes through a screw gill box similar to those already described, but made part of the machine so that any interference with the fibres in passing through the sud trough and over the cylinders will be again reduced, and the fibres brought back to their parallel position. In addition to the gill box there is usually an oiling arrangement which, when desired, puts a sufficient quantity of oil on the wool to assist in the subsequent operations of combing, drawing, and spinning.

Backwashing Machines.

A backwashing machine is composed essentially of three parts :—(1) scouring tanks ; (2) drying arrangements ; (3) a gill box. Two or more scouring tanks are employed according to the manufacturer's requirements. The drying arrangements consist of a series of hollow brass or copper rollers, having one of their ends free so as to facilitate the placing of the wool in position. As in all cases when the nature of the operation necessitates heat being used, it is essential, in order to obtain the best results, to have some means of readily ascertaining the temperature at which the work is being carried on. A thermometer should be fixed in some convienent position, so as to prevent the steam being turned on and off in a haphazard way. Some makers have adopted this plan with very beneficial results, and there is certainly no reason why it should not be universally used.

The gill box in this machine is provided with a balling head, or press rollers which conduct the sliver into a can.

During recent years great advance has been made in improving and perfecting backwashing machines, especially the drying part. In machines of the modern type *hot air* is forced or drawn through the back-washed sliver, instead of employing steam-heated cylinders for drying the material by direct contact as heretofore.

Steam-Heated Cylinders and Contact Drying.

It is proposed only to refer briefly to the older principle of *steam drying*, for purposes of education, and to record the lines of development and progress, and because many machines built on this principle are still in use.

In all backwashers designed to clothe the above principle of drying, the washed sliver passes over a number of steam-heated cylinders, and consequently the fibres on the outside of the sliver are dried by direct contact with the cylinders; but since wool is a poor conductor of heat, the interior fibres are less rapidly and thoroughly dried than those on the outside, which frequently results in discoloration or scorching, and weakening of the outside fibres, whenever attempts are made to dry the material quickly by forcing larger quantities of steam through the drying cylinders.

I.—Indirect Steam Drying.—This principle comprises drying with one large steam cylinder and a series of small ones. Fig. 71 is a transverse sectional illustration in elevation of the sud bowls and drying cylinders. A shows one of the guide pins used for conducting the sliver B into the nip of the feed rollers C, from whence it passes into the first sud bowl D, which contains a large press roller E, driven by frictional contact with five or seven small rollers F, in turn positively driven. The sliver B passes between the nip of these rollers which are rotating in the "scour," so that it is successively immersed and squeezed, and thereby receives what is termed a "wet nip." It is urged by some combers that this not only cleans the wool more completely, but that it also causes it to become more lustrous than when it is omitted. This probably results from the fact that when wool is saturated with heated water it becomes softened and swells. If in this condition it be passed through a pair of press rollers, the fibres will become flattened, and consequently their reflecting surface is much increased. There can be no question but that the treatment which occurs in this bowl will effectually cleanse the fibres from adhering grease and dirt. After leaving the last of the series of preliminary rollers E and F, it is re-saturated and passes forward to the first pair of heavy press rollers G, which, being also weighted by levers, weights, and springs, can be so regulated as to exert much pressure and so remove the surplus moisture. As in all types of backwashing machines these rollers are provided with the ordinary ratchet catchbox arrangement to prevent any trouble arising through lumps or uneven places. From here the sliver is passed on to the second sud bowl H, near the bottom of which are placed the im-

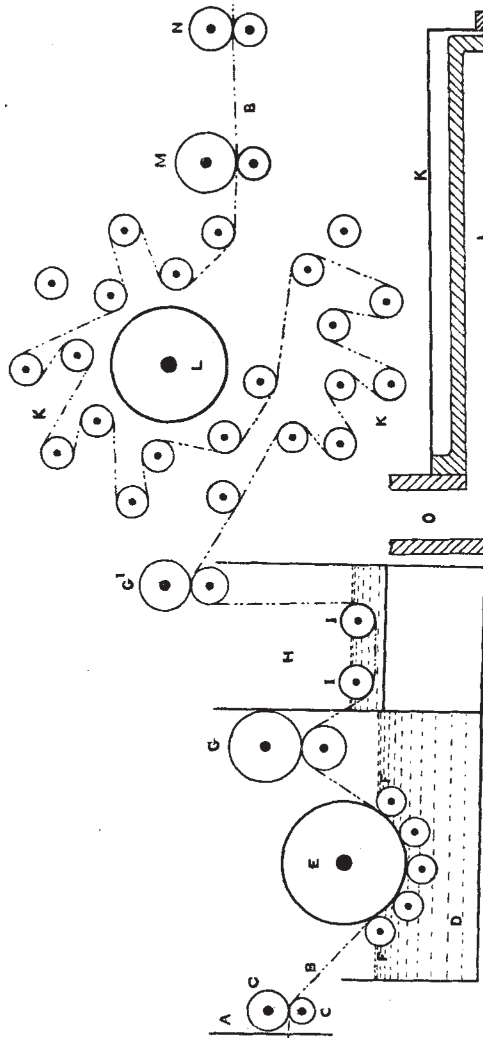


Fig. 71.

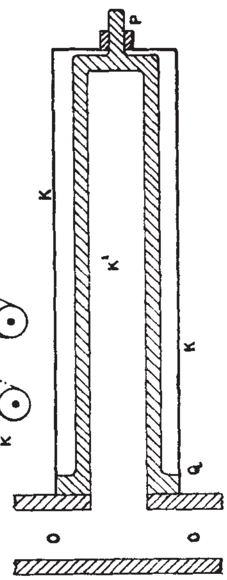


Fig. 72.

mersion rollers I, under which the slivers are passed to keep them in the scour, and then through the second press rollers G^1, after which they are taken round the drying rollers K, so that all the surplus water shall be driven off. These rollers are one of the special features of the machine.

They are arranged in pairs, as shown in the illustration, around a large steam-heated cylinder L, generally about 16½in. diameter, and 30in. "face." The small drying rollers K are attached to a steam chest at the back of the machine. Their internal construction is such that instead of the sliver being brought in contact with a directly steam-heated surface, a cushion of air is interposed between the steam-heated chamber and the outer shell around which the wool passes. The arrangement is shown at Fig. 72, where O is the steam chest, suitably provided with inlet and exit pipes. Attached to the inner side is the roller chamber K^1 which is a cast iron shell having a short journal P at its free end, to support the revolving cover roller K. At the steam chest end is a collar Q, and upon this and the journal P the loose jacket K is free to rotate. The course of the sliver is indicated by the dotted line B in Fig. 71, from which it will be seen that the centre cylinder L does not come in contact with the wool, its function being to furnish heat, in order that both sides of the sliver may be dried as it passes forward. After leaving the drying rollers, the wool is passed through a gill box of the ordinary form, provided with the calender roller and balling head. The back rollers of the machine are indicated at M, and the front rollers at N. An oiling motion, similar to that illustrated at Fig. 56, Vol I., is placed over the fallers, and the

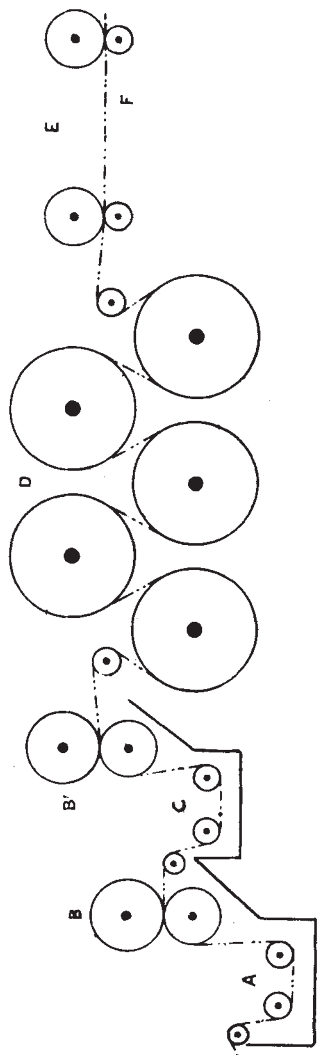


Fig. 73.

remarks made in that connection with regard to the nature of the oil used are equally applicable at this stage.

II.—Contact or Direct Steam-Drying.—This principle consists in drying with steam cylinders of uniform diameter, and is illustrated diagrammatically at Fig. 73, which is a sectional elevation of the arrangement of the cylinders. A indicates the first wash bowl; B the first squeezing rollers; C the second sud bowl, and B^1 the final squeezing rollers. D indicates the drying cylinders, which are charged with steam; E the gilling section of the machine, and F the sliver.

The chief feature of this machine is the steam-drying cylinders D, which are usually five to seven in number, and seventeen to twenty inches in diameter. The sliver passes alternately over and under the cylinders D, with which it is in contact, as indicated. Each cylinder is provided with separate pipes and valves for inlet and outlet, so that one or more may remain idle at will. Further, the supply of steam can be regulated to the required heat so as to dry the material without scorching. In some instances the metal of the cylinders is very thick, the object being to avoid too high a temperature. This also facilitates the storage of a greater quantity of heat and so counteracts any tendency to sudden variations of temperature, which would result in scorching or unevenness of drying. In other machines the cylinders D are constructed on the double shell principle, like the cylinders K, Fig. 72.

GILLING AFTER BACKWASHING.

The gill box at this stage serves the double purpose of opening out the fibres which have become somewhat matted by their passage through the scour, and of improving the appearance of the wool. This is the primary object of this operation and great care should be taken to secure its attainment. The same points need attention in the operation of backwashing as were emphasised in that of wool washing. The scour should be heated just sufficiently to enable it to do its work completely, while the soap must be slightly alkaline, potash soaps being preferable.

A difference of opinion exists to a slight extent among wool-combers as to which is really the best stage at which to backwash. Some urge that it is better before combing, and others after. The former method or period is customary, since it causes the wool to work somewhat more lightly and freely in the pins of the comb circles. On the contrary, it is affirmed that since purity of colour is the object sought after, it is better to take the oil out of the wool as late as possible, that is after the combing.

Drying by Hot Air.

The objection to each of the foregoing types of machine is that the fundamental principle of contact drying is at fault, for since wool is a poor conductor of heat, it follows that while the outside of the sliver may be thoroughly dried, the interior may still retain much miosture. Contact drying is, moreover, conducive to scorching, for since the regulation of the temperature of the drying rollers is somewhat difficult, they are liable to become overheated. The result of overheating is not only that the surplus moisture is driven off, but also a portion of what must be regarded as the constitutional moisture, upon the presence and influence of which the wool is dependent for most of its peculiar characteristic properties. Under such circumstances it is not surprising that the wool acquires a dry, harsh handle, and lacks that cohesiveness which is always characteristic of a good sliver. Moreover, since it is not capable of exercising sufficient resistance to enable it to withstand the strain placed upon it by the rollers during drafting, in the succeeding operations irregular or twitty ends are sometimes produced. When this occurs it may generally be remedied by making a reduction in the amount of draft; but it is always better to prevent having to do this by avoiding in the first instance any overdrying of the wool. Further than this, when too dry there is always a tendency for the shorter fibres to fly away from the body of the sliver as it becomes more and more attenuated, and to cling to the metallic parts of the various machines.

The introduction of the principle of drying the backwashed sliver by passing a continuous stream of *hot air* through it as it travels over perforated conveying rollers, removes at once the defects of contact drying. Scorching and discolouring are avoided: when the machine is standing there is no overheating of cylinders: the dried wool is loftier and softer to the touch: its lustre is retained better, and the subsequent yarn spins with fewer breakages. The temperature for drying is under more simple control, which is a most important factor, when it is borne in mind that a large variety of wools have generally to be worked from time to time, and that there are seldom two kinds which agree in absorptive and

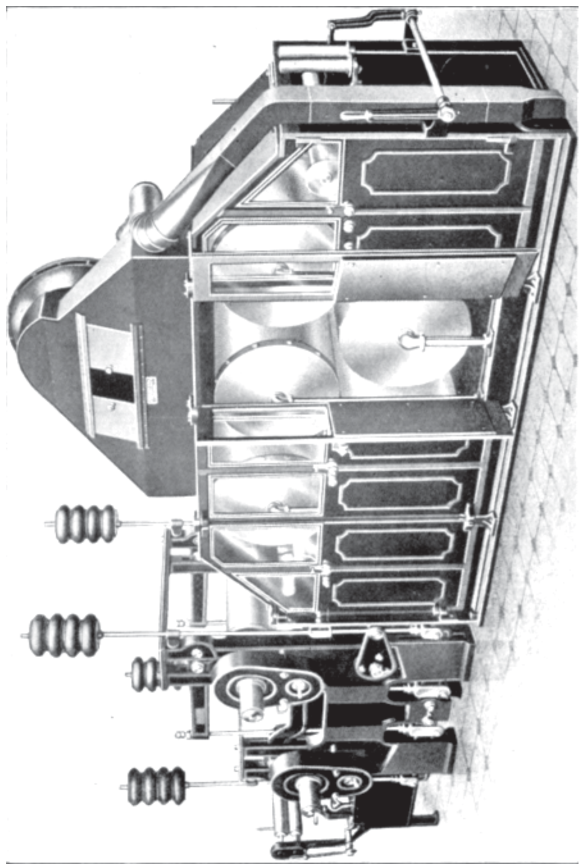


Fig. 74.
Hot Air Backwashing Machine.

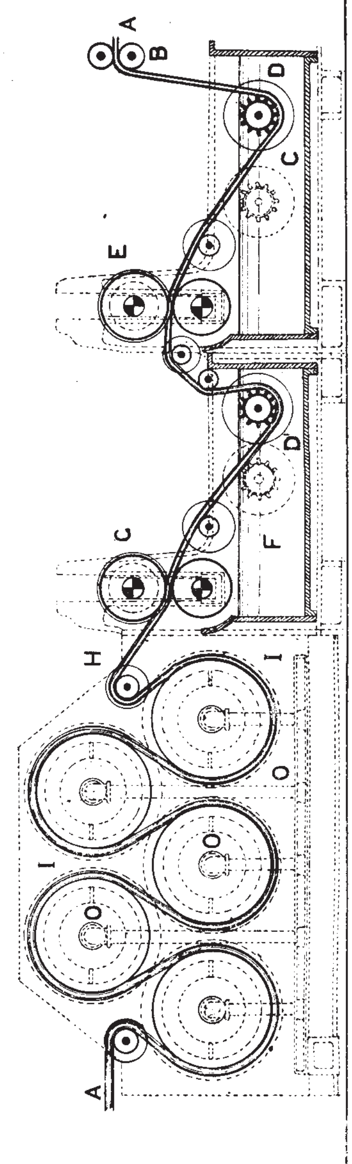
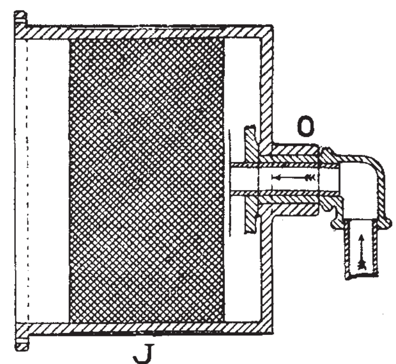


Fig. 75.

retentive properties—one holding less, and parting more readily with its moisture than another.

Fig. 74 is a perspective view, and Fig. 75 a sectional elevation of Howarth & Musgrave's patent hot air backwashing machine, made by Prince Smith & Son. Fig. 76 shows a longitudinal section of the drying apparatus, and Fig. 77 a plan of the perforated brass shell over which the sliver passes. The same letters in each diagram refer to similar details. A is the sliver; B the feed rollers; C the first trough; D an immerser roller; E the first pair of squeezing rollers; F the second scouring trough; D^1 the immerser roller, and G the final squeezing rollers. After the washed sliver A emerges through the squeezing rollers G it passes over the guide roller H to the drying chambers, in which five or more drying cylinders I, charged with steam, are arranged. Each cylinder is surrounded by a brass *perforated shell* J, over which the sliver A passes. The steam cylinder I is further provided with an internal air chamber K. Steam is passed into the cylinder I through the pipe L, and after heating the cylinder, it makes its escape through the exit pipe M. A constant supply of *warm air*, of combing-room temperature, is *forced* through the conducting pipe O into the internal chamber K. After being heated, the air escapes through holes drilled in the solid section of the cylinder I, and forces its way through the perforations in the brass shell J, and ultimately through the sliver which circumscribes it. The constant flow of hot air through the wool tends to *lift it*, and to form a cushion between it and the indirectly heated shell J. This is one of the factors which prevents overheating or scorching of the wool during

Fig. 77.



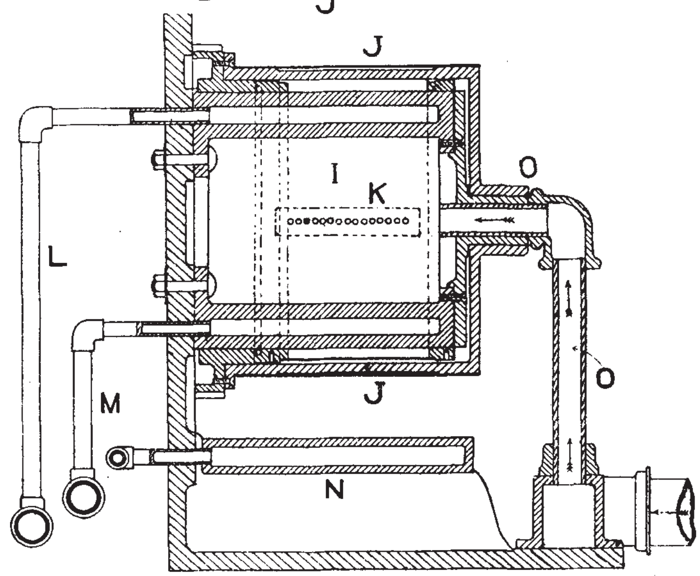


Fig. 76.

drying, and is assisted by the blower which continues to act even though the machine may be temporarily stationary. The blowers are now fitted with ball bearings, by which addition a saving in horse-power consumption is effected.

It is sometimes advantageous, when treating light wool or hair, to pass the sliver straight across two or more drying cylinders instead of circumscribing all the cylinders, and entirely miss the last drying cylinder.

A backwashing machine on the principle of hot air drying, differing somewhat in construction from the foregoing, is made by Boldy & Son, Bradford. An important feature of this machine is the employment of Sowden's perforated brass drying cylinders. These cylinders are provided with corrugations, the grooves of which run axially to within three inches of each extremity. The slivers to be dried travel in close contact with the convex part of the cylinders, but the warm air issuing from the perforations circulates freely between the slivers and the concave or grooved part of the cylinder.

CHAPTER XXII.

WOOL COMBING.

Necessity and Object of Wool Combing.

IT has been seen that carding occupies the same position in the treatment of short wools, as preparing does in the case of long wools. No attempt whatever has been made to sort the fibres, so as to remove the shortest. From what has been said previously with regard to the character of a worsted thread, so far as a clean surface is concerned, it will be easy to see that if this is to be obtained, all the very short fibres must be removed. Further, a twisted strand of fibres, *i.e.* yarn, must possess a certain amount of strength, which is dependent in a great measure upon two factors, viz., the length of the fibres, and the number present in its cross section. *Length* is considered first because, if two yarns be taken, each having the same number of turns and of individual fibres, but one composed of very short wool, while the other is made up of long wool, the latter yarn will be the stronger. This is chiefly due to the fact that the fibres are twisted round each other a greater number of times, and consequently exercise more resistance when the yarn is subjected to tensile strain. An *increase* in the number of fibres also gives greater strength ; but if the shorter fibres predominate, a source of weakness is introduced, since the added resistance is not proportional to the increase in the number of fibres. Admitting this to be an accurate statement of fact, it is therefore seen that one primary requirement in the making of a perfect thread is the presence of fibres having a uniform length, and that as great as possible. Another feature, also, must be mentioned at this stage--viz : the strength and utility of a worsted yarn are more or less governed by the parallelism of its fibres. This must be as perfect as possible, and hence succeeding operations are devoted chiefly to securing it.

The object of combing is to effect the separation of the short and curly, from the long and straight fibres, and to impart to those fibres which are capable of being utilised a strictly parallel arrangement. Two of the fundamental features necessary for the production of a sound yarn are thereby secured, viz., filaments of a good *length*, the whole of which are available to enable them to be readily twisted around each other so as to give the most *strength* to the strand into which they enter. The necessity for the preservation of the exterior of the fibre has already been emphasised, and in order to prevent, as much as possible the stripping of the fibres, those parts of the machines immediately engaged in dealing with the wool in detail are heated by means of gas or steam, preferably the latter.

Briefly stated, then, a perfect thread must have for its basis an absolutely uniform material upon which to work, and every operation is designed towards the production of such a yarn. In the manipulation of the wool fibres into worsted yarn, combing is undoubtedly the most important process through which the sliver passes in all its sequence of operations.

As a result of the action of the card wires, the sliver at this stage contains a large number of neps, small vegetable impurities and short fibres, all of which must be removed before the formation of the thread is attempted. The fibres themselves have no definite arrangement, but are crossed and intermingled in every direction. This intermingling is to a great extent overcome by the gilling which follows backwashing, in order to prepare the wool for the next process of combing. Seeing that the carded slivers are composed of all classes of fibres—long, short, curly and straight—some method must be adopted to get rid of those which cannot be utilised. The wool has now, therefore, to be separated into two portions. One of these, termed the "top," consists of all the fibres which are of sufficient length to enable them to be used in making the thread; the remainder is known as noil, neps, shives, etc. During the process of combing, many of the neps get opened out or much reduced, owing to the longest fibres being drawn away from them.

The relation between the amount of top and noil produced is expressed as the "tear" of the wool. For instance, a wool that yields 7lbs. of top to 1lb. of noil is said to tear 7 to 1; if making 3 of top to 1 of noil, then it is tearing 3 to 1, and so on. This is the basis upon which the commission comber formulates his scale of charges, wool with a high tearage being the most difficult to comb.

Prices for Combing.	1913.	1922.
Merinos. All above 56s quality.		
*Tearing 5 to 1 and over ...	$2\frac{1}{2}$d. per lb.	$6\frac{1}{4}$d.
,, 4 and under 5 to 1 ...	$2\frac{3}{4}$d. ,,	$6\frac{3}{4}$d.
,, 3 ,, 4 to 1 ...	3d. ,,	$7\frac{1}{4}$d.
,, 2 ,, 3 to 1 ...	$3\frac{1}{4}$d. ,,	8d.
,, Under 2 to 1 ...	$3\frac{1}{2}$d. ,,	$8\frac{3}{4}$d.
Burring	$\frac{1}{4}$d. extra	1d.
Gilling in	$\frac{1}{4}$d. ,,	$\frac{1}{2}$d.
Carded Crossbreds.		
*56s (Carding, Backwashing and Gilling)	2d. per lb.	$3\frac{7}{8}$d.
Burring	$\frac{1}{8}$d. ,, extra	$\frac{3}{8}$d.
Gilling in	$\frac{1}{4}$d. ,, ,,	$\frac{1}{2}$d.
*50s, Tearing 7 to 1 and over ...	$1\frac{7}{8}$d. ,,	$4\frac{3}{4}$d.
,, 5 and under 7 to 1 ...	2d. ,,	$5\frac{1}{4}$d.
,, under 5 to 1	$2\frac{1}{8}$d. ,,	$5\frac{3}{4}$d.
Burring	$\frac{1}{8}$d. ,, extra	$\frac{1}{4}$d.
Gilling in	$\frac{1}{4}$d. ,, ,,	$\frac{1}{2}$d.
*30s to 46s, Tearing 8 to 1 and over	$1\frac{5}{8}$d. ,,	$4\frac{1}{4}$d.
,, 6 and under 8 to 1	$1\frac{3}{4}$d. ,,	$4\frac{3}{4}$d.
,, under 6 to 1 ...	$1\frac{7}{8}$d. ,,	$5\frac{1}{4}$d.
Burring	$\frac{1}{8}$d. ,, extra	$\frac{3}{4}$d.
Gilling in	$\frac{1}{4}$d. ,, ,,	$\frac{1}{2}$d.
Carding, Backwashing and Gilling only	$1\frac{3}{8}$d. ,,	$3\frac{7}{8}$d.
Prepared Wools.		
*32s, 36s, 40s	$1\frac{1}{4}$d. per lb.	$3\frac{3}{4}$d.
*Over 40s	$1\frac{3}{8}$d. ,,	4d.
Slipe and Skin Wools	$\frac{1}{8}$d. ,, extra	$\frac{1}{2}$d.
Burry and Seedy Wools	$\frac{1}{4}$d. ,, ,,	1d.
Gilling in	$\frac{1}{4}$d. ,, ,,	$\frac{1}{2}$d.
Scotch Wools	$1\frac{3}{8}$d. ,,	$4\frac{3}{8}$d.
Scouring	$\frac{5}{8}$d. per lb. of washed wool	

* The prices for combing are inclusive of washing, preparing and combing, but exclusive of specified extras.

The aim of the worsted spinner is to obtain as much top from his wool as he possibly can, since the noil is of no use to him, and has to be sold to the woollen spinner, who converts it into a different class of yarn. It is essential, therefore, to guard against everything which tends to increase the quantity of noil. The soundness and general character of the raw material form a very important factor in this respect, since a wool is often found which, in the grease measures perhaps 6 to 6½in. in length and yields a top of 5 or 5½in., or even shorter. A portion of this decrease is due to the shrinkage which results from scouring; but most of it arises from breakage, caused very probably by some inherent weakness in the fibre itself. The strength and tenacity of the staple should be very carefully examined and tested, because wools are frequently found which readily break about ¾in. from the tip. Defects of this kind are of great consequence, since the strength of the finished thread is primarily dependent upon the length of the fibres being preserved. All other things being equal—fineness, softness, soundness, etc.—the top with the longest wool is by far the most valuable. At a later stage it will be seen that it has an important bearing in another direction also. A short top requires more twist in the spinning and preceding operations of the drawing to enable it to work properly: this of course reduces the quantity of work turned off, and hence results in a material loss.

Noil Increasing Factors.

So far as personal investigations into this question have proceeded, it would seem that a frequent cause of the mischief lies in the injurious influence which the substances composing the "dips" and "smears" used by the wool grower exert upon the fibre. They appear to act on the tissues, and completely change their physical properties, making them dry, tender, and devoid of elasticity at that particular place, and rendering them unable to resist a longitudinal strain. This is only another illustration of the fact that many times in its growth and during the earlier stages of manufacture, it is treated with substances which are prejudicial to the suceeding operations. What is wanted is a better understanding of the requirements of each process by all those concerned in the production and manipulation of wool. The practice of branding with tar should always be discouraged, since it causes the fibres to adhere, and the lumps have to be removed by the sorter with his shears, the result being that a number of short particles are left in the fleece. Weakness of the fibre may arise from other causes, such as the sheep being unhealthy, or from not having sufficient food and nourishment, or by exposure to extreme variations of weather; but in these cases the faulty places are generally found at intervals throughout the length, and hence the fibres break into several pieces.

Burrs and other fruits with hooked spines and hairs tend to increase the quantity of short fibres by causing the wool to become much entangled and difficult to separate without considerable injury. The breaking which takes place in the preparatory stages of working at each operation must be included as an accessory cause, and particularly when for some reason or other the fibres have become badly felted. All these are contributory causes which *assist in producing the noil*; but most of

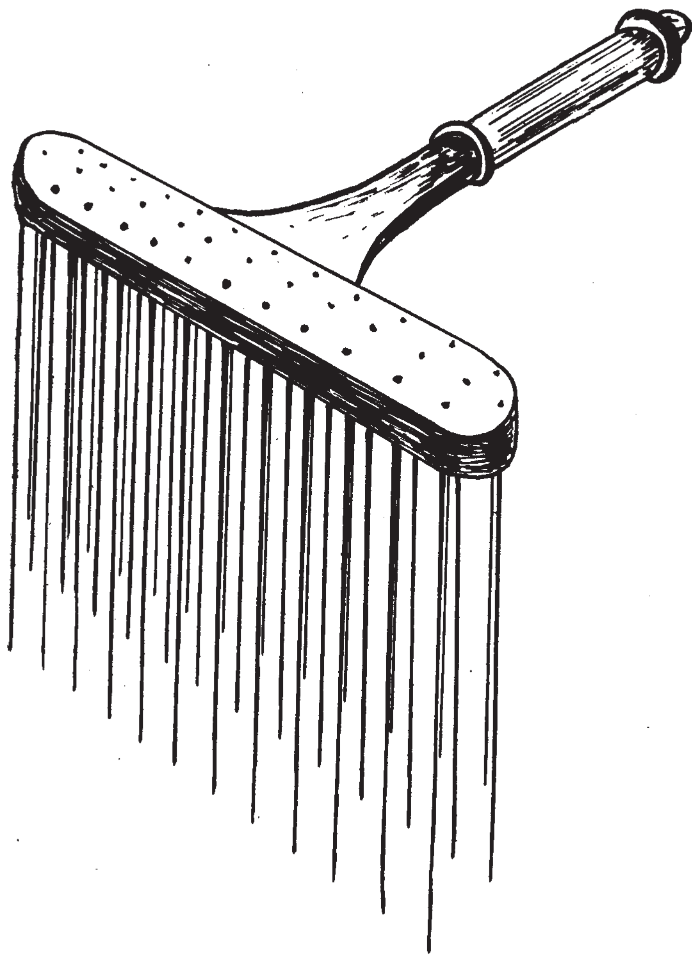


Fig. 78.

them can in a great measure be obviated by care and attention on the part of those who superintend the initial stages. They arise principally through ignorance or indifference to the fundamental requirements of worsted spinning.

Hand Combing.

For a long period, the process of combing was performed entirely by hand. Fig. 78 is a sketch of a hand comb, and Fig. 79 is a perspective view illustrative of the principle of this method of combing. Both illustrations are reproductions from Hume's Essays.

The hand comber uses two combs in working his wool, one of which is fixed to a wooden framework. Having previously washed and oiled his wool, the comber fills it upon this comb by striking or (to use the term peculiar to the trade) "lashing" the end of the portion held in his hand into the teeth. He then takes the other or working comb and strikes its teeth into and draws them through the fibres, which are hanging out from the holding comb, till the noil has been combed out. He next gradually draws out the worked wool into a long sliver, which completes the combing process, the noil being retained in the teeth of the holding comb.

Hand Combing as a factor in Worsted.

H. Hume, L.L.D., F.S.A., in his Essays (1857) on Spinning and Weaving, records the following data relative to combing, and incidentally asserts that this process is the chief factor in the manipulation of wool into worsted :

"*Worsted*, a town in Norfolk, devised a new method of its own for the carding of the wool with combs of iron well heated, and then twisting the thread more than usual, in peculiar quality, to which the name itself of *worsted* was immediately given. To such high repute did the new web grow, that church vestments and domestic furniture of the choicest sorts were made of it.

Fig. 79.

Exeter Cathedral among its chasubles had several "de nigro worsted" in cloth of gold. Vestments made of worsted variously spelt "worsett" and "woryst" are enumerated in the fabric rolls of York Minster."

Combing by Machinery.

It is no exaggeration to say that the worsted trade received its greatest impetus by the introduction of the wool-combing machine. It has been the chief means of bringing the various sections of this trade into a more compact whole, as compared with the manual system, in which every successive stage was isolated.

The present system of combing by machinery received its first creative spirit in the person of Dr. Cartwright, an ordained minister of the Church of England. Dr. Cartwright's first invention relating to combing machinery dates from the year 1790. In this year he applied for three patents. The most important patent for which he applied was in the year 1801. Dr. Cartwright's chief aim appears to have been to construct a machine that should imitate the process of the hand comber as closely as possible. His machine, though it straightened the wool somewhat, did not efficiently comb it. Like most other machines which immediately followed, it was too complicated and required too much attention.

The introduction and development of wool combing is well described in Burnley's *History of Wool and Wool Combing*.

Principle of Machine Combing.

Combing is accomplished by drawing the fibres between a number of closely-set pins, which are arranged either in circles or as fallers. The fineness of the pins and their setting vary according to the character of the wool. Where a number of rows is used the pitch is made progressively finer as the pins approach the outer or inner edge of the circle, as the case may be. In some instances flat pins are used in order to obtain as much combing surface as possible to prevent any neps passing into the top. It is sometimes considered a great mistake to have the pins too fine and set too finely, because, in the first instance, they are of necessity unable to bear much strain, and again the foundation is weakened owing to the large number of holes which have to be drilled in it in very close proximity to each other. If coarser pins were used it is argued that no combing surface would be lost, since they could be placed quite near without much injury to the brass in which they are fixed. This is not an ideal system of combing, because in the first instance, in an ideal system, each fibre should be dealt with separately, and it follows that this will be more nearly approached when the number of pins, with their corresponding interstices is greatest. When thick pins are employed they may be set close together, but the number of spaces are fewer, and consequently more fibres are placed in each. The following example will make this more clear: assume that in a fine set circle we have 2000 spaces. If fully utilised these will carry and comb the same number of fibres; decrease them now by one-half, then while it may still take 2000 fibres, there will be two in each division where previously there was only one. Under these circumstances it will be evident that the combing and clearing will not be as perfect as before.

Now, the essential requirements of a top, so far as the machines are concerned, are that all its fibres must be strictly parallel and clear, free from neps and slubs, while the end must be perfectly regular. This is obviously impossible in every case, because the diameter of the fibre is very much less than the distance which separates the pins, and consequently they are not dealt with singly, but in mass. The finer the pins and their setting can be made, the nearer the ideal top will be approached.

It is absolutely necessary that the circles should be kept clean and free from any solid impurities, which, if allowed to accumulate, would hold the pins apart, and thus allow the small neps to pass forward. Many automatic cleaners have been devised, but probably the most successful is that of Greenwood & Farrar's, which consists of a small circular brush held in position by a spring, to be detailed later. Attention must also be paid to the condition of the circles or fallers concerned in the combing. If the pins get bent or broken, especially in the inner rows of the large, or outer rows of the small circles in the Noble comb, the character of the work will be materially affected for there is nothing to collect the neps, etc. Their points must be sharp, free from grooves and hooks, so that the fibres may be dabbed well into the circle or fallers. A clean, smooth, and well-polished pin is also a desideratum which must not be overlooked, for if rough or rusty it acts as a rasp, injuring the outside of the fibres as they are drawn against it. Two kinds of pins are employed—round and flat; the latter being generally regarded as the best combers, are used where the greatest amount of separation and retention is required, as, for example, in the fallers of the Lister comb and parts of the circles in the Noble comb.

The operation of combing may be conveniently divided into four stages, which are successive but not always continuous : 1st, the feeding of the wool ; 2nd, its partial combing ; 3rd, combing, completed by drawing off the longest fibres to form the top ; and 4th, the removal of the noil. These may be readily distinguished in the various machines, though accomplished somewhat differently.

Types of Combing Machines.

There are five types of combs in general use : the Noble or circular comb, which may be conveniently used for a very wide range of wools ; the Lister or nip comb, specially adapted for dealing with the long lustre wools, such as Lincoln, Romney Marsh, Mohair and Alpaca ; the Holden or square motion comb, largely used for short merino wools ; Little and Eastwood's comb, also for short-stapled wools up to 6 or 7in. ; and the Heilman comb. There are three chief makes of the Heilman type, viz. : Dilett, Schlumberger and Alsatian, which last is made in this country by Prince Smith & Son, being used chiefly in the fine worsted trade for re-combing. The Schlumberger interpretation of this type of comb is largely employed for combing the better flax tows.

CHAPTER XXIII.

THE NOBLE COMB.

OF the several machines now in use, it is proposed, in this treatise, to describe and illustrate first the Noble comb. A thorough and exhaustive consideration of this machine will embody all the fundamental and general principles of modern combing.

The Noble comb, with its later developments and improvements, occupies the most prominent position in the combing world. The modern type of the comb is the product of many minds, rather than the evolution of one idea. A few years ago I observed that fully 75% of the patent specifications on combing related to this machine, which demonstrates, incidentally, its practical usefulness. The Noble machine is more generally employed as a general purpose comb than any other type, primarily, perhaps, because of its ready adaptation to a wide variety of materials and qualities, together with its large productive capacities. It is especially favoured by most wool combers because of the facility with which it can be altered to comb either botany wool or crossbreds. The large number of parts and small devices, together with the introduction of ball bearings for the comb circles are the prime factors which have contributed to its great utility and popularity. It covers an approximate area of $7\frac{1}{2}$ feet $\times$ $7\frac{1}{2}$ feet, exclusive of the coiler.

James Noble. The prototype of the existing Noble comb was introduced on 13th April, 1853, by James Noble, described as a manufacturer, Leeds, in the County of York. James Noble, as is evidenced by a search through the patent records, was interested in worsted manufacture and wool combing, in different parts of the country, for a long number of years. As far back as 29th June, 1805, a patent was granted to James Noble, worsted spinner, Coggershall, in the County of Essex. The nature of this invention is described as a machine for separating "tear from noiles," and drawing what is commonly called a sliver from combs. We next come across his name in 1833, when a provisional patent specification was applied for, but was never enrolled. In the year 1834, James Noble, worsted spinner, of Halifax, in the County of York, took out a patent for an invention relating to "certain improvements in combing wool." It was simply a modification of the then well known parts of combing machines. In 1836 a patent relating to a "Rotary Comb Carrier" was granted to James Noble, "the elder," wool comber of Mill Place, Commercial Road, in the County of Middlesex. In the year 1836 James Noble combined with John Perry to take out a patent which related to "circular carrying combs combined with circular working combs." Both patentees are described as wool combers in the borough of Leicester. In 1853 a patent was granted to James Noble, Leeds; but his name appears—and with his Leeds address—for the last time in connection with the prototype of the present Noble combing machine. The patent specification of the original machine is summarised as follows :—The principle "consists of combining two rotating rings of combs. Each circular comb is provided with spur teeth, one ring of teeth rotating within the other, but eccentric thereto, so that at one point of their revolution the two combs come together. Above the rotating comb-rings, on the axis of the inner circle, is a circular frame carrying bobbins prepared with cotton or other fibres, and such prepared fibres descend into, and come between two curved surfaces on levers suitably supported and carried round with the inner comb-ring. At a point just previous to where the two circles are tangential, a lever brush operates to place the materials, descending from the bobbins, into the pins of the two combs. Immediately the combs meet, the fibres are drawn from between the pins by a pair of drawing off rollers, placed in contact with the external periphery of the outer comb ring. As the distance apart of the two revolving combs increases, the long fibres are retained and project from the pins of the inner comb, while the shorter fibres, or noil, are retained in the pins of the outer comb circle, from which they are removed by a brush. The long fibres thus retained by the inner comb are lifted out of the pins, and again placed into the comb circles to be drawn off by the rollers at the point where the circles meet."

I have no desire to trace out minutely the complete sequence of developments of the Noble comb, but rather to pass over the intervening additions and modifications, except those which are chiefly combined with the machines at present in use. At this juncture it is, perhaps, only right to state that though the name of G. E. Donisthorpe, of Bradford, is not associated with the original patent specification, it is a matter of common

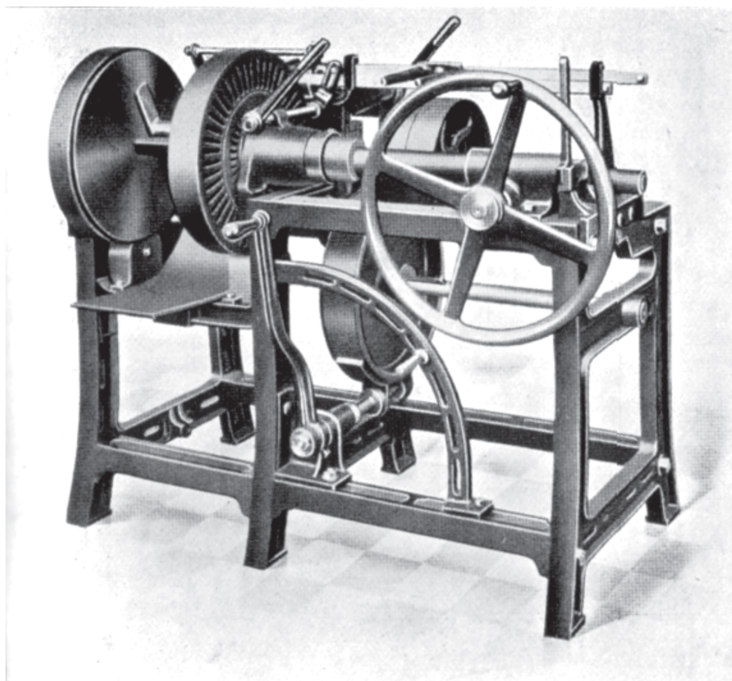


Fig. 80.

Balling Machine or "Punch Box," with Hand-wheel for withdrawing the Spindle.

knowledge that it was the application of his ingenious mind to the problem of wool combing on the Noble principle which made the machine of practical combing value.

It will have been noted that the original Noble comb was made with two circles only. The modern comb, which consists of three, dates from about 1862. In the Cooper comb, which dispenses with the use of dabbing brushes, one large and three or four small comb circles are used.

At the present time there are three important types of the Noble comb, viz. :—Prince Smith & Son's Noble wool combing machine, constructed with divided pillars; Taylor, Wordsworth & Co.'s Noble comb, built with the pillar shafts arranged outside the small circles; Cooper's Noble comb, which, as already mentioned, dispenses with dabbing brushes.

BALLING OR "PUNCH" MACHINE AND ITS OPERATION.

Immediately preceding treatment in the Noble comb, four prepared or backwashed slivers are arranged at the back of a balling machine, usually designated the "punch box."

The function of this machine is to wind the four slivers parallel into one roll—the average diameter of each roll is approximately 18in., and its weight varies from 15 to 25 lbs., from fine merino to long heavy crossbreds. The Noble comb requires 18 of these rolls, or "balls," making 72 slivers in all for each supply of combing. The slivers should be wound of sufficient tightness to form a firm ball, but not so tight as to cause the different slivers to "mat." Briefly, the balls must be wound in such a manner that in the subsequent process of unwinding each sliver shall retain its individuality.

Fig. 80 is a perspective view, and Fig. 81 shows, in plan, the main features of the " punch box " as made by Prince Smith & Son. Fig. 82 is a line diagram in elevation of the same machine, and Fig. 83 a front elevation in detail of the pressing plate and part spindle. The same letters in each diagram refer to corresponding details.

In the older type of balling machines the principle of the mechanism was so simple that any technical description was unnecessary ; but the modern machines are so much more complex, automatic, effective and interesting, as to justify detailed description, even though the work done by the " punch box " cannot be classified as a process. It is only a preparatory operation. In the modern type of machine, the ball-spindle is withdrawn by mechanical power, whereas formerly, this difficult task was accomplished by hand. To allow of its withdrawal, one of the binding plates has to be removed laterally from its normal and operative position, so as to release the pressure on the completed ball. In the modern machine, one of the binding plates is released, simultaneously with the withdrawal of the spindle, which thus permits the ball to fall by gravity into a suitable receiver, ready for removal from the machine.

Mechanism and Operation.

The principle of the mechanism and the process of operation may be described as follows :

The ball spindle, 1, is tapered where the four slivers are wound on to it, but that part of the spindle which

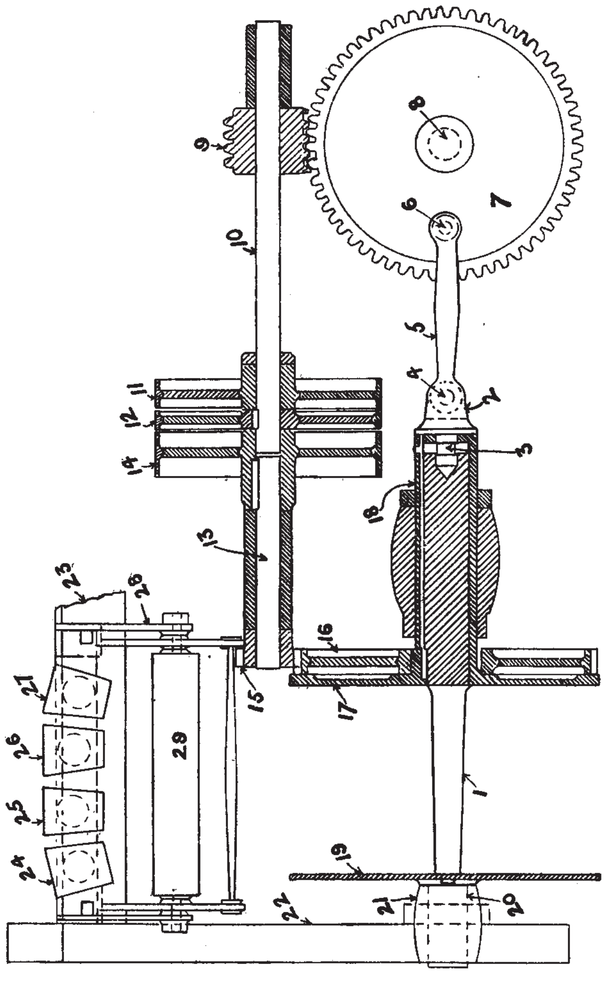


Fig. 81.

combines with the driving gear and withdrawing mechanism is cylindrical. Combined with the right extremity of the spindle is a specially constructed "swivel" link, 2, containing the stud, 3. The latter fits into a correspondingly shaped groove near the right end of spindle 1, and consequently does not interfere with the free rotation of the ball spindle. A stud, 4, unites the bracket, 2, with a swivel link, 5. This last is combined eccentrically by a stud, 6, with the worm-wheel, 7. The worm-wheel, 7, is adjustable, and free to rotate on the shaft 8, receiving its motion from a worm, 9, compounded with a supplementary pulley-shaft, 10. A loose pulley, 11, and a fast, but narrow pulley, 12, are placed on the shaft, 10, as shown in the illustration. A second driving shaft, 13, in alignment with shaft 10, carries a third pulley, 14, keyed fast to the shaft 13, part of its boss also circumscribing the free end of shaft 10. Compounded with the main shaft 13 is a spur pinion, 15, which gears into and drives a larger spur wheel, 16. The spur wheel 16 is compounded or mounted with the "binding" plate, 17, on the boss, 18, which is situated on the ball spindle, 1. The spindle 1 is designed to slide laterally in either direction, or to rotate with the boss 18, at will. A keyway formed the full length of the sleeve 18, and a key projecting from the spindle 1 facilitate this operation. The left, and free end of the spindle 1 fits into the centre of the second binding plate, 19, which in turn is combined with, and free to rotate in the sleeve 21. This sleeve is supported in the machine gable, 22. A cross-rail, 23, supports the four sliver funnels, 24, 25, 26, and 27, and the adjustable swivel bracket, 28. The last, in its turn, supports a press roller, 29, free to rotate in sympathy with a positively driven roller, 30, between which the slivers pass on to the spindle 1. A " pressing " plate, 31, carrying a roller, 32, is kept in rigid frictional contact with the periphery of the ball during the whole process of winding ; the object being to assist in making the balls hard. The

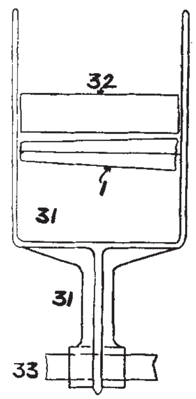


Fig. 83.

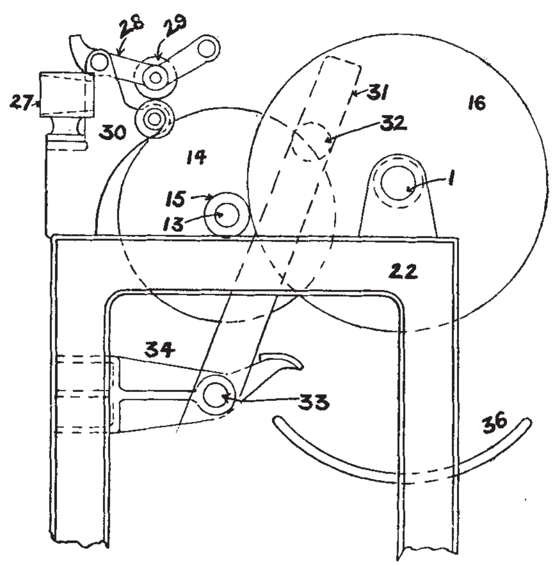


Fig. 82.

friction plate, 31, is mounted on a shaft, 33, suitably supported and free to oscillate in bracket 34, which is securely bolted to the machine gable. The amount of pressure exerted by plate 31 and the hardness of the ball are regulated by a frictional arrangement described later.

The four slivers from the last gill box are passed through the funnels 24, 25, 26, and 27, and afterwards between the rollers 29 and 30, onwards to the bare spindle 1. The belt is then placed on the fast pulley 14, and through it, shaft 13 and pinion 15 rotate spur wheel 16, binding plate 17, sleeve 18, and spindle 1. The operation continues until the required length of sliver has been wound to complete the ball. Meanwhile the pressure plate, 31, and roller, 32, have been exerting frictional pressure in contact with the growing ball, to produce the requisite hardness. Immediately the ball has attained the required size, the pressure plate 31, which has been gradually forced backwards with the increasing diameter of the rolls, operates through connections not shown, so as to move the driving belt from the fast pulley, 14, to the fast, narrow pulley, 12, on the aligned shaft 10. The remaining width of belt is passed over the face of the loose pulley, 11; the result of this action being to stop the rotation of the shaft, 13, and, through its connections, the ball spindle 1, with the completed roll of slivers. But since the narrow pulley 12, is compounded with the worm-shaft 10, the latter rotates; and, in sympathy, the worm 9 rotates the worm-wheel 7, a distance equal to one half of a revolution. The further rotation of the worm-shaft 10, is automatically resisted by details of mechanism not shown. The semi-revolution of worm-wheel 7 operates through stud 6, link 5, studs 4 and 3, and swivel bracket 2, to withdraw spindle 1 from the interior of the ball, and simultaneously to move laterally the binding plate 17, with spur wheel 16, a short distance, sufficient to release the pressure of the binding plate from the completed ball. Meanwhile the operator breaks off the slivers from the ball, which is thus free to drop by its own weight into the receptacle 36, prepared to receive it.

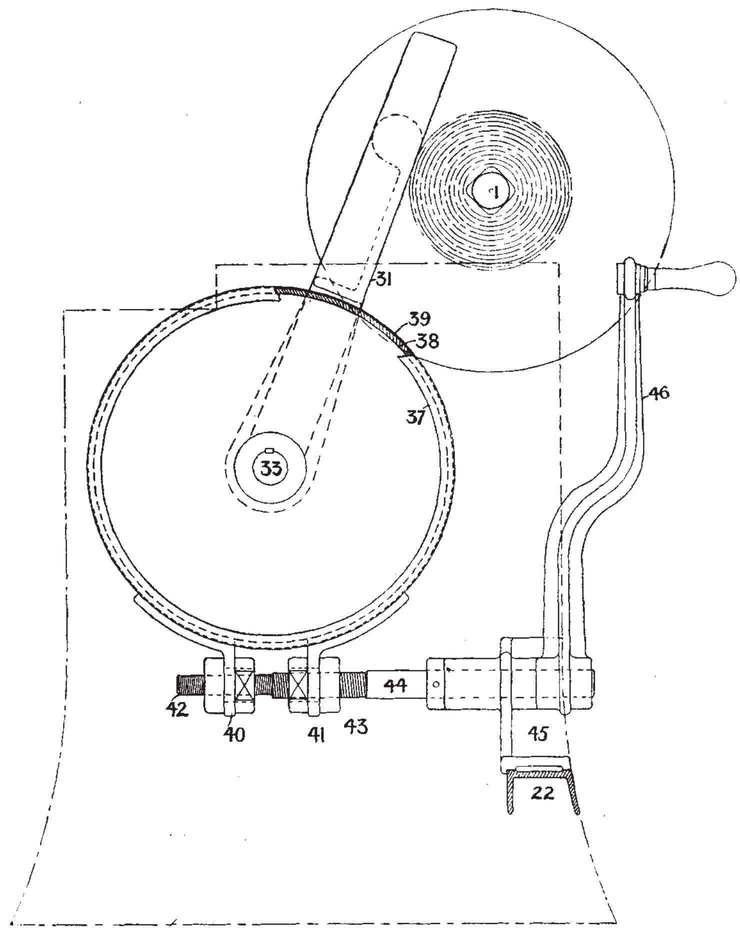


Fig. 84.

The attendant next sets free, by means of a suitably placed handle, the mechanism which withdraws the spindle 1 and eases the binding plate 17. The narrow pulley 12 then puts into action again the worm-wheel 7, this time to complete its revolution and to return the spindle 1 and binding plate 17, through the details already described, into their original positions. The pressing plate is again set free to fall into its operative position, and simultaneously the driving belt is placed by the operator on the fast pulley 14 to repeat the operation.

The extra details of mechanism which control the automatic withdrawal of the spindle, though ingenious, do not necessarily form an integral part of the standarised machine.

Pressure on Balls.

Fig. 84 is a sectional elevation of the pressure mechanism. Mounted and keyed fast to the shaft 33 (Fig. 83), which carries the pressing plate 31, is a friction pulley 37. The face of this pulley is sunk between two flanges, and into this depression a leather strap 38 fits and circumscribes the pulley; a steel strap 39 fits over and circumscribes nearly the whole of the leather strap 38. The lower and free ends of the steel strap 39 are compounded with strong steel loops 40 and 41. The loop 40 fits over a right hand threaded screw 42, and the loop 41 fits over a left handed threaded screw 43. The screws 42 and 43 are formed in different parts of the shaft 44, which is supported in the bracket 45, in turn compounded with the machine frame 22. A hand lever 46 is set screwed fast to the shaft 44. The turning of the lever increases or decreases the amount of friction applied to the friction pulley 37, and through it to the friction plate

31, on the same shaft. An almost unlimited amount of tension can be applied to the tension plate 31, in fact sufficient to actually stop the ball slivers. An adjustable stud can be fixed in the quadrant shown in the perspective, to limit the amount of friction which is judged necessary to produce the required hardness of ball. As the ball fills, the pressure plate is forced backwards while the friction pulley offers the continuous and requisite amount of resistance.

General Description and Action of the Noble Comb.

The standard Noble combing machine consists essentially of three comb circles, one large and two small, containing a series of concentric rows of steel pins projecting, in an upright direction, from the bed of a brass circular foundation plate. These several rows of pins gradually increase in fineness and setting from the outside to the inside of the large comb, but this order is reversed for the small combs. Each foundation plate is compounded with a strong plate denominated the "comb plate." All three comb plates with their respective comb circles rotate in a clockwise direction and at approximately the same surface speed.

The operation of combing is accomplished in sequent order as follows:—Eighteen "balls" each containing four "ends" or slivers are separately threaded through brass rings—sliver guides—and afterwards through specially constructed "feed," "conductor" or "trap" boxes. These are made of brass or steel each being provided with a lid, pivoted so as to leave the inlet ends open for the free entrance of the sliver, and the exit ends resting passively on the sliver, thus preventing any slipping backwards towards the ball. The ball creels, sliver guides and conductor boxes are compounded with the large comb plate and revolve in unison with it.

The wool is intermittingly drawn off the balls through the feed boxes and fed on to the comb circles at the two places where the large and small circles converge. By a simple contrivance the conductor boxes are made to travel over a stationary cam plate, described in common parlance as the "inclined plane," and placed immediately preceding the points of contact. Simultaneously, the sliver still remaining in the pins of the large comb circle, passes under a strong steel bar—the "feed knife," adjusted and fixed to the stationery part of the machine. This knife holds the wool, while its adjustment modifies the amount of sliver which is pulled through the "trap" boxes from the balls. Next in order of sequence, the wool, embedded in the pins of the large comb, travels into contact with a series of "plough knives" placed between the pins of the concentric rows of comb circles. Immediately the slivers are lifted clear of the plough knives they gradually drop on to and are spread over a fixed steel plate arranged just over and clear of the points of the pins in both circles. The wool, as it leaves this "cover" plate drops on to the tips of the pins of both the large and small circles. Now, at this point where the circles are nearest to each other, a "dabbing brush" reciprocates vertically and forces the wool thoroughly into the pins of the comb circles. The continued rotation of the combs separates and forces the slivers to divide into two portions—a fringe of combed fibres which project from the outside of each small comb circle and two fringes which project from the inside of the large comb circle.

The separation of the fibres is assisted by a stroker or divider known as the "star wheel," which rotates with a high velocity in the angle formed between the circles. The stroker consists of a series of radial blades which stroke the projecting fringes in the direction of the traverse of the circles. Each fringe is subsequently gripped by a separate pair of vertical drawing-off rollers, which draw the fibres through the pins and complete the combing operation. The four projecting fringes thus continuously rotated into the grip of each respective pair of rollers, are combined to form the "combed top" which passes through a brass funnel to a "coiling can" ready for the subsequent process of finishing. The fibres which remain in the small circle after passing the drawing-off rollers, are all short and known as "noil." These travel onwards until they contact with a graduated series of triangular shaped knives or blades adjusted and fixed concentrically between the rows of pins in the circle. The contact of the noil with these knives causes the latter to gradually ascend the incline until it is clear of the pin points, when it naturally falls over the outer or inner side of the comb circle, according to whether the knives graduate from the outer to the inner side and vice versa. The foregoing is a type of description which the student should be able to give, either from a studied or practical knowledge of the machine without the aid of supplementary diagrams. A thorough knowledge of the machine and its principle of combing requires an ability, not only to describe, but also to illustrate its every essential and detail principle of mechanism.

Noble Machine—Principal Details.

The attainment of the highest success with any machine, in respect to production or quality of work done, involves a thorough knowledge of its construction and complete working details.

In the immediate subsequent pages it is proposed to illustrate and describe fully the Noble machine, which, for reasons already set forth, has established a priority of claim for treatment in any work which deals with wool combing.

Two plan views of the three comb circles are supplied at Figs. 85 and 86 ; not as examples of the latest arrangement of circles, rollers, leathers, etc., but primarily for demonstrating the first and fundamental principles of combing in this type of machine. The former of these diagrams represents an arrangement now obsolete, but the latter is drawn from a machine in use.

Fig. 85 is a plan view of the three comb circles, drawing-off rollers, leathers, and path of the combed sliver. Fig. 86 is also a plan of the three combs, for long wool, shewing seven concentric rows of pins in the large circle, and five in each of the smaller circles, together with other additional and important details to be subsequently considered. The same numerals in each diagram refer to corresponding details of the machine.

The position of the large circle is indicated at 1 ; the small circles at 2 and 2^1 ; 3 and 3^1 are the drawing off rollers for the large circle ; 4 and 4^1 are the drawing off rollers for the small circles. 5, 6, and 7, together with their duplicates, are adjustable tension rollers for the conducting leathers 10 and 11 and their duplicates respectively. 12 is a leather which passes round one of the drawing off rollers 4, and one of the pair of delivery

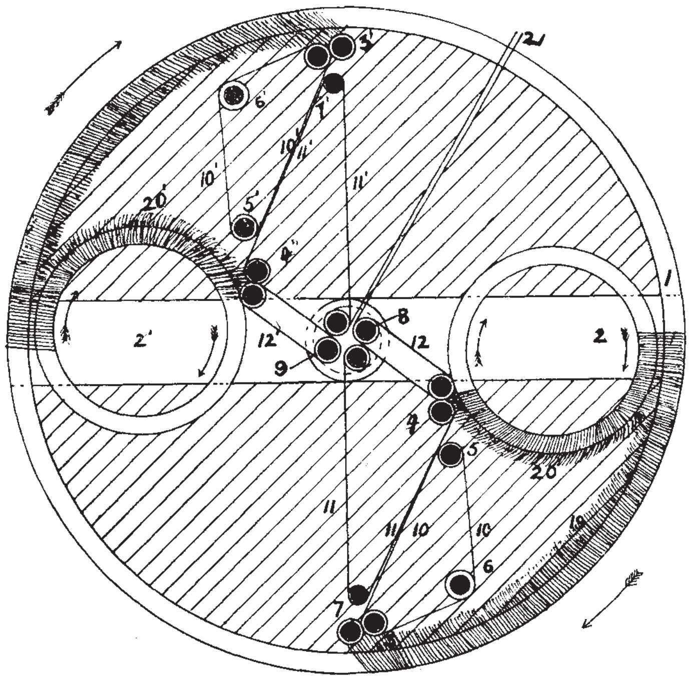


Fig. 85.

rollers 8. The leather 12^1 similarly passes round one of the drawing off rollers 4^1, and one of the delivery rollers 9, now obsolete. Additional details are shewn in Fig. 90, where 13 is a segment steel plate, described as the pressing or feed knife. It is rigidly, but adjustably, suspended concentrically between the two rows of pins arranged on the external periphery of the large circle. For finer wools this feed knife is arranged between the outside of the large comb circles and the feed boxes. The knife 13 regulates the amount of feed to the combs, and incidentally influences the quantity of noil made. A set of "plough knives" 14, is placed between each row of pins in the large circle, their functions being to raise all the wool fibres clean out of the pins immediately after they emerge from under the pressing plate 13. One of the knives 14, is detached and shewn in elevation just outside the large circle. 15 and its duplicate 15^1 are smooth, thin, "cover-plates," which are fixed over the comb circles just immediately before their point of contact. 16 is a star wheel or "divider," containing about thirty blades, which is free to rotate with a high velocity. Its function is to assist in the complete separation of the fibres as they are being drawn through the pins of the two comb circles, and also to stroke the fibres projecting from the small circle, in the direction of the rotation of the circle. 17 and 17^1 are sets of thin steel plates, termed "noil knives." They are placed separately and concentrically between the rows of pins in the small circles. 18 and 18^1 are respectively receptacles designed to catch and convey or store the "noil" lifted out of the small comb circles. 19 indicates the fringe of combed fibres which have been drawn through the pins of the small circles. 20 and 20^1 are the fringes projecting from the pins on the external periphery of the small circles, after being drawn through those of the large circle. The drawing off rollers complete the combing operation, and with the aid of the leathers, whose function is in part similar to that of the stroker upon the projecting fibres, convey to the "funnel" the four slivers, where they are combined

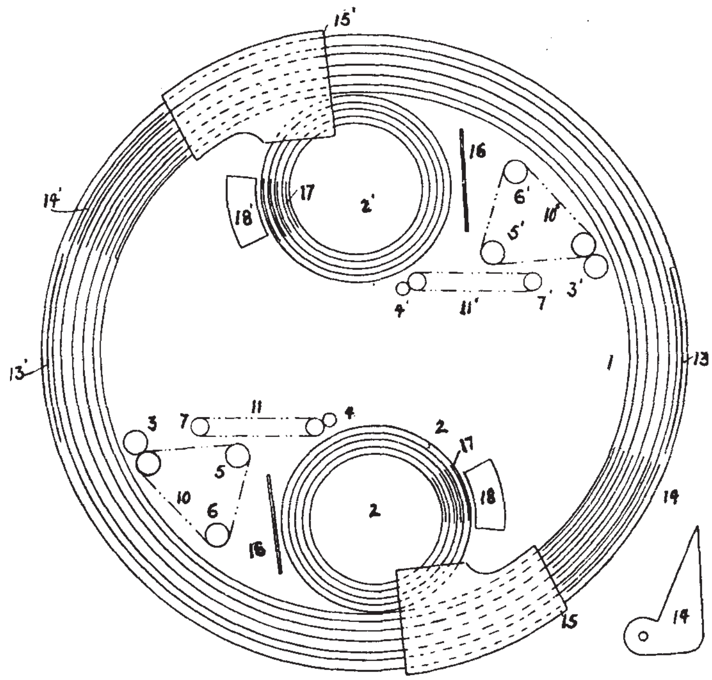


Fig. 86.

into a rope-like thread 21, designated *top*. The sliver, as it passes through the funnel, receives a certain amount of artificial twist which enables the combed top to hold together until required for the next operation.

Fig. 87 is a vertical sectional illustration of a Noble combing machine, which was the standard type until the introduction of ball bearings. A consideration of this diagram will serve to illustrate not only the position and relation of the various parts of the machine as it still exists, but also to show the process of recent evolution.

M indicates the driving pulleys fixed on the horizontal shaft N, which, by means of bevel wheels, drives the two upright shafts P. These pass down two pillars K to the gearing plate, and carry the wheels for turning the different revolving parts. G is a revolving rack or carriage, which is one of the peculiar features of the machine. It has attached to it the feed boxes R and large circle T, as well as the creels *a* for the balls of wool. Its inner face is annular and has spur teeth, which gear with a small wheel driven from the shaft P. The circle varies in size, according to individual requirement, from 48 to 60in. being the usual size. It consists of a brass foundation, which fastens on to the rack by means of screws, its width varying according to the quality of the wool. Aroung the outside edge of the rack are the feed boxes R and R^1, seventy-two in number, each fixed to a short stud by a hinge joint so as to admit of their position being readily altered when required. When the wool is in the pins the front or " nose " of the box is almost level with the top of the brass, as shown at R, but by sliding up the inclined plane Z the front portion is raised as at R^1 to facilitate the ends being lifted out of the circle, in order that they may be placed over both sets of pins in readiness for the dabbing brush. They are rectangular in form, and generally made of brass, with a heavy lid, hinged at the back so as to allow it to compress the sliver at the point where it emerges on to the circle, in order to prevent it being drawn back. The dabbing brushes S have a rapid up-and-down motion which is required to

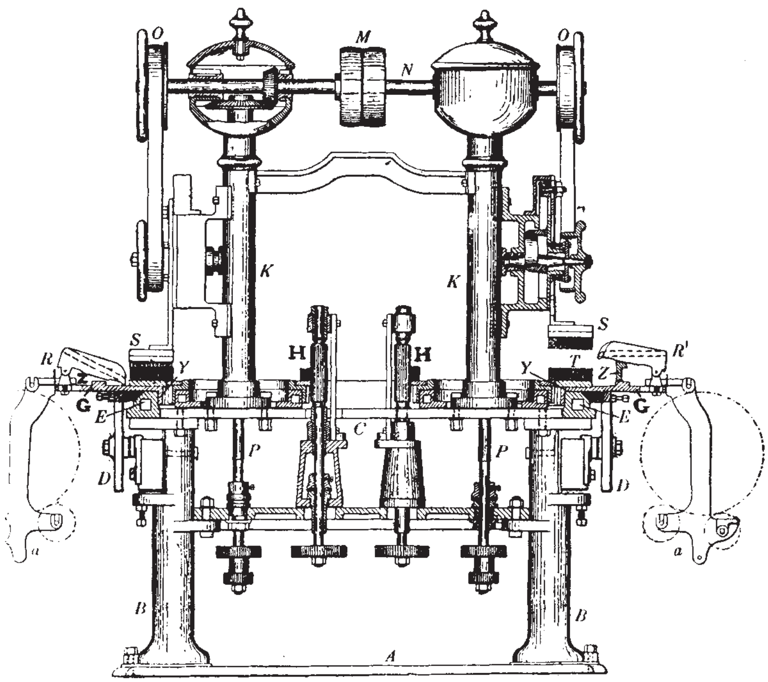


Fig. 87.

press the wool well into the pins of both circles. They are placed immediately over the point where the circles meet, and are frequently driven by a strap from the shaft N by means of the pulleys O. It is essential that they should give a quick, clean dab, so as to prevent any of the fibres getting displaced as the circles move. E is a steam chest placed just beneath the large circle in order to heat the pins and cause the wool to work more easily and freely. A similar arrangement will also be seen under each of the small circles. D represents adjustable anti-friction rollers upon which the carriage rests so as to render it easy to turn. It is necessary that it should run lightly and in a perfectly true path. To this end there have been introduced several devices which will be dealt with after a general idea of the construction of the comb as a whole has been given. The drawing-off rollers HH for the small circles must of necessity have a small diameter so as to enable them to be placed close to the pins. Z is the inclined plane placed underneath the feed boxes, just in front of where the circles meet. It is about a yard in length, and curved to correspond with the carriage, and is attached by a bracket to the table underneath the carriage. It is stationary, so that as the feed boxes are carried round, they are raised. Being provided with screw adjustments the inclined plane can be raised or lowered according to requirements. The slope during the ascent of the boxes is gradual, but the descending portion of the plane is steep. B represents the comb-legs, and A a foundation plate on which the machine is built to ensure rigidity and steady running.

The action of the mechanism will be best understood if the course of the wool be traced from the feed to the delivery end of the machine. Beginning at the point where the large and small circles meet, *i.e.*, where the wool is dabbed into the pins of both circles, as the circles 1 and 2 separate, the fibres stretched between them are divided by the stroker wheel 16, Fig. 90, and the ends projecting from the small circle are turned in the direction of the drawing-off rollers. The fringe on the inside of the large circle is conducted by the leather 10 into the nip of the rollers 3, which take all the fibres they can seize and form them into a small sliver. These rollers are all of the fluted type and are positively driven. Being vertical, some difficulty is often experienced in getting even weight at each end, but several devices have been introduced by which this can be secured. The wool has here been drawn off close to the pins, consequently before any more can be combed the position of the wool in the pins must be changed. It now passes under the press plate 13 while the feed boxes R begin to ascend the inclined plane Z, the result being that a certain quantity of wool is drawn from the ball. It is here that the amount of noil is regulated. The press plate may be raised or lowered by means of screws as required. When depressed it causes a greater length of sliver to come forward, since the distance from its base to the nose of the boxes is increased as they gradually rise. After emerging from under the plate, the feed boxes still passing up the inclined plane, the wool is gradually lifted out of the circle, until it is clear of the pins, the operation being assisted by the knives 17, which are placed between the several rows, as shown. From here the wool passes on to the cover plate 15, which is fixed over the top of both circles so as to prevent the ends from coming in contact with the pins. The boxes are now on a level with the plate, and the slack portion of the wool drawn through by the press plate naturally straightens itself out and overlaps both circles as they approach each other. Reaching the end of the cover 15, the feed boxes begin to descend rapidly and the wool is laid on the top of the two series of pins, when it is immediately dabbed into them by the dabbing brush, after which the process just described is repeated. Coming now to the small circles: they carry away all the noil and the fringe of fibres which have been drawn through the pins of the large circle. The longest of these fibres are removed by the rollers H, and combining with the slivers from the other sets of rollers, go to form the top. It will thus be seen that there are four ends drawn off and made into one. All the fibres which can be utilised have now been drawn off, and only the noil is left in the pins. This is lifted out by the set of knives 17, and falls over into the receptacles 18, placed to receive it.

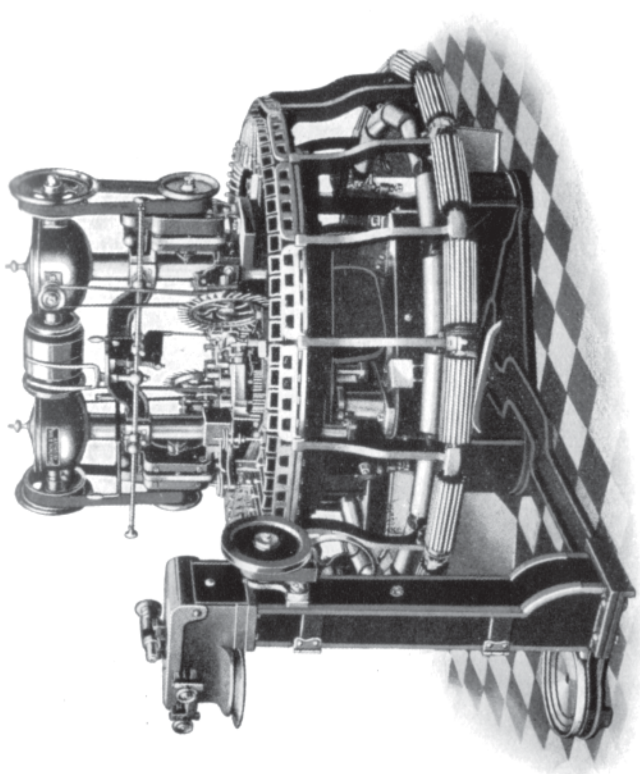


Fig. 88.
The Noble Comb with Detachable Pillars.

CHAPTER XXIV.

THE MODERN NOBLE COMB.

INNUMERABLE and many praiseworthy attempts have been made during the last few decades to perfect and standardise the Noble comb.

Attention has been devoted to the details of construction, including the design of the framework, so as to ensure greater stability in all parts of the machine than formerly, and to facilitate the changing of the circles for different qualities of wool. Roller or ball bearings have been successfully introduced in lieu of "disc runners" for supporting uniformly the comb circles, reducing the amount of friction when turning and economising the driving power required.

Dabber steel blades are supplanting the dabbing brushes, and a further invention is being introduced to obviate their use entirely.

Minor details such as ball feed, feed knife, drawing off rollers and leathers, and noil brushes, have all received their due share of attention. The main principle of combing nevertheless remains unchanged.

Prince Smith's Noble Comb.

This comb is constructed with detachable pillars which enable the comb circles to be readily changed

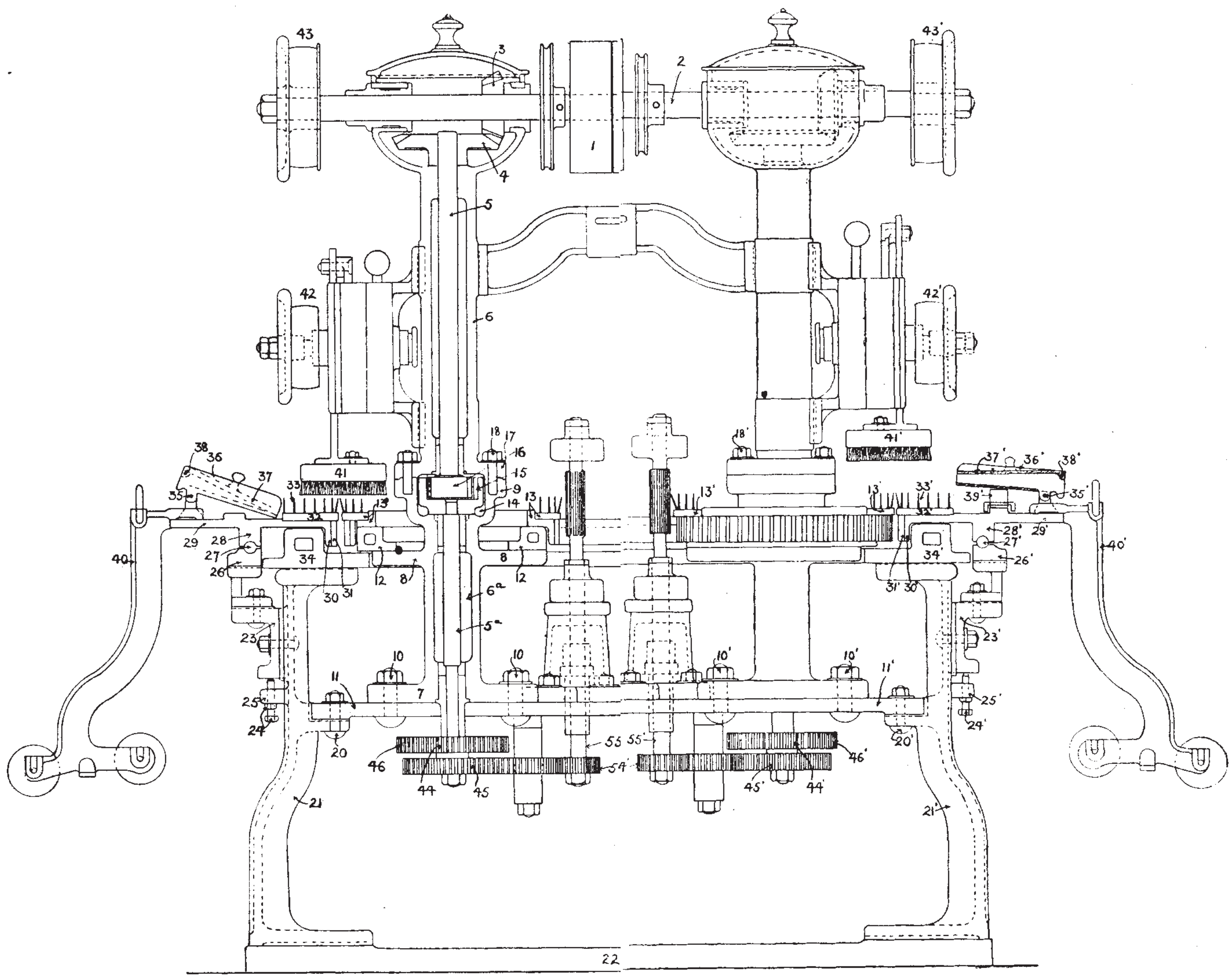


Fig. 89. Fig. 90.

without the necessity of removing the cross or pulley shaft, or having to lift the comb circles over the top of the pillar shafts as formerly. Its general construction is good, and its equipment in respect to details embodies all the recent improvements of approved experience.

Fig. 88 is a perspective view and Fig. 89 is an elevation in section of one half of this type of the Noble comb.

Fig. 90 is an elevation, partly perspective, of the complementary half of this same comb.

Fig. 91 is a plan of the pinion wheel compounded with the base of the upper pillar shaft and intermeshed with that of the annular wheel compounded with the top of the lower pillar shaft.

Fig. 92 is a vertical section, on a larger scale, prepared to illustrate more distinctly the compounding of the upper and lower pillars.

Fig. 93 shows in elevation the manner of detachment of the upper part of the pillars and pillar shafts, together with the cross shaft and driving pulleys lifted clear of the comb circles.

Fig. 94 is a plan of the comb circles, drawing off rollers, leathers, combed fringes and the noil brushes.

Fig. 95 shows a plan of the gearing details.

Fig. 96 is a line diagram in elevation illustrative of the annular driving of the comb circles.

Fig. 97 is a similar detailed line diagram in elevation showing the driving of the drawing off rollers.

Other important items such as feed, dabbing brushes, knocking off motions, etc., are considered under their respective headings.

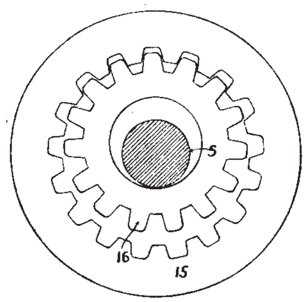


Fig. 91.

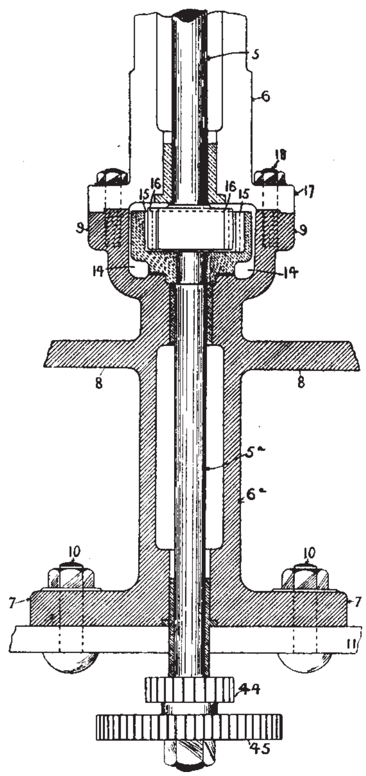


Fig. 92.

The same numerals in each diagram refer to corresponding details.

The machine driving pulleys, one of which is fast and the other loose, are indicated at 1, on the cross or horizontal shaft 2. Compounded with the shaft 2 is a driving bevel 3 which gears into and drives the bevel wheel 4, keyed fast to the pillar shaft 5. The pillar shaft 5 is supported by, free to revolve in the centre of, and concentric with the pillar 6.

The pillar 6 and pillar shaft are each made in two parts; the lower part or base column 6a is constructed with three flanges, 7, 8 and 9; nuts and bolts 10 combine rigidly, the bottom flange 7 with the gearing plate 11; the middle flange 8 is annular and supports the small annular steam chest 12 arranged under the small circles 13; the top flange 9 is formed with a cavity 14.

The lower pillar shaft 5a has compounded with its upper end an annular toothed wheel 15 which is free to rotate in and concentrically with, the cavity 14. A spur pinion 16 is compounded with the base of the upper shaft 5 and its teeth intermesh with those of the annular wheel 15 so that both wheel and shafts are free to rotate in unison; a flange 17 is formed at the base of the upper pillar 6; bolts and nuts 18 combine this flange with that of flange 9, so that the pillars 6 and 6a are virtually one and the same. See drawing on larger scale, Fig. 92.

The gearing plate 11 is secured by bolts and nuts 20 to the legs 21 of the comb as shown. The legs of the comb are designed as in the illustration with a special spreading formation, the feet of which are secured to the foundation plate 22. The object of the design is to

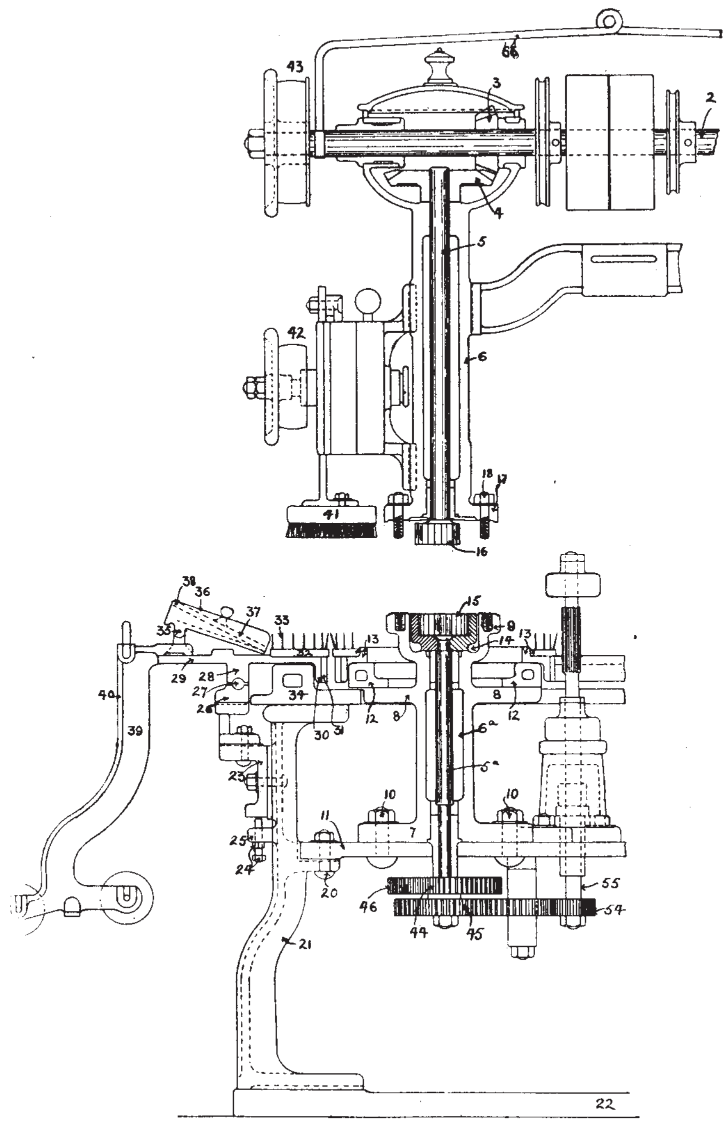


Fig. 93.

give a wider base and to ensure perfect rigidity to the whole comb, a difficult operation considering the amount of leverage which the driving shaft 2 exercises in response to the pull of the driving belt.

An adjustable chair bracket 23, in two parts is bolted fast to the leg 21 as shown. The adjustment is completed by the set screw and lock nut 24. A fixed projecting "lug" 25 in leg 21 is bored and threaded to receive the set screw 24 which is adjusted into supporting contact with the base of bracket 23. An annular frame 26 is supported on the adjustable chair 23.

A semi-circular groove is cut in the upper surface of the frame 26 and into this groove, steel balls 27 are placed. In this comb there is room in the ball race for 173 one inch balls, but usually only 172 are inserted. A similar groove is cut in the underside of the projecting flange ring 28 compounded with the base of the comb plate 29. The groove in the flange ring 28 rests passively on the balls 27 but clear of frictional contact with the carrying frame 26. Compounded with the inside of the comb plate 29 is a second depressed annular flange 30 on the periphery of which is formed the annular rack teeth of the large circle. Set screwed to the upper and inner circle of the comb plate 29 is a brass foundation 32, studded or "set over" with comb pins 33.

The steam chest is annular and supported on the top of the legs 21 but sufficiently clear of the comb plate 29 to avoid frictional contact with it when the latter revolves. The depressed flange rings 28 and 30 partly enclose the steam chest 34 and serve to concentrate the heat for the large circle. Four small holes formed in the flange ring 28, at equal distances apart, permit the space between the steam chest and comb plate to be tested at will.

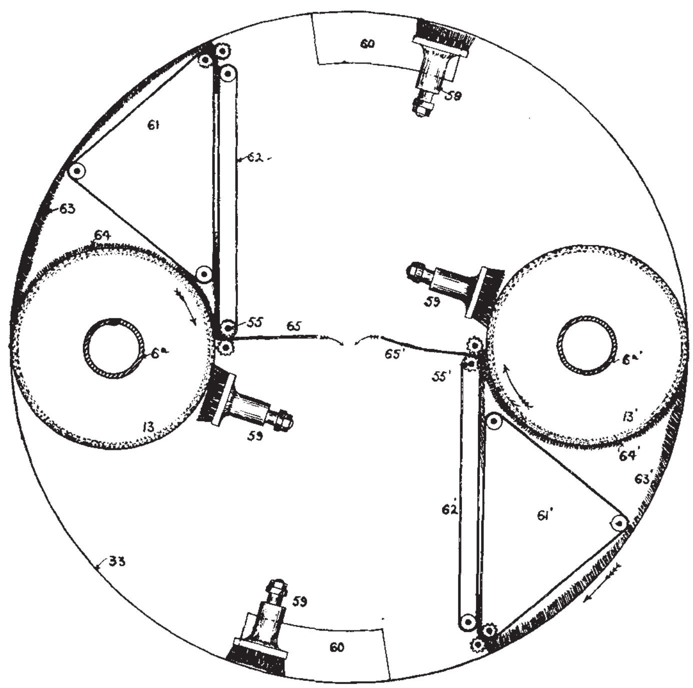


Fig. 94.

Compounded with the comb plate on the upper surface and near the outside are a bracket and stud 35 on which the feed boxes 36 are pivoted with their free ends resting passively in contact with the comb plate, and near to the outer row of pins in the comb circle.

The lid 37 of the feed boxes is pivoted near its outer extremity as at 38, its free and heavy end rests normally against the base plate of the feed box, close to its inner and delivery end. The inclined plane up which the feed boxes slide when drawing off a fresh supply of wool is shown at 39^1, Fig. 90.

Also compounded with the comb plate 29, and near its outer extremity, is the creel 40 for carrying the balls of sliver, separately illustrated and described later. The dabbing brush 41, together with its details, is adjusted to the pillar 6 as indicated. The driving pulley combined with the eccentric is shown at 42, and its driving pulley 43 is combined with shaft 2. The details of the dabbing brush and double eccentric are separately illustrated at Figs. 123 and 124, and described on pages 374 to 378.

Driving the Circles and Drawing off Rollers.

Near the base of the lower pillar shaft 5a is a double stud wheel 44 and 45, keyed and secured as shown. The stud pinion 44 intermeshes with and drives, through an intermediate wheel, the spur wheel 46 which is keyed fast and near the base of the rack shaft 47. See Figs. 95 and 96.

The rack shaft 47 is supported in a vertical plane from the gearing plate 11. A spur pinion 48 near the top of this shaft gears into the rack teeth 31 on the inner periphery of the large comb plate 29 and drives it. Compounded also with the rack shaft 47 is a third spur pinion 49, the teeth of which intermesh and drive a spur pinion 50 keyed fast to an adjustable vertical shaft 51. A second spur pinion 52 gears into the teeth of the small circle 13.

Reverting to the stud wheel 45 which is the source of movement to the drawing off rollers, the following is briefly a description of the arrangement for same. The

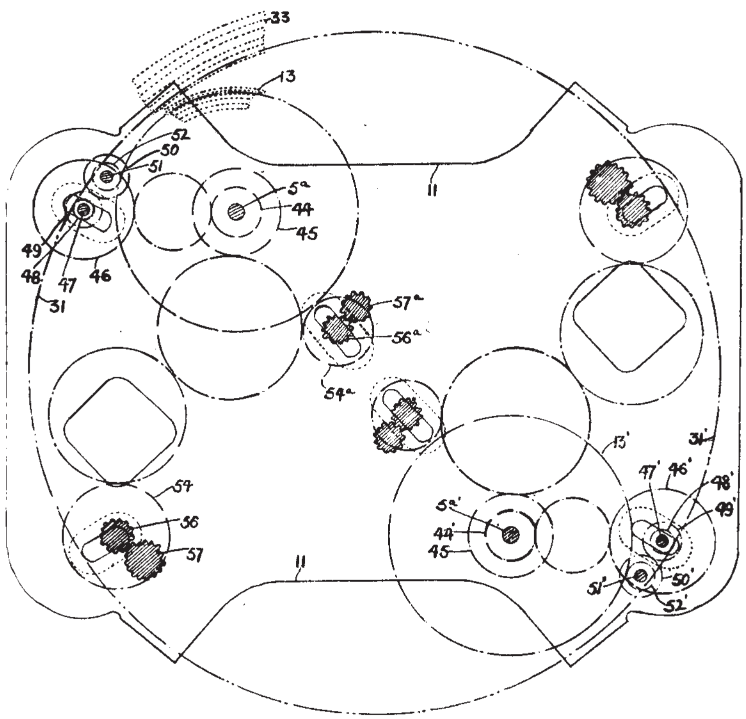
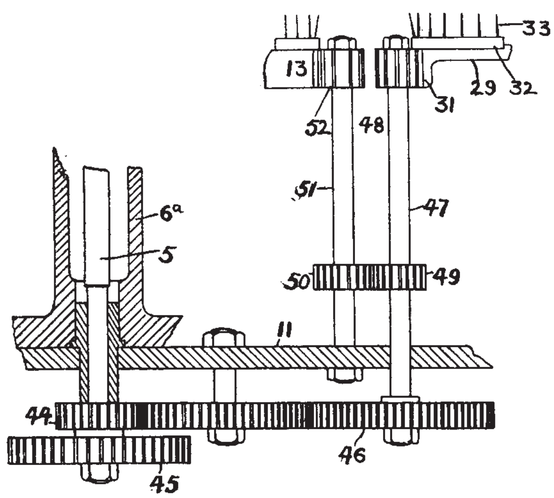


Fig. 95.

stud wheel 45 drives, through an intermediate, the spur pinion 54 compounded with and near the base of the upright shaft 55 (see Figs. 95 and 97) also supported from the gearing plate 11. The fluted roller 56 is com-

Fig. 96.


33
13
29
32
31
52
48
51
47
6a
5
50
49
11
44
46
45

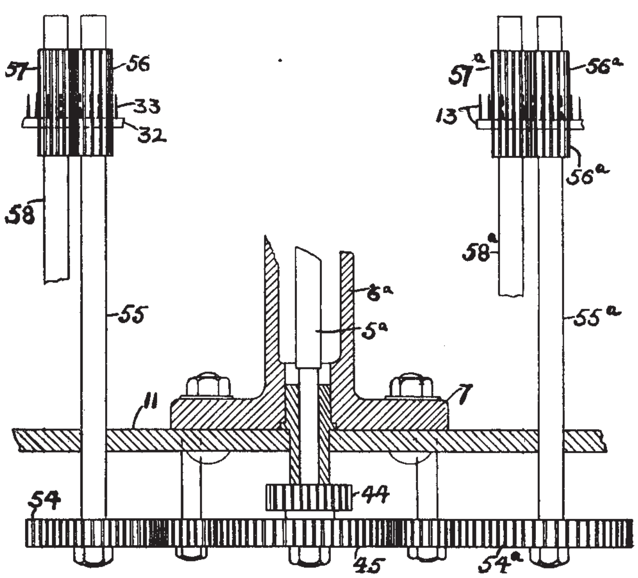

57
56
33
32
58
57a
56a
13
56a
58a
55
6a
5a
55a
11
7
44
54
45
54a

Fig. 97

pounded with the shaft 55 near the top as shown ; the second fluted roller 57 on shaft 58 is driven through the contact with the fluted rollers 56.

All the parts enumerated are duplicated for the second small circle and are correspondingly represented by numerals 54a to 58a inclusive. The values of these trains of wheels and their influence on the combed top are subsequently dealt with under the heading of Drafting in the Noble Comb.

In the plan Fig. 94, details not hitherto described are shown, viz. :—the relative positions of the noil brushes 59, bracket support for same 60, the conveying leathers 61 and 62, and the combed fringes 63 and 64 together with their duplicates. The combed top directed towards the usual funnel is indicated at 65.

Alternative Form of Detachment of Pillars and Shafts.

Fig. 98 shows, partly in elevation and partly in section, an alternative form of detachment of the pillars and pillar-shafts, as designed by T. Middlemiss, of Bradford. The consideration of this, apart from the principle involved, should prove helpful, as do most comparisons of machine details. The illustration shows the overhead and detachable parts of the machine, lifted and held in suspension by pulley blocks, clear of the lower and fixed parts, as it is when ready for the removal of the comb circles.

Fig. 99 shows a plan of the lower pillar and pillar-shaft with square socket. The chief features and functions of this mechanism may be described as follows :

A indicates the upper part of one of the usual pillars, the base of which is constructed with a flange as shewn at B. The lower part of the pillar A^1 is designed with an upper and a lower flange, D and E. This pillar A^1 is bolted through the lower flange E to the common cross-plate F, as shewn. The pillar shaft G G^1 is also in two parts: the upper part G, is geared and driven, as shewn, from the usual cross driving shaft H. The base terminal of the pillar shaft G is reduced to form a stud, I, of square section. A plan in section of this is shewn at the side. The lower pillar shaft G^1, passes concentrically through the pillar A^1, and is supported by it. The diameter of shaft G^1 near the top is greater than that of the lower portions. The shoulder of the greater portion rests on a complementary shoulder recessed within the walls of pillar A^1, as shewn. (See also plan, Fig. 99). A square socket J, the complement of the stud I, is sunk into the top of shaft G^1, which passes through, and is adjusted to the gearing plate K, being in turn bolted as at L to the machine support M. When the pillar A, the shaft G, and their duplicates are lowered into position, the flanges B and D are bolted fast to each other. The square stud I in shaft G coincides exactly with the square socket J, in the shaft G^1. The rotation of the upper pillar shaft G, causes the rotation of the lower shaft G^1, which, through its usual connections, communicates motion to all parts of the machine.

Fig. 98.

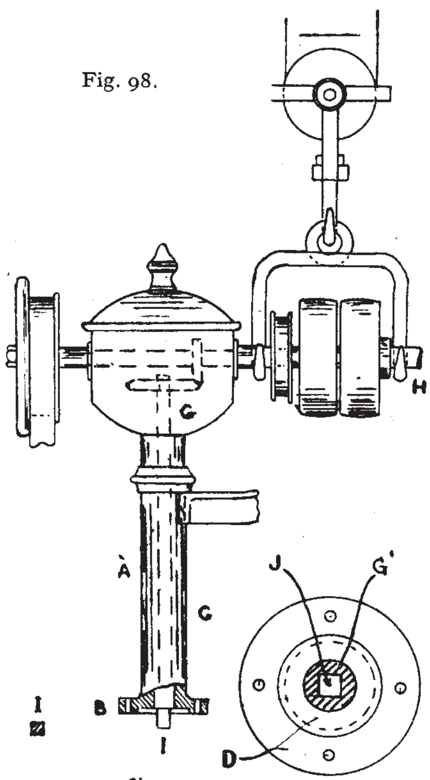


Fig. 99.

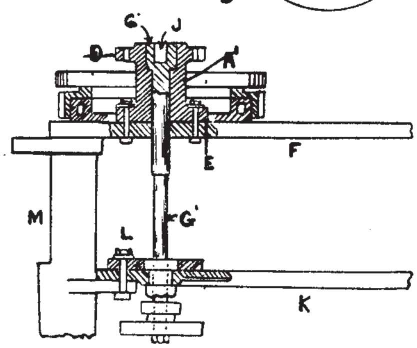


Fig. 98.

Construction of Comb with Pillars outside the small Circles.

Fig. 100 shows a sectional elevation of the Noble comb, as made by Taylor, Wadsworth & Co. The special feature of this design is the placing of the pillars in the angles between the large and small circles, instead of, as formerly, in the centre of, and concentric with the small circles. The obvious object of this arrangement is to facilitate the removal of all three circles without disturbing the pillars.

Fig. 101 shows in plan the relative positions of the circles, pillars, drawing off rollers, and noil receptacle.

Fig. 102 indicates, in elevation, the noil removing arrangement and receptacle.

Fig. 103 shows in part plan the modified arrangement of the dabbing brush necessitated by the placing of the pillars outside the small comb circles. The same numerals in each diagram refer to corresponding details. 1 is the pulley shaft ; 2, the fast and loose pulleys ; 3, a driving bevel containing sixteen teeth, and keyed fast to shaft 1, driving a second bevel wheel which contains thirty-two teeth, and is, in turn, compounded with the vertical pillar shaft 5. The pillar shaft 5 passes concentrically through pillar 6, and is supported by it. The pillar 6, together with its duplicate 6^1, is bolted to and supported by the usual cross plate 7. The pillars 6 and 6^1 likewise support the cross shaft 1 and the dabbing brushes, together with their special carrying brackets, to which subsequent reference is made. The cross plate 7 is supported by four short pillars 8, only two of which are shown. The pillars 8 rest securely on the gearing plate 9, which is compounded with the legs 10 and 10^1. The cross section of these legs or supports is a quadrant of a circle. The base of each support is turned out at

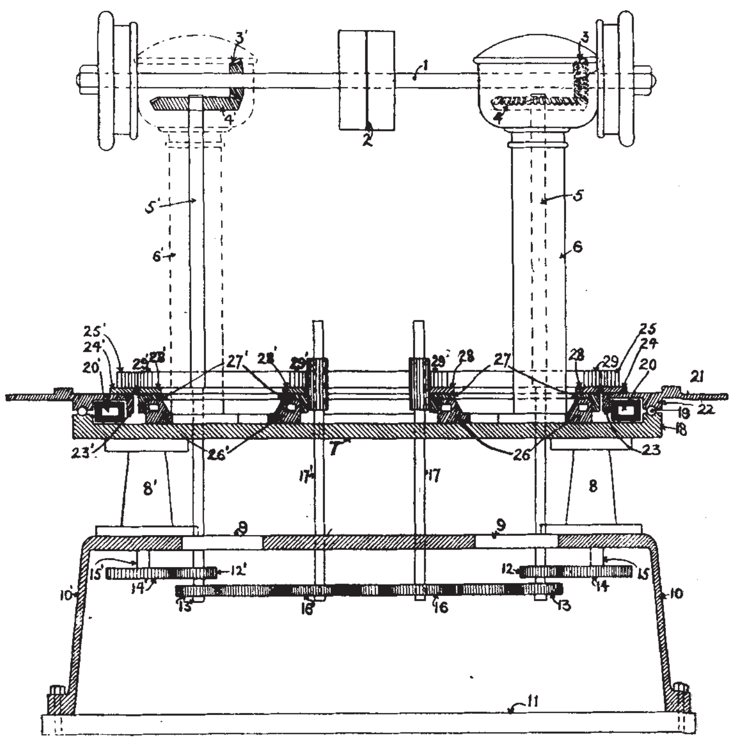
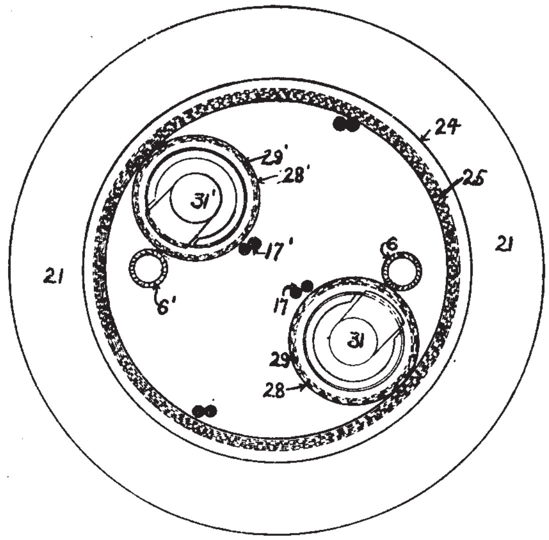


Fig. 100.

right angles to form feet, which are bolted fast to the foundation plate 11. The cross plate 7 is designed so as to pass outside and clear of the small circles. The pillar shaft carries near its base a double stud wheel 12 and 13, the pinion wheel 12 of which drives, through an intermediate, the spur pinion 14. This is compounded with, and near the base of the rack shaft 15, which, through gears similar to the arrangement shown at Fig. 96, drives the large and small circles. The stud wheel 13 drives, through an intermediate, the spur wheel 16, which is keyed fast to the fluted roller shaft 17 near its base. This shaft rotates by frictional contact the fluted pressing roller and conveying leathers for the small circle. The drawing off rollers for the large circle are similarly controlled from the same stud wheel 13. The whole of the gearing is secured by bolts and nuts to the gearing plate 9. An annular plate 18, is cast with the cross plate 7, and on the upper surface of this plate is formed a semicircular groove, into which the usual steel balls 19, are placed. The cross plate 7 supports above it an annular steam chest 20, for the large circle, special bearing strips being arranged between the cross plate 7 and the steam chest in such a manner as to permit free expansion of the steam chest. The comb plate 21, is cast with two depending flanges, 22 and 23. The former is constructed with a groove to fit over the balls 19, and to move freely in contact with them. It also partially encloses the steam chest 20. Compounded with the comb plate 21, is the brass foundation 24, studded with pins 25. The steam chest, comb plate with brass foundation, and pins for the small circles, are indicated respectively by the numerals 26, 27, 28 and 29. The noil shoot is placed inside the small circle, as at 31, Figs. 101 and 102. The noil knives 32, are arranged with the largest knife to operate between

Fig. 101.



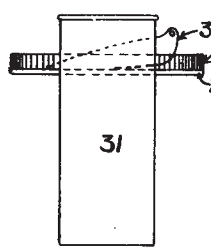


Fig. 102.

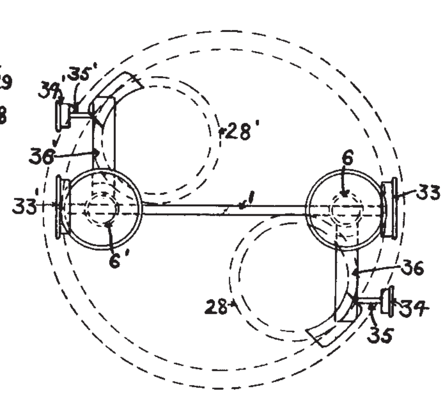


Fig. 103.

the extreme rows of pins, the remaining knives gradually decreasing towards the centre. The foregoing arrangement therefore causes the noil to fall over the pins towards the inside of the small circle, and into the shoot 31, as required. The position and arrangement of the mechanism for operating the dabbing brushes are more clearly represented by the detached illustration, Fig. 103. The driving pulley 33 is compounded with the main driving shaft 1. The driven pulley 34 is compounded with the eccentric stud shaft 35, which, it will be observed, is parallel to the main driving shaft 1. A bracket 36, projecting from the pillar 6, supports the slide box, eccentric stud, eccentric, and dabbing brush immediately over the point of contact of the comb circles, as shown. The bracket 36, together with the dabbing brush details, can be moved outside the range of contact of the circles whenever it is desired to substitute a new set.

CHAPTER XXV.

FEEDING THE NOBLE COMB.

THE method of supplying the requisite uniform quantity of sliver to the comb circles does not consist of one simple operation or process. On the contrary, it is compounded of a series of mechanisms and operations.

Feeding the Noble comb comprises essentially the following sequence of operations :—The ball creel and its rotation ; the feed or trap boxes ; the feed knife and its adjustment ; and the inclined plane, supplemented by the plough knives, the cover plate, and the dabbing brushes.

Ball Creel. The prepared sliver ball is placed upon the creel rollers which are shown in perspective at Fig. 88. These rollers are made of fluted wood or corrugated tubes. They may be made to revolve and give off the wool automatically, or be drawn round as the wool is taken forward by the feed boxes, and so give up the sliver. It is not an easy matter to make a satisfactory automatic feed motion to regulate the feed of the balls on a Noble comb, as it is a very difficult thing to prepare to exactly the same thickness each of the four slivers of which the balls are composed. It consequently follows that when the four slivers are simultaneously drawn off the same length, any variation in diameter of the slivers will result in the smaller ends gradually accumulating a slackness until they hang limp on the ball.

It might, however, be noted with advantage that the amount of sliver feed varies with the tension on the material, and this varies with the varying diameter of the four-sliver ball. Since wool is very elastic, any tension put upon the slivers between the ball creel and the feed boxes, modifies the amount of feed to the comb circle. The tension put upon the slivers decreases in sympathy with the diminishing size of the ball.

Numerous attempts have been made to feed the sliver into the comb circles with uniformity. The following methods have been selected primarily to illustrate the fundaments of the principle, and, incidentally, to emphasise the variety of effort and mechanism.

Fig. 104 is an elevation showing part of Prince Smith & Son's comb, including the ball creel and one of the feed boxes. Fig. 105 is a part plan of the same. The reference marking of like denomination in these two diagrams and the four subsequent illustrations refer to corresponding details in the comb.

A is one of the eighteen depending arms secured to the comb plate, as previously described, all of which rotate in sympathy. The base of each contiguous pair of depending arms A is constructed to support and permit the free rotation of two rollers, B and C. The outer roller, B, is fluted and provided with a ratchet wheel, to which is added a common pawl lever, shown separately at Figs. 106 and 107.

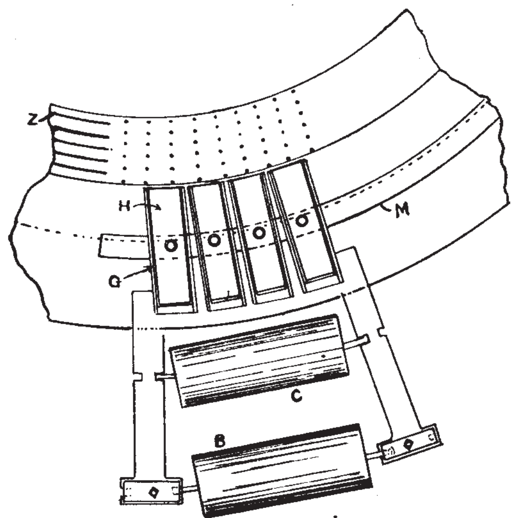


Fig. 105.

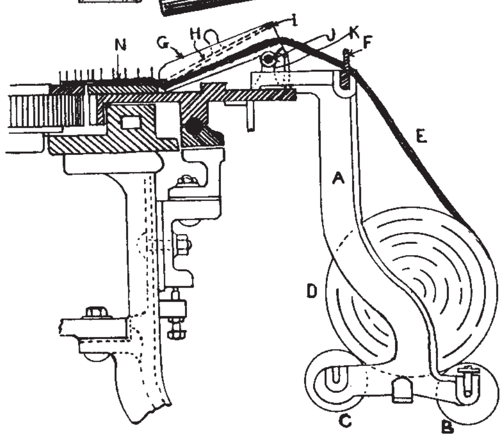


Fig. 104.

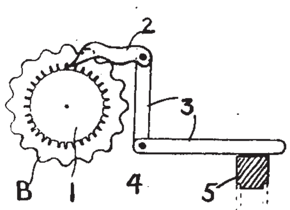


Fig. 106.

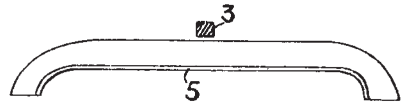


Fig. 107.

A prepared ball of wool D is placed on and between the two rollers B and C. Eighteen of these balls are required to complete the circle, making seventy-two in all. One of the wool slivers E is shown passing up to and through the guide rings F, to the feed box G and comb circles.

Feed or Conductor Boxes.

Corresponding with the number of wool slivers E, there are seventy-two "feed," "trap," or conductor boxes, G. Each feed box consists of two fixed sides, a base, and a pivoted lid H. The lid H is pivoted on the stud I which passes through the two sides of the box G, near the upper and outer end. The completed box G is pivoted on a stud J in the bracket K, compounded with the usual comb plate with which the boxes G rotate. The pivoted end of the conductor box is open, and through it the sliver E can freely enter. At the "toe," or opposite end of the box, the lid H rests normally in contact with the sliver E, by which arrangement the sliver is prevented from slipping back towards the ball D. The free end of each of the boxes G normally rests on the comb plate, just immediately in front of the comb circle, with a supply of wool normally in the pins of the large circle. The comb is initially fed by hand.

Inclined Plane.

A short distance previous to the point of contact of the two comb circles a cam incline, or segment steel bar M is fixed concentrically with the comb plate. The cam incline is about one yard in length and is adjustably attached to a bracket, which in turn is compounded with the stationary part of the machine. The inclined plane or cam incline

M is arranged under the feed boxes in such a manner that as the comb plate, with the feed boxes G, rotates, the latter gradually rise until they are in a horizontal position, as shown in Fig. 90. Simultaneously, but gradually, the slivers E pass under a stationary pressing or regulating knife designed to retain the sliver in the pins of the large comb circle. Then since the sliver E cannot slip backwards through the conductors G, owing to the resisting action of the lid H, it must as a consequence be drawn from the ball D. The length drawn off—about one inch—together with that already in the pins of the large circle, is sufficient to cover the set over of the small comb circle.

The common method of "giving slack" to the sliver E at the moment when the "trap" boxes G are travelling up the inclined plane, is to operate simultaneously two pairs of contiguous creel rollers B by a separate pawl lever and ratchet wheel. This arrangement, though primitive, is still extensively employed. Figs. 106 and 107 are line diagrams which illustrate the principle. A ratchet wheel 1 is compounded with one of the ends of the fluted roller B. A ratchet pawl 2, pivoted near the top of the vertical arm of the bell crank lever 3, is free to turn the ratchet wheel 1 and creel roller B in the direction which slackens the sliver. The bell crank lever 3 is pivoted on stud 4, the whole being supported by, and rotating in sympathy with the creel frame.

Opposite each point at which the sliver has to be fed into the comb there is fixed a stationary cam plate 5, shaped as shown separately at Fig. 107. Then, as the ball creel rotates, the horizontal arm of lever 3 comes in contact with the face of the cam plate 5, and gradually rises as it travels over it, by which means the vertical arm with the pawl 2 is slightly rotated about the pivot 4, and the ratchet wheel I with the creel roller is likewise rotated, causing a slackening of the sliver E to facilitate its passage through the feed boxes G at the moment when they are passing over the inclined plane. It is important to note that the above "picking motion" rotates the creel roller B equal distances at each operation, whether the sliver is large or small. If the lengths thus reeled off are not immediately absorbed by the comb and feed motion, this slackness of sliver remains or accumulates.

Feed Knife. The arrangement of the feed knife is illustrated separately at Figs. 108 and 109. The former is an elevation, partly in section, and transversely through the large comb circle. The latter illustration is a front elevation of the feed knife, together with the supporting bracket. The illustrations are from details applied to the Noble comb by the Patent Conveyor Company, Bradford.

The mechanism and its function may be described as follows :—M is the cam incline ; N the large circle ; O the comb plate ; P the balls ; Q the annular ring, compounded with the stationary and supporting part of the machine. A bracket R, shown partly in section, is secured by the set screw S to the steam chest T, or other stationary part of the machine. An adjustable sliding plate U is secured through the projecting wings V and V¹ by the set-screw W, as shown. The regulating or feed knife is fastened by the screws Y to the adjustable sliding plate U. Without labouring the subject it will be evident that the sliding plate U, together with the feed knife X, may be finely regulated by the adjusting screw W, to increase or decrease the amount of feed required.

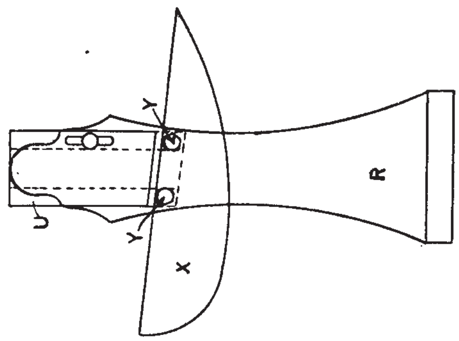


Fig. 109.

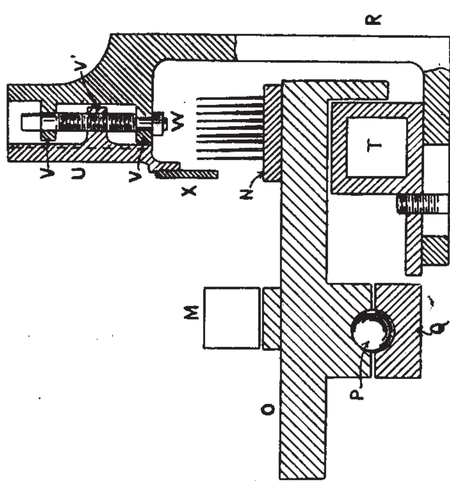


Fig. 108.

This fine adjustment is the special feature of this arrangement.

In some instances a micrometer scale is attached to the end of the feed knife, and a pointer fixed in the stationary bracket R, by which addition the feed knife X may be fixed to the same standard position determined by experience, and only altered by a responsible person as required.

Clearer Knives and Comb Cover. Then as the conductor boxes and comb continue to rotate, a series of triangular knives Z is placed between the rows of pins of the large circle, and these lift the sliver gradually out of the large comb circle until it is clear and above the pins. At this juncture a smooth steel plate (see Fig. 86) covers the pins of both comb circles. The sliver gradually passes over this plate, and naturally straightens out until it reaches the point of contact of the comb circles, when it falls over the top of the pins, to be immediately pressed down into them by the dabbing brush.

Automatic Feeds.

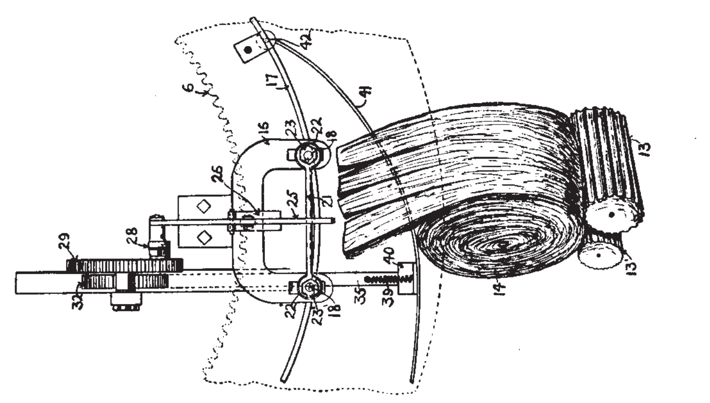
The desire to automatically maintain a constant and uniform supply of sliver to the comb circles has been attempted by quite a number of interested parties, including both machine makers and combers.

The gradual decrease in the size and weight of the balls causes a variation in the tension on the slivers which are being fed to the comb circles. With the object of making the tension and feed uniform, various devices have been introduced. A few of the chief, together with their essential details of mechanism are set forth in the succeeding pages.

The following arrangement by the Goodall Worsted Co., Sanford, U.S.A., though possessing merit, is not put forth as a complete solution of the difficulties (see text, pages 345 and 346). Fig. 110 is an elevation of the comb with the feed attachment. Fig. 111 is a part plan with ball and creel rollers, in perspective. Figs. 112 and 113 are details to be referred to in the subsequent text. Similar numerals of reference in each diagram indicate corresponding details. 1 is a section of part of the machine support. 2 is an annular bracket bolted fast to the main support 1. The usual annular ball race is indicated at 3, resting securely on the annular bracket 2. The steam chest is shown at 4; the comb plate at 5, with rack teeth 6, brass foundation and pins 7, balls 8, feed box 9 pivoted at 10, and the cam or inclined plate at 11.

Depending from the external periphery of the comb plate 5 are brackets 12, which, at their base, support steel rollers 13 and 13^1, on which the sliver balls 14 are placed. The sliver guides are shown at 15. A bracket 16 is bolted to the fixed annular part of the machine and projects over the comb pins as shown. This bracket carries all the fixed and adjustable supports for the feed knife 17 (see also Fig. 112). Two vertical rods 18 and 18^1 are guided in bearings 19 which are held in position by nuts 20. A link 21, with loops 22 and 22^1, connects the two rods 18 and 18^1 through the medium of lock nuts 23 and 24. A lever 25, centred and pivoted to the fixed bracket 26, is slotted as at 27. The link 21 is passed through the slot 27 of lever 25 and is thereby supported and controlled. The lever 25 is also attached to the link 28. The link 28 is combined with the spur gear 29 through the stud 30, set out of centre. The gear 29 intermeshes with the stud pinion 31, compounded with stud wheel 32, which is mounted and free to totate on stud 33, supported in the fixed bracket 34. The stud gear 32 intermeshes with the teeth of rack 35. This rack is mounted and free to slide laterally and radially to the machine (see also Fig. 113). A cord 36 fastened to the rear of the rack bar passes over a free pulley 37. A weight 38, attached to the free end of the cord 36, tends normally to pull the rack bar outwards to the right, in the direction of the sliver ball 14. The right and forward end of the rack bar is connected by a spiral spring 39 to a small bracket 40, which is in turn combined to the free end of a metal strip 41, pivoted below the feed knife to the machine framing at 42. The metal strip 41 is the special feature of this arrangement of mechanism. It is curved downwards and outwards in such a manner that it makes contact with each ball 14 as the latter rotates into the position opposite the feed knife.

Action of the Mechanism. With the bodily rotation of the ball frame and balls, each ball as it comes in contact with the metal strip 41 causes the free end of the latter to yield to the gentle pressure thus brought to bear upon it. The metal strip 41 then acts through bracket 40 to move the rack bar 35 radially towards the centre of the machine, and through it to turn gears 32 and 31 clockwise, but the gear 29 with eccentric stud 30 counterclockwise, so that the link 28 rises with the inner arm of lever 25, and the outer arm descends with the vertical rods 18 and the feed knife 17, to put the maxi-



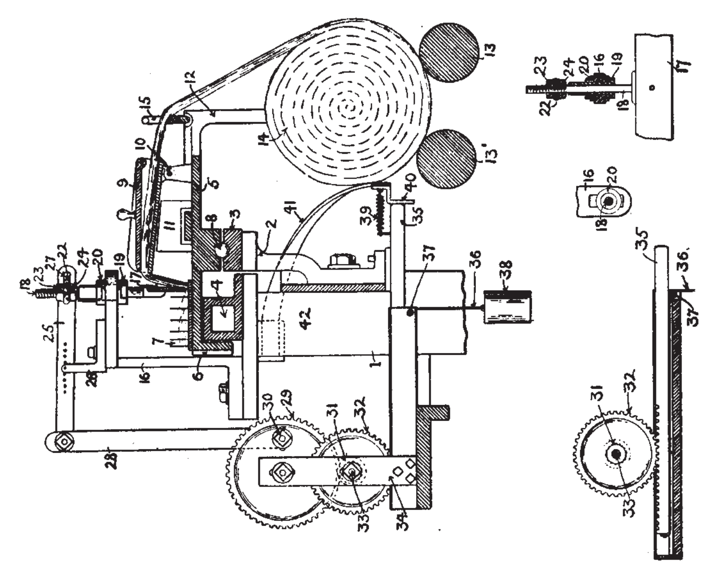


Fig. 112.

Fig. 113.

mum pressure on the sliver 14 for a full ball, and the minimum for an almost empty ball.

Flax Syndicate Automatic Feed. Though the Noble comb is almost exclusively used as a general purpose comb in the worsted trade, efforts have nevertheless been made to employ it for combing flax and like vegetable fibres.

The flax slivers are first wound, under heavy pressure and very hard, on to a double-headed bobbin or barrel without flanges. Any tendency of the slivers to hang slack between the balls and the conductor boxes is more detrimental to the non-elastic flax than to the worsted material. The tight slivers are liable to break, and the slack slivers cause too much waste.

In December, 1897, the Flax Combing Syndicate introduced an automatic feed to this comb, the distinctive principles of which were new.

Each roll or ball of four slivers is mounted in the outer free arm of a balk or rocking lever, radially adjusted to the comb circle, and pivoted to the revolving creel frame. The inner arm of this rocking shaft is designed to slide intermittingly in contact with a fixed cam plate, the function of the mechanism being to automatically raise the ball and slacken the slivers at the moment when the conductor boxes are passing over the inclined plane.

The essential features of the mechanism are illustrated at Figs. 114 and 115, of which the former is a sectional elevation, and the latter a plan. Letters of like denomination occurring in the different diagrams

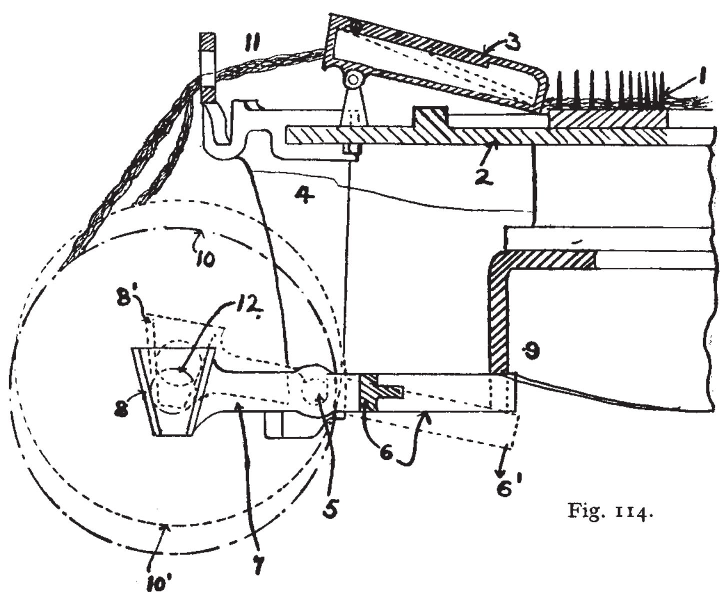


Fig. 114.

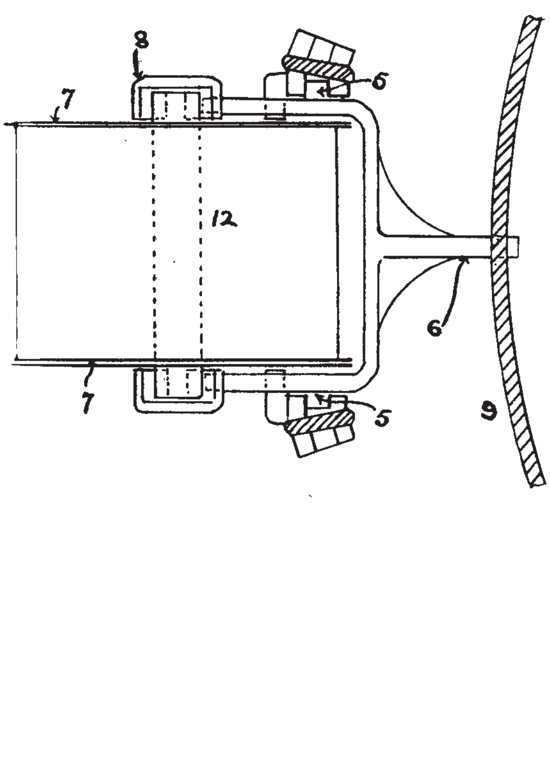


Fig. 115.

refer to like parts. 1 is a transverse section of the large comb circle and brass foundation, and 2 a section of the comb plate. 3 shows one of the conductor boxes, and 4 the ball creel. Mounted on the stud 5, near the base of creel 4, is a rocking lever comprising inner and outer arms 6 and 7. The outer and free arm carries a specially constructed V-shaped bearing 8. The projecting ends or trunions carrying the balls rest freely in the V-shaped groove. The inner arms 6 intermittingly pass under a stationary cam plate 9. The balls or bobbins are shown at 10 and the slivers at 11.

The action of the mechanism is briefly as follows :—coinciding with the period when the conductor boxes are ascending the usual inclined plane to draw the sliver 11 from the balls 10, the latter automatically rise and slacken the sliver. The elevation of the balls is achieved by arranging that the lever arm 6 shall pass under the face of cam plate 9. The inner arm 6 is consequently depressed, but the outer arm 7 is, conversely, raised together with ball 10. The relative positions of the raised bobbin 10 and slackened sliver 11 are indicated at 10^1 and 11^1 respectively. The arrangement as described permits the feeding apparatus to draw forward freely the required amount of sliver with the minimum amount of tension, from the given ball. Immediately the feeding of this section of the comb is complete, the design of the cam plate 9 permits the outer arm 6 to ascend, which is facilitated by the gravitation load of the ball and the weight of the outer lever arm 7. The descent of the ball 10 to its normal position *takes up the slack remaining in the sliver*, which is further drawn off the ball as it descends to its lowest position. The retaining action of the conductor boxes is a further factor which contributes to this end.

Taylor and Wordsworth's Automatic Feed.

Recently an automatic feeding arrangement, based on the same principle of *lifting the balls* together with the creel rollers, has been introduced by Taylor and Wordsworth. Fig. 116 is a front elevation showing the essential parts of the mechanism of this arrangement. Fig. 117 is a vertical section of the same. Fig. 118 is a plan of the creel rollers with supporting bar. The corresponding numerals in each diagram refer to similar details.

The numerals 1 to 7 inclusive indicate well known parts hitherto described. The ball 8 rests freely on the creel rollers 9, supported and free to rotate in the ends of a carrier frame 10. A tie bar 11 provided with a perforator 12 and sockets or guides 13 and 13^1, links together two consecutive depending arms 6. A vertical depending stud 14 is cast or otherwise compounded with the cross bar of carrier frame 10. The stud 14 passes freely through the perforation 12, and carries near its base an anti-friction roller 15. Two additional studs 16 and 16^1 are screwed into the under side of the cross bar of carrier frame 10. These studs respectively fit into, and are free to slide in the sockets or guides 13 and 13^1, their function being to ensure a true vertical reciprocation of the carrier frame 10. A cam incline 17, which is adjustable, is secured through bolt 18 and bracket 19 to the machine frame, directly opposite the place where the conductor boxes ascend the usual inclined plane.

With the continued rotation of the large comb, the anti-friction roller 15 travels into rolling contact with the

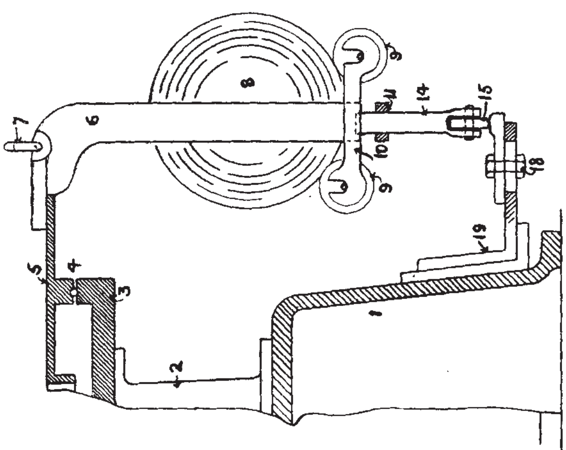


Fig. 117.

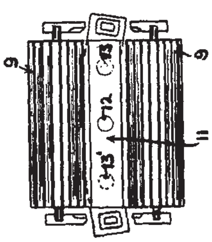


Fig. 118.

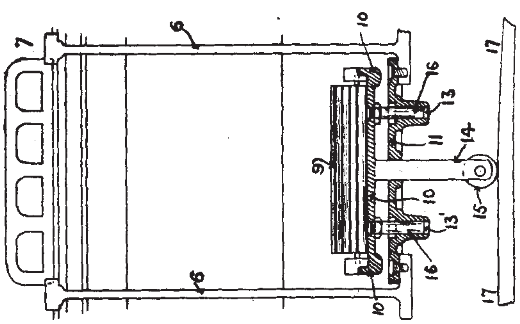


Fig. 116.

face of cam plate 17. The resulting action of this contact is to lift the roller 15, the stud 14, the carrier frame 10, the creel rollers 9, and the balls 8, thus yielding the requisite amount of slackness of sliver to permit the usual feeding operation. The release of the pressure of the cam plate 17 on the anti-friction roller permits the above parts of the mechanism, together with the balls and sliver, to resume their normal positions, ready to repeat the operation for feeding the comb opposite the second small circle.

CHAPTER XXVI.

DABBING MECHANISMS.

Dabbing Brushes and Operation.

IN the sequence of combing operations, the next important step is to successfully place the wool fibres into the pins of both comb circles at the point where they converge. The operation must be accomplished with the least possible delay. The slivers at this moment are lying on the top of the pins as hitherto described.

The mechanism consists primarily of a brush to which a rapid, vertical and reciprocating motion is imparted. The process is technically denominated "dabbing."

The dabbing brush together with its controlling mechanism, though comparatively simple in construction and operation, is nevertheless the weakest part in the Noble comb and a continued source of expense ; from the date of its introduction to the present time an infinite amount of attention has been devoted to improving, simplifying and perfecting its details of mechanism. During recent years much time and thought have been devoted to the invention of a contrivance to supersede the brushes—rotating discs and dabbing blades or knives of various sorts have been tried with varying degrees of success. If ultimately, permanent success is achieved on these lines, much capital and working expense will be saved, and the way cleared for still greater improvements in this general purpose comb.

The speed of the machine is governed largely by the speed at which the dabbing brushes can operate. With the consistent and gradual improvement of the comb in its numerous details, it has been possible to increase the speed of the comb circles and general rate of combing which incidentally, have necessitated a corresponding increase in the velocity ratio of the dabbing brushes.

The high speed at which these brushes must now run in order to give a quick, clean dab and so effectively push the fibres well into the pins, involves that the brushes must be perfect in construction and action. They must be of excellent quality, kept in constant repair and frequently adjusted near to the comb in sympathy with their reduction, due to wear. They nevertheless wear out rapidly, require constant attention, and are a source of much expense.

The average rate at which the dabbing brushes reciprocate is from 800 to 1000 dabs per minute—the balanced eccentric dabbing brush attains the high velocity of 1200 to 1500 dabs per minute. The quick dabbing movement of the brush reduces to a minimum the lateral dragging of the pins through the bristles of the brush before it ascends above the surface of the pins. When the brush is detained too long in the pins it results in the production of bad work.

Relation of Motion in Dabbing Brushes to Comb Circles.

The horizontal distance which the comb pins travel through the brush for each dab, for a given speed of dabbing brushes, is graphically represented at Fig. 119, which is a line diagram supplied by Mr. John Robinscn, Denholme.

The diagram is constructed to scale for a machine combing long wool, the large circle of which is 43 inches in diameter, and makes $4\frac{5}{18}$ revolutions per minute. The speed of the dabbing brush is 700 dabs per minute, and its stroke is 2·6 inches.

The surface distance travelled by the comb circle for each dab is therefore

$$\frac{\text{Revs. of circle} \times \text{diameter of comb circle} \times \frac{22}{7}}{\text{Dabs per minute.}}$$

$$= \frac{4\frac{5}{18} \times 43 \times 22}{700 \times 7} = 0{\cdot}82 \text{ inches.}$$

The principle of construction of the diagram is explained below.

Take any point X and draw a vertical straight line X Y, unlimited towards Y. In X Y take any point A, and with A as centre describe a circle E to represent the periphery of the eccentric. In X Y take a point below the centre A whose distance from A equals half the stroke of the dabbing brush (1·3″). With this point as centre describe a small circle B to represent the spindle shaft on which the eccentric E is mounted. Divide the semicircle of E into twelve, or any number of equal parts, from the apex where it intersects the vertical line X Y in O, to the base where it intersects X Y in 12. Each section from o to 12 represents equal divisions of time during the rotation of the disc E. With B as centre describe

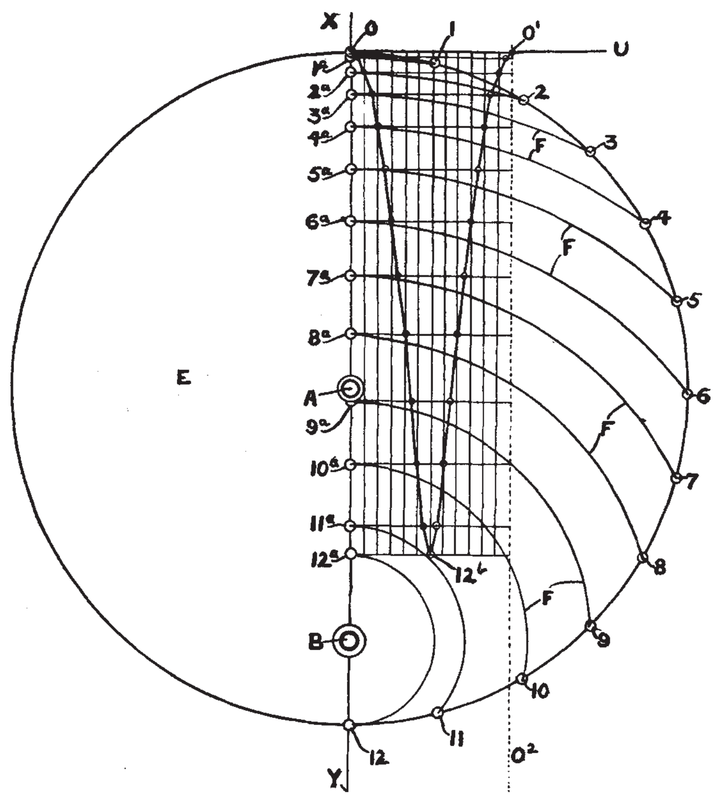


Fig. 119.

arcs of circles F which pass through the respective points o to 12 on the periphery of the semi-circle of E, and continue each arc of circle until it intersects the vertical line X Y in points 1^a to 12^a respectively. The spaces 0–1^a, 1^a–2^a, ... 11^a–12^a, represent the distances which the dabbing brush descends in the corresponding equal divisions of time from 0 to 12 on the periphery of the eccentric; *i.e.*, when the periphery of the eccentric E rotates from 0 to 1, the dabbing brush descends a distance equal to the distance 0–1^a. The divisional distances representing the motion of the dabbing brush gradually increase up to the point 9^a, from which they gradually decrease to 12^a. These unequal divisions therefore represent the variable velocity of the dabbing brush in its downward stroke, and conversely for its upward stroke.

Through the point O draw a line O U perpendicular to X Y and unlimited towards U. In O U mark off a point O^1 whose distance from O is equal to the traverse of the circle for each complete reciprocation of the dabbing brush (0·82″). Through the point O^1 draw a straight line O^1 O^2 perpendicular to O U and unlimited towards O^2. Then draw from the points 1^a to 12^a straight lines perpendicular to X Y, intersecting the straight line O^1 O^2. Divide the distance O O^1 into twenty-four equal parts, to represent equal divisions of time during the complete revolution of the eccentric E. In this example only twelve divisions are made, simply to avoid congestion. Each division therefore represents two divisions of time on the periphery of the eccentric E. By drawing a line from O^1, through the points where the horizontal and vertical lines intersect, to the bottom of the stroke, as at 12^b, and conversely to the top of the stroke, as at O, the relative motion of the dabbing brush and comb pins for

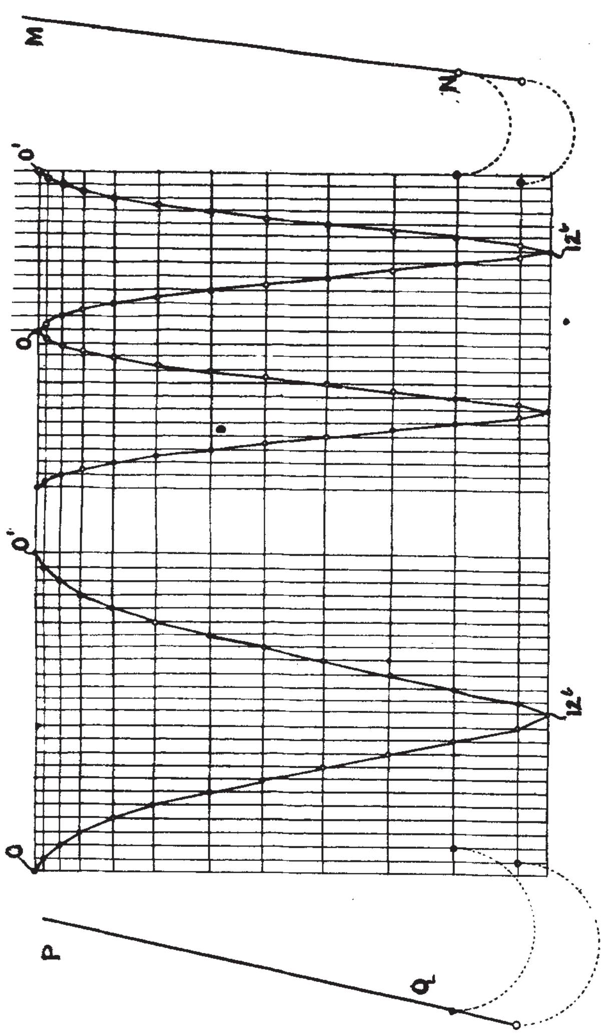


Fig. 119a.

Fig. 120.

each downward and upward stroke of the brush is obtained.

Fig. 119a shows the graph part of the diagram detached for purpose of comparison with Fig. 120, which shows similar relative motions to the above, in the case of a dabbing brush moving at half the number of dabs per minute for the same surface speed of comb circle, and incidentally demonstrates the increased wear to which the brush is subjected when making relatively fewer dabs per minute.

The average angles at which the dabbing brushes strike the pins are shown at M N and P Q. The method of construction will be readily perceived from the diagrams.

Numerous attempts have been made to impart a simultaneous horizontal movement to the brush from the moment it enters the pins until it rises out of them. It will, however, be evident that such horizontal movement of the brush is necessarily tangential to both comb circles, and that consequently the pins of the circles must still be dragged through the brushes, though in such cases to a less degree.

The bristles in the heel of the brush wear out more frequently than those in other parts, for which reason several attempts have been made to replace the bristles in this part of the brush independently of the other parts. In some cases the brush is made in two sections, in others the bristles themselves are adjustable. These and other defects have led to innumerable attempts to modify, supersede, or even dispense with the brush. In many instances two brushes have been tried, and in one case even three brushes were attempted. Efforts to supersede the brush include the fitting of segmental rows or strips of india-rubber to the usual brush stock, arranged to reciprocate vertically between the rows of pins in the comb circle in the ordinary way.

In lieu of bristles several rows of steel pins have been inserted into the back piece. The back or carrying piece is attached to a two-armed lever mounted and free to reciprocate on stud bearings, supported by the framework of the machine. The reciprocating movement of the lever and the " comb brush " is operated by a cam eccentric, after the usual manner.

Types of Dabbing Brush Mechanisms.

The introduction, history and development of dabbing brushes and their substitutes is sufficient to form a treatise of no inconsiderable dimensions, but attention will be devoted chiefly to the types of dabbing brushes or their substitutes in modern use. These comprise single eccentric, balanced or double eccentric dabbing and roller brushes, discs and dabbing blades.

Single Eccentric Dabbing Brush.

The reciprocation of the dabbing brush on the single eccentric principle is extensively used. There are several varieties of this type of which Fig. 121 is a typical example. It is an elevation partly in section and shown attached in position to the strong upright pillar.

A is the usual cross shaft, B the fixed pulley on same, which drives through the belt C, the pulley D secured to the conical stud E. The stud E is supported and free to

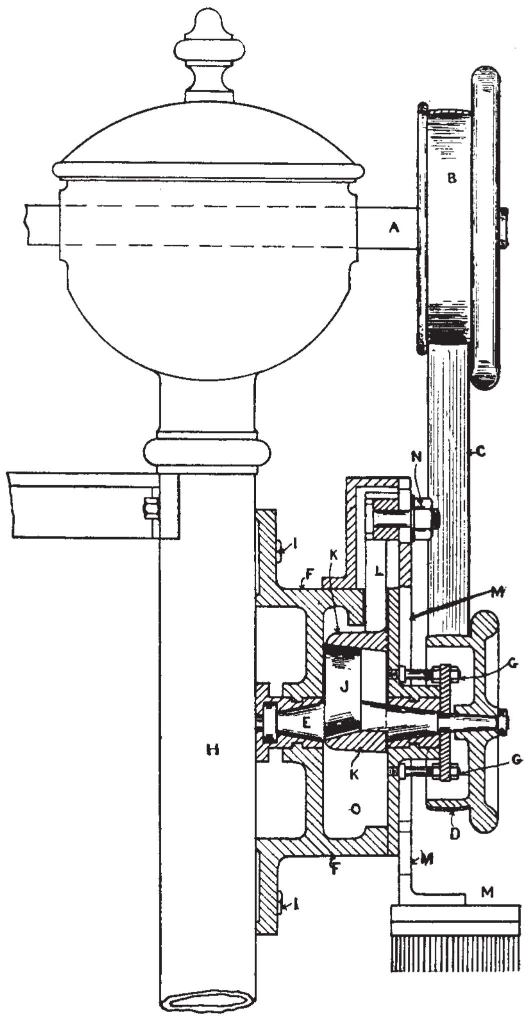


Fig. 121.

rotate at high speeds without any undue shaking or twisting in the adjustable bearings of the bracket F. The conical stud shaft E is adjustably secured to the bracket F, by the bolts and nuts G; the bracket F is in turn securely fastened to the upright pillar H by the bolts I as shown. Compounded with the conical stud E is a bevelled face cam eccentric J, which fits and rotates in close contact with a conical disc of a "die" which fits between the corresponding bevelled faces of two arms K projecting from and forming parts of the slide L to which the shank of the brush M is fastened by the bolt and nut N. The bevelled wings K of the slide L together with part of the conical spindle E are enclosed in a chamber O into which a sufficient quantity of oil is poured to permit of the immersion of the cam J at every downward stroke. Consequently, on each journey, the rapid reciprocating action of the cam slide splashes the oil to all the internal bearings of the eccentric mechanism and automatically lubricates all the details in frictional contact.

The operation is simple. The constant rotation of shaft A communicates motion through the pulley B and belt C, to pulley D, conical stud E and eccentric J. The rapid rotation of the eccentric J operates through wings G and slide L, the requisite reciprocating motion to the dabbing brush M which, with this mechanism, attains a maximum speed of about 1000 dabs per minute.

Crank Pin Eccentric. Fig. 122 is an elevation in section of a slightly different arrangement from the foregoing, though similar in principle of action. This modification was originally designed by J. E. Stephenson and applied by John Perry of Bradford. The essential features of the mechanism together with its operation may be briefly described as follows :—A is the usual bracket case affixed to the comb pillar ; B, the eccentric shaft supported in the bearings C of bracket A. D is a pulley compounded with shaft B and driven as usual. The shaft B is provided with a large disc E which is free to rotate in frictional contact with the bearing F in bracket A.

A crank pin G is compounded with the disc E. A grooved annular metal ring H of larger bore than the diameter of pin G circumscribes the latter. Three rings of balls I are placed in grooves between the annular ring H and the pin G. A sleeve J forming the lower part of the connecting rod K circumscribes the annular ring H. The bore of the sleeve J is larger than the diameter of the annular ring H, and three rows of balls L are arranged within the grooves formed between the sleeve J and the annular ring H. The connecting rod K is combined through the stud and bolt M with the shank N to the foot of which the usual dabbing brush is affixed. O is an enclosed chamber containing a reservoir of oil. Combined with the base of sleeve J is a projecting tube P curved in the direction of the traverse of the sleeve J, so that with each downward movement of the connecting rod K and sleeve J, the tube P collects a quantity of oil, which, with each rapid ascent of the tube, is distributed to the enclosed bearings of the mechanism.

Operation. The constant rotation of the pulley D produces a like rotation in the shaft B, disc E and crank pin G. As the crank pin G rotates it produces the requisite reciprocating motion in the sleeve

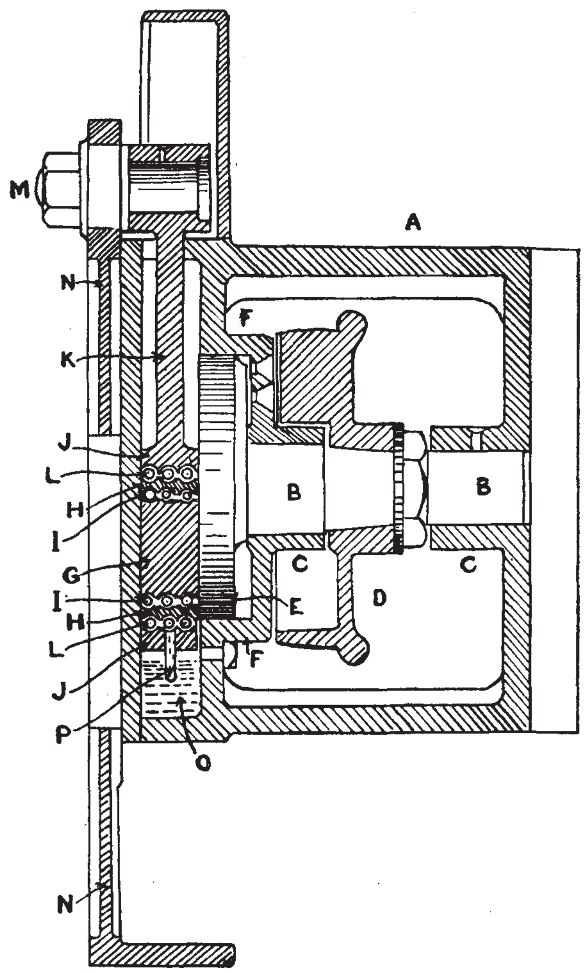


Fig. 122.

J, connecting rod K, shank N and the dabbing brushes. The introduction of the rings I and L reduces the frictional contact to a minimum.

The number of modifications of the single eccentric dabbing brush is truly legion ; the two examples already detailed are primarily given as types and to demonstrate the principle.

The Balanced Dabber. The introduction of the double eccentric or balanced dabbing brush was designed to impart a steadier and more uniform movement than was reasonably possible with the single eccentric, and also to economise power.

The chief feature of this mechanism is the addition of a second eccentric slide. The combined weight of the dabbing brush, shank, bolts, nuts, slide and the eccentric bearing ring is ascertained for each comb. The balanced slide together with its duplicate eccentric bearing ring are then made to exactly the same weight. The two eccentrics are diametrically opposed ; the brush and balanced slide which are independent of each other, rise and fall alternately.

The resultant effect of this arrangement is that the brush and its accessories are just balanced by the extra slide and the only work which the eccentrics have to do is to overcome the frictional resistance and supply the initial motion. The dabber brush is assisted in its ascent by the falling balanced slide and vice versa. The average weight of the dabber brush and its accessories for fine, medium and long wools is 10lbs. 10 ozs., 11lbs., and 11lbs. 2 ozs. respectively.

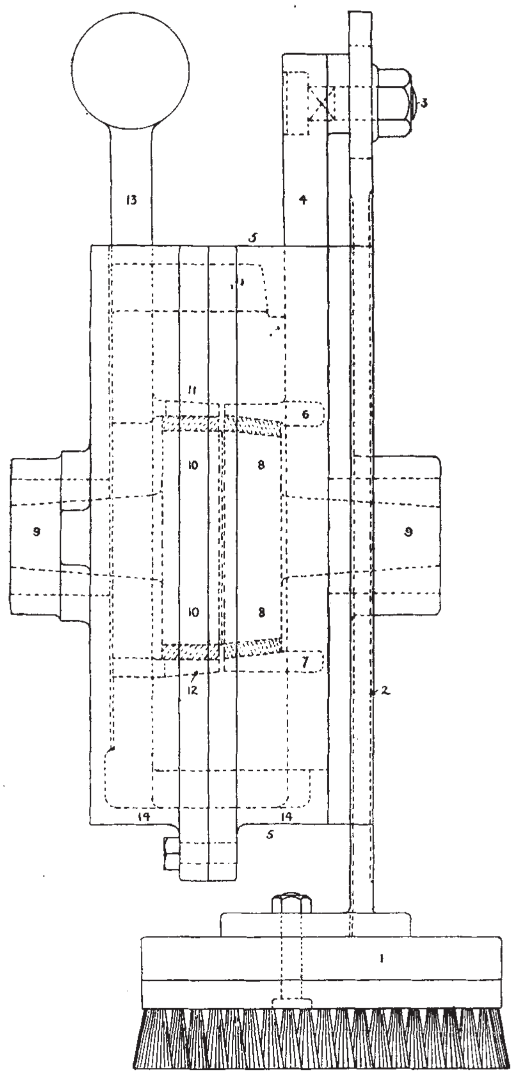


Fig. 123.

Fig. 123 is a sectional elevation of this principle of mechanism as designed by Prince Smith & Son.

Fig. 124 is a sectional plan of the same brush details. The numerals of like denomination refer to similar parts.

1 is the brush, 2 the shank to which it is bolted and which is in turn secured by the bolt and nut 3 to the upright rod 4 which is free to slide vertically in the enclosed box 5. The slide piece 4 is formed with two projecting shoulder pieces 6 and 7; a square "die" (shown in section) with a circular centre fits between the shoulder parts 6 and 7. A cam eccentric 8 affixed to the spindle shaft 9 rotates in frictional contact with the disc part of the above square "die" through which medium the slide 4 reciprocates in its vertical plane. The spindle shaft 9 is of special conical construction as shown in the plan, which, combined with its comparatively long length, contributes to reduce friction in the bearings—all of which are conical in shape—and to increase the life of the mechanism.

The second eccentric 10, diametrically opposed to the first eccentric 8, is also affixed to the spindle shaft 9. The eccentric 10 rotates in frictional contact with the internal rings of the duplicate square "die" placed between the shoulder pieces 11 and 12, and which are flanges or wings projecting from the weighted and balance slide 13. The slide 13 is free to reciprocate in a vertical plane conversely with the brush slide 4 and thereby acts as a counterpoise to the action of the brush. The lower part of the box 5 forms a chamber 14 which is supplied with a constant quantity of oil. The eccentrics 8 and 10, together with the lower parts of slide pieces 4 and 13, dip into this reservoir of oil at each downward stroke; the upward stroke of these parts

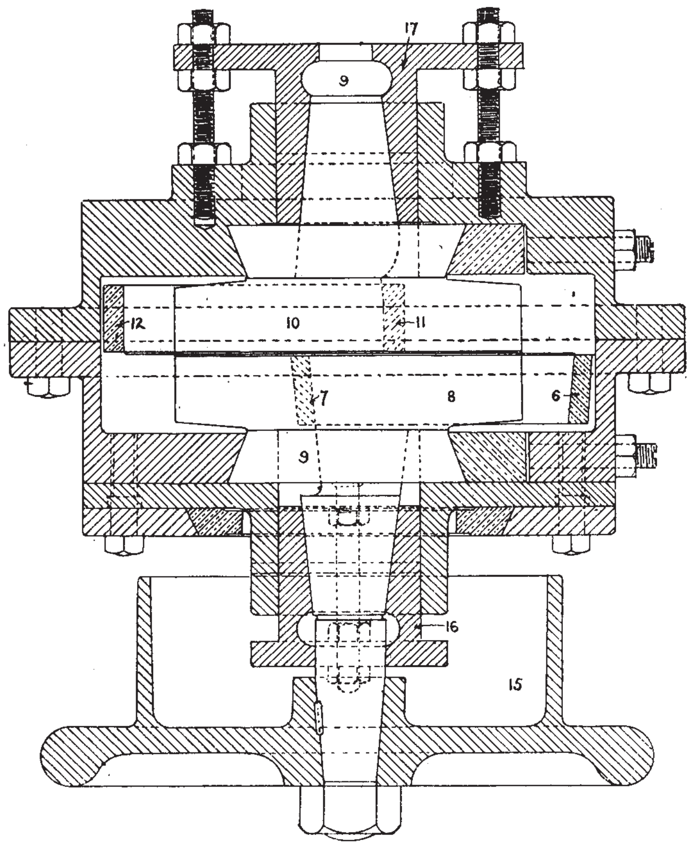


Fig. 124.

alternately and continually throws the oil while the downward stroke splashes it to all the internal bearings of the eccentrics and slides, which are, consequently, continuously and thoroughly lubricated. Provision is made to retain all the oil within the slide box.

The driven pulley 15 is compounded with a spindle shaft 9 in such a manner that it tends to tighten as it runs ; the bearings for front and rear of shaft 9 are indicated at 16 and 17 respectively. The position and method of attachment to the main upright pillars of the comb are shown in Fig. 90.

The constant rotation of the driving pulley 15 with cone spindle shaft 9 produces, through eccentric 8, the requisite rapid reciprocating motion of the dabbing brush 1. The second eccentric 10 which is likewise and simultaneously operated produces an alternate and converse motion, and so acts as the counterpoise to balance and steady the brush which can reciprocate with the foregoing mechanism at an approximate maximum speed of from 1400 to 1500 dabs per minute.

Dabbing Blades.

It is more than twenty years since dabbing blades were first employed in lieu of dabbing brushes to press the wool or other textile fibres into the pins of the comb circles. The earliest record dates from 1891, and consists of an arrangement designed by W. M. Lange, Amiens.

This system of dabbing comprises a series of steel blades arranged endwise in a block. Each blade is slightly curved and adapted to correspond with, and enter into, the space between the respective concentric rows of pins in such a way as not to strike or injure them. For certain classes of wool, flax and other vegetable fibres,

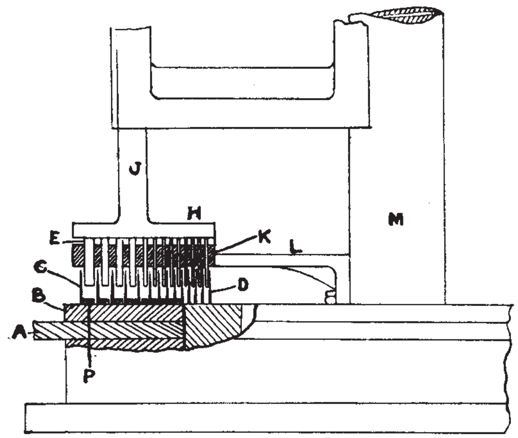


Fig. 125.

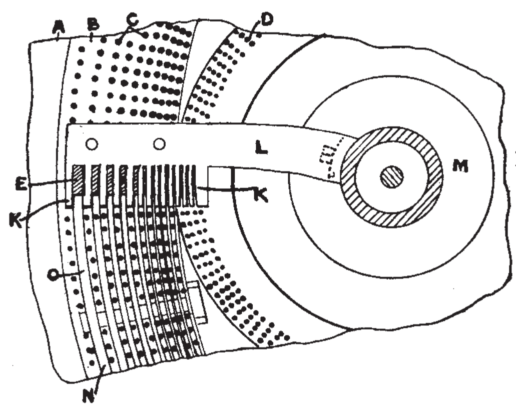


Fig. 127.

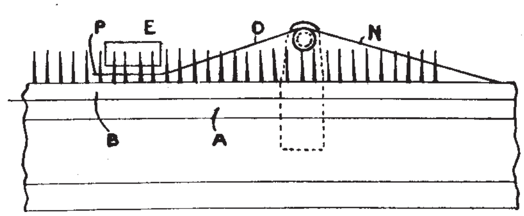


Fig. 126.

this principle of dabbing has met with a limited amount of success. The steel blades do not wear out so readily as brushes, and as a consequence, effect a considerable saving of expense.

Flax Syndicate's Dabbing Blades.

In the year 1897 the Flax Combing Syndicate introduced a dabbing arrangement which is simple, and will serve as a basis for a description of the first principles of this conception. Fig. 125 is a part elevation in section of the essential details. Fig. 126 is a front elevation of the plough knives, dabber blade and part of the large comb circle. Fig. 127 is a plan of the details referred to in Figs. 125 and 126. The same letters in the different diagrams refer to the same details of mechanism.

A indicates a portion of the large comb plate; B, a portion of the brass foundation for the pins C. The pins in the small circle are shown at D. The dabber plates E are compounded with the head stock H, attached in turn to the rod J which reciprocates in a vertical plane after the usual manner. A grid K is carried at the end of a bracket arm L, in turn compounded to the pillar M. The dabber plates E pass freely through the perforations in the grid K.

An additional feature is the modification of the plough knives inserted and rigidly fixed between the several rows of pins in the large circle for lifting the ends of the slivers clear above the points of the pins C, preparatory to the usual feeding and dabbing operations. The modified plough knives have a double incline—upwards as at N, and downwards as at O, in the direction of the traverse of

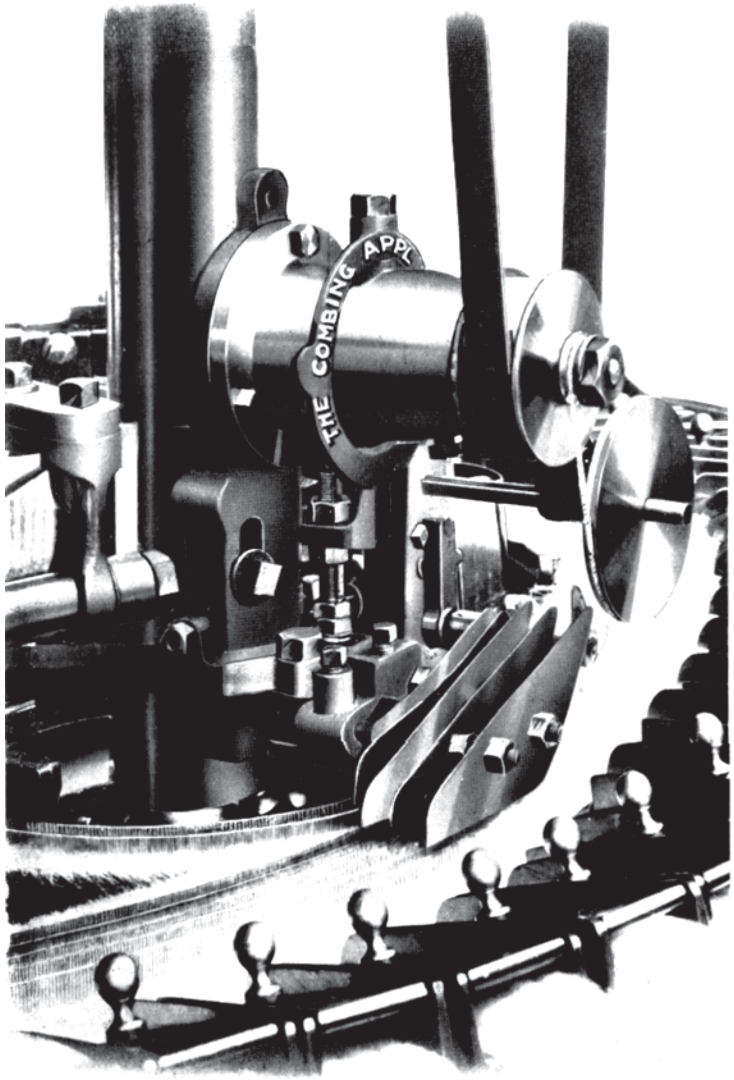


Fig. 128.

The Noble Comb, with Dabbing Blades.

the comb. The plough knife is finally reduced to the horizontal, as at P. This horizontal part is near the root of the pins, and directly under the dabbing plates E. The apex of the inclines projects above the tops of the pins.

In sympathy with the continued rotation of the large circle, the sliver gradually ascends the incline N until it is thoroughly clear of the pins. It next gradually descends the incline O towards and on to the pins C and D, immediately after which the dabbing blades E descend to strike and depress the sliver into the pins of the comb.

The dabbing blades E are accurately guided, by the grid device K, into the spaces between the concentric rows of pins C and D.

The usual "star wheel" is supplanted by a lever mounted on a pivot. The free end of this lever intermittently strokes the flax fibres, and helps to complete their separation at the points where the large and small circles diverge.

Combing Appliance's Dabbing Blades.

The dabbing apparatus, as applied to the Noble comb by the Combing Appliance's Ltd., Leeds, was designed by Messrs. E. and J. Greenwood in the year 1905, in sympathy with similar efforts to replace the dabbing brushes. Minor details have since been added, and the apparatus is now used on a large number of combs.

An important feature of this recently improved mechanism is an arrangement which seeks to avoid any injury to the comb pins whenever any hard substance accidently passes with the sliver into the combs. The dabber in immediate contact with the hard substance automatically yields to the extra resistance and permits the obstruction to pass forward with the minimum injury to the comb circles.

Fig. 128 is a perspective view of the Noble comb with this dabber motion attached.

Fig. 129 is a side elevation of the dabbing apparatus.

Fig. 130 is a plan of the same.

Figs. 131, 132 and 133 represent details to which subsequent reference will be made. The same numerals occurring in the different diagrams refer to the same details.

1 is the usual pillar; 2, a bracket of butterfly shape, which partially circumscribes the pillar 1. A second and diametrically opposed bracket 3, partly circular in construction is fastened by the bolts and nuts 4 to the ends of the bracket 2. The bracket 3 is slotted, and is adjusted to the pillar 1 by the bolts 5, as shown.

The base of the bracket 2 at the inner side of the pillar is turned upwards as at 6. A right-angled bracket 7 is adjustably bolted, as shown, to the bracket part 6. The base terminal of the bracket 7 is constructed to form a boss or circular bearing 8, through which a horizontal shaft 9 is inserted and free to rotate. The ends of shaft 9 support and form the pivot for the two arms of a forked lever 11, to which the dabber carrier 12 is attached. Two horizontal rods 13 are supported in a socket 14 in the dabber carrier 12. The rods 13 are adjustable, and are secured by the set screws 15. The dabber blades 16 for the large circle are mounted on the rods 13, adjustably spaced by washers 17 and secured by nuts 18. The dabber blades 19 are supported through the medium of depending studs 20, from the dabber bracket 12. The part of each of these blades which first encounters the sliver is formed with an incline, tapering from the base, as in Fig. 133. The feature of this arrangement is that with each successive dab, the wool is gradually pressed

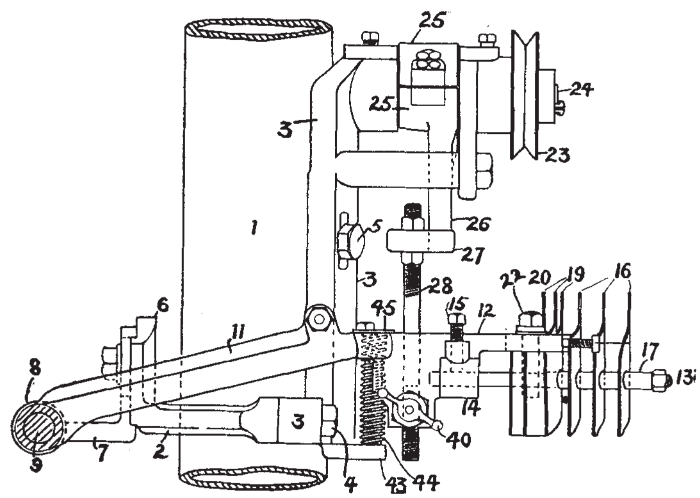


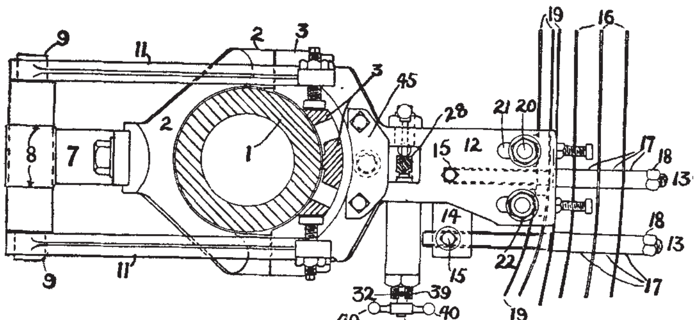
Fig. 129.

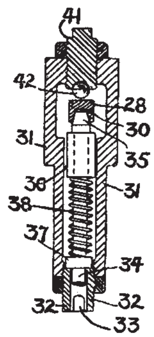
further down into the pins of the comb. The stud bolts 20 are adjustable in the slot 21, and secured by nuts 22. The bracket 3 supports the reciprocating mechanism which comprises the pulley 23 mounted on the shaft 24, carrying a common eccentric. A split collar or boss 25 circumscribes the eccentric on shaft 24. The base of the collar 25 is formed with a depending rod 26, terminating in a foot projection 27. Adjusted to the foot 27 is the reciprocating rod 28, which passes through the dabber carrier 12. The rod 28 is provisionally compounded with the dabber carrier 12 to reciprocate the same.

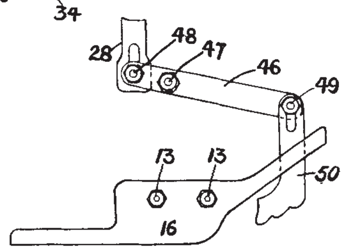
Escapement Apparatus for Dabber Blades.

Immediately the dabber knives come in contact with any hard or resisting matter, in the process of dabbing, the dabber carrier with the knives is automatically released. The added mechanism which effects this desideratum comprises the following details (see plan Fig. 131) :—The reciprocating rod 28 is square in cross section for a limited length towards its lower end. A hole 30, of conical formation, is sunk into the side of the square portion. Directly below the orifice in the dabber carrier 12, and at right angles to the conical hole 30, a hollow boss 31 is formed. Both internal terminals of the boss 31 are threaded. A collar 32, threaded externally, is adjusted into one end of the boss 31. A cross cut 33, for adjustment, is formed in the collar 32. A stud shaft 34, provided with a conical end 35, fits into the conical hole 30 in rod 28. The shaft 34 carries a fixed collar 36, and a loose collar 37, between which a spiral spring circumscribes the stud shaft 34. A fixed pin 39 (see Fig. 130), in the shaft 34, normally fits into the cross cut 33 in the collar 32, and a handle 40, compounded with the end of the stud shaft 34, completes the details for adjustment of the collar 32, through which the requisite amount of compression is imparted to the spring 38 to keep the conical end of shaft 34 in the conical hole 30. The shaft 34 may be detached from engagement with the rod 28, by pulling the handle 40

Fig. 130.







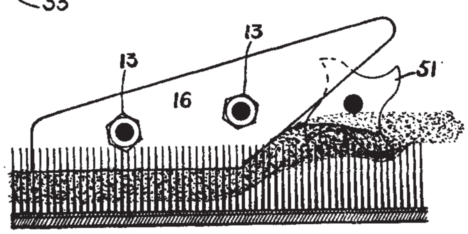


Fig. 131. Fig. 133. Fig. 132.

and turning it with the pin 39, so that the latter is disengaged from the cross cut 33.

The true alignment of the rod 28 is maintained by an adjusting screw 41, which supports a ball 42 in easy pressing contact with the square face of rod 28, diametrically opposite the rod 34. A projecting foot 43, in the bracket 3 supports a spiral spring 44, which is in contact with a plate 45, compounded with the dabber carrier 12 (Fig. 129).

The action of the mechanism is briefly as follows :— With the continued rotation of the driving pulley 23 and eccentric shaft 24, the collar 25 with rod 26 reciprocates the dabber carrier 12 and blades 16 and 17 continuously. Any unusual resistance to the blades, as referred to already, causes the dabber carrier to rise, and assisted by the spring 44 it tends to force the conical end of shaft 34 out of its conical socket in the reciprocating rod 28. With the normal ascent of rod 28, the conical end of rod 34 automatically returns through the influence of spring 38, into the conical hole 30.

Auxiliary Feed to Dabber Blades.

Fig. 132 shows an arrangement for assisting the dabber blades to press the sliver well into the pins. 46 is a simple balk lever pivoted on the fixed stud 47. The short arm of the lever 46 is connected through stud 48 to the reciprocating rod 28. A stud 49, affixed in the longer arm 46, adjustably supports a supplementary blade or blades 50, suitably spaced between the retreating or turned up ends of the dabber blades 16 or 17. The foot of the depending blades is inclined and serrated as shown. It will be observed that as the reciprocating rod, dabber carrier and blades ascend, the longer arm of lever 46 descends with the blades 50. The latter reach just into contact with the slivers, and keep them from accumulating in front of the dabber blades, with the descent of which the blades 50 rise clear of the slivers and comb circles.

An alternative and more *recent modification* is the introduction of a rotating disc wheel 51 (Fig. 133), which is placed between the retreating ends of the dabber blades 16. The disc wheel 51 rotates with a surface velocity approximately the same as that of the comb circles—by preference a trifle faster. The function of the wheel 51 is to assist the wool forward and into the pins preparatory to the dabbing action of the blades already described.

Rotary Brush for Pressing the Slivers Into the Comb Circles.

The chief feature of this arrangement is a rotary brush combined with a stationary knife for depressing the slivers into the pins of the Noble Comb. This system requires a reduction in the surface area of the usual cover plate, and involves a modification from a *single* to a *double* "inclined plane," but it dispenses with the usual dabbing brushes or blades.

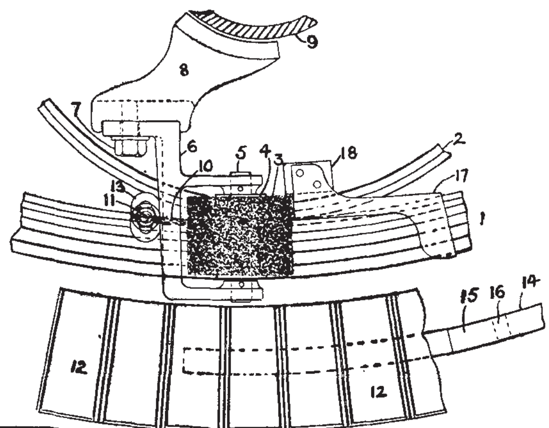
The mechanism was designed by Kenneth Wilson, Halifax, and is made by Prince Smith & Son, Keighley.

Fig. 134 is an elevation of the brush part and the adjustable pressure blade together with the modified "inclined plane" and part of the comb circle. Fig. 135 is a plan of these details, showing also the reduced cover plate. The same numerals occurring in the different diagrams refer to the same details.

1 indicates a portion of the large comb circle; 2 a portion of the small comb circle. 3 is a circular brush, the bristles of which project from a boss 4, which is mounted and free to rotate on a stud 5 between the two arms of a "carrying bracket" 6, in turn combined through the bolt 7 to a second bracket 8, which is secured to the usual pillar 9. The brush is sufficiently wide to cover the "set over" of both comb circles at the point where they converge. The bristles are not set radially, but obliquely to the periphery of the socket 4. They penetrate well into the pins of the comb, so as to press the slivers thoroughly into them. The brush rotates in the same direction, and necessarily at the same velocity as the comb circle. A blade 10, the front end of which tapers upwards from the base, is adjustably fixed concentrically with the pins of the large circle, preferably between the last two rows. The function of this blade is to depress the sliver well into the pins of the comb, to intercept any fibres which tend to rise with the brush as it leaves the pins, and incidentally to keep the fibres from wrapping round the brush. The blade 10 is secured through the nut 11 to a bracket arm 13 depending from the carrying bracket 6. The usual conductor boxes are indicated at 12. The inclined plane 14 is supplemented by an additional incline 15, to the left of the supporting bolt 16. A steel cover 17, adjusted to a fixed part of the comb at 18, keeps the free ends of the lifted slivers 19 clear of the pins of the small circle, part of which it encloses, but the greater part of that portion of the cover which usually projects over the pins of the large circle is removed. This arrangement permits the slivers to descend directly and ride freely on the surface of the pins of this comb.

The action of the combined details of this mechanism is summarised as follows:—As the conductor boxes 13 travel up the incline 14, they draw off a fresh supply of

Fig. 135.



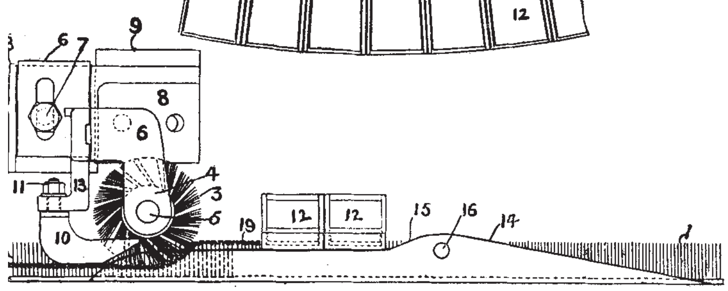


Fig. 134.

sliver from the balls. Then as the boxes descend the incline 15, the projecting free ends of the slivers are naturally distributed over the cover plate 17, while the intervening part of the slivers falls on to the top of the pins of the large circle, on which they ride until the bristles of the rotating brush gradually lay hold of the fibres. Owing to the oblique setting of the bristles, the pressing of the fibres into the pins of the circles is accomplished by a more or less stroking action. Any tendency of these fibres to rise with or wrap round the brush, is immediately arrested by the inclined part of the blade 10, the point of which enters well into the bristles of the brush. The slivers then gradually pass under the stationary blade 10, by which means they are thoroughly depressed into the pins of the combs.

CHAPTER XXVII.

DRAWING-OFF MECHANISMS.

THE completion of the combing of the slivers projecting from each of the three circles is accomplished by separate pairs of vertically adjusted fluted rollers, one of which in each pair is driven positively and the other by frictional contact, through the medium of a leather which passes round it and acts as a cushion between the nip of the two fluted rollers (see also Fig. 94).

DRAWING-OFF ROLLERS, LEATHERS, &c.

The wear on the drawing-off leathers, of which there are never less than four in a Noble comb, is a factor of considerable importance and pecuniary interest to wool combers.

Fluted drawing-off rollers usually jam, cut or otherwise damage the wool slivers unless they are covered with leather or other yielding material to act as a cushion, at the point where the fibres are gripped. The leathers are usually employed in the form of endless bands or aprons, which however, soon wear out as a result of the severe bending strain to which they are subjected in passing between the corrugated rollers. The leathers are also excessively worn at those places which grip the fibres and draw them through the pins of the comb.

If the sliver, when taken from the comb circle, is permitted to run continuously in contact with the same portion of the carrying leather, the latter is rapidly destroyed in the part which draws off the sliver, the other parts of the leather remaining in good condition. This defect is most manifest in those leathers which draw off the sliver from the large circle because from this circle the longest fibres are drawn and consequently the drawing-off leathers are here subjected to the greatest strain. The expense necessarily incurred in supplying and keeping these leathers in constant repair is very great. In sympathy with the efforts to improve the other fundamental parts of this machine, numerous attempts have been made to increase the life of the leathers: (1) By improved methods of applying the pressure to the pressing rollers and reducing the friction on the bearing and permitting the leathers to work more freely; (2) By the application of ball-bearings to the journals of the drawing-off rollers; (3) By designing the drawing-off rollers with a cushioning or yielding material at the point where the slivers are nipped, so as to prevent the cutting of the fibres, and thereby to obviate the use of leathers altogether; (4) By imparting a vertical reciprocating movement to the leathers so as to distribute the wear and tear over a greater surface.

In addition to the above defects in relation to the leathers, the constant heat from the steam chest combined with the friction of the fibres in contact with the heated pins generates electricity among the fibres, and, as a consequence, they "fly" from the body of the sliver and are attracted to the steel rollers around which they tend to wrap, resulting in damage to the pins of the circle and the production of thin places in the sliver.

Weighting the Drawing-off Rollers. The mechanism of the drawing-off rollers, as fitted in the usual plain bearings for drawing off the combed sliver is illustrated as follows :—

Fig. 136 is an elevation of the drawing-off rollers.

Fig. 137 is a sectional plan through X Y (Fig. 136).

Figs. 138, 139, 140 and 141 are details to which subsequent reference will be made. The numerals of like denomination occurring in the different diagrams refer to corresponding parts.

1 and 2 represent the upper and lower "slide" brackets, both of which are compounded to the upright bar 3, and adjustably secured, through the bracket arm 4, to a fixed part of the machine. 5 is the fluted drawing-off roller, and 6 the shaft with which it is compounded. This shaft, as previously demonstrated, is positively driven through the spur wheel 7, and is free to rotate in the bush bearings 8. A fluted pressing roller 9 is mounted *loosely* on the vertical shaft 10, which modification was first introduced by Sharp & Jowett, Bradford.

The shaft 10 is square in cross section towards its base, as at 10^1, and is formed with an enlarged collar 10^2 immediately above the square section. This collar fits into a sliding block 11 contained and free to move laterally in the slide carrier 2. The block 11 and a portion of the shaft 10 are detached and shown separately at Figs. 138 and 139 respectively.

The enlarged or collar part 10^2 rests freely on the block 11. A loose collar 12 is mounted on the shaft 10 and bridges the distance between the fixed collar 10^2 and the fluted pressing roller 9, which it supports. This roller has a recessed base which fits over collar 12. The top of the pressing roller is likewise recessed, and into it fits a loose collar 13, also mounted on the shaft 10. This arrangement tends to keep the dust from entering between the fluted roller 9 and its shaft. The collar 13 is prevented from rotating, by the extended projection 13^1 which fits into contact with the notch 14^1 of the sliding block and bearing 14 mounted on the shaft 10 and free to move laterally in the slide bracket 1. The collar 13 and the block 14 are detached and separately shown at Figs. 140 and 141 respectively.

A threaded bolt 15 passes freely through the end of the carrier 2, and is screwed through an adjustable nut 16 into contact with the bearing block 11. A spiral spring 17 is mounted over the stud bolt 15, enclosed between the end of carrier 2 and the loose piece 16.

An oil duct or longitudinal groove 10^3 (Fig. 139) is formed in the shaft 10 for the purpose of lubricating the loose fluted roller 9.

The fluted pressing roller, with its mounted leathers, is forced by the above described mechanism into close contact with the fluted drawing-off roller, and is consequently rotated by this frictional contact. Any hard or foreign matter passing between the nip of the fluted rollers overcomes the resistance of the spring 17, and passes forward without further detriment to the mechanism or material.

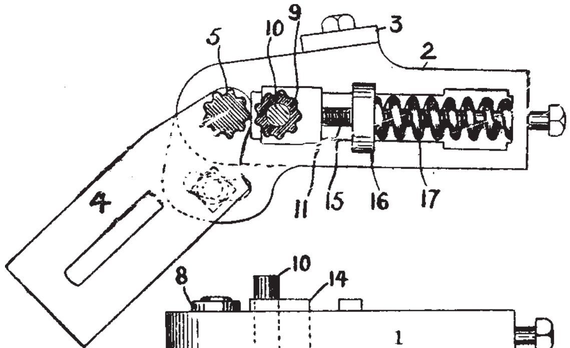


Fig. 137.

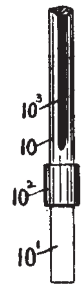
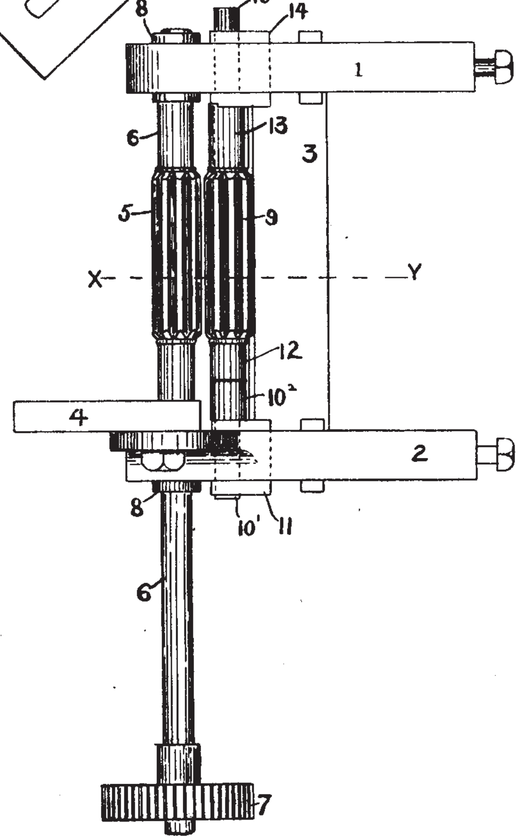


Fig. 139.



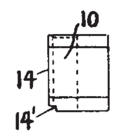


Fig. 141.

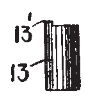


Fig. 140.

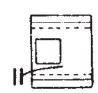


Fig. 138.

Fig. 136.

Weighting the Roller by a Single Spring. An arrangement was introduced in 1891 by T. H. Shaw, of Shaw & Mitton's, Bradford, in which, by the use of only one screw, equal pressure was applied to both ends of the pressing roller and across the full width of the leather so as to reduce the wear and tear on it and draw a more even and perfect sliver from the circles.

Fig. 142 is a sectional elevation illustrative of the essential features of this mechanism.

Fig. 143 is a plan of same.

A is the drawing-off roller, B the pressing roller, C the upper and D the lower carrier. Carrier D is combined with the bracket E which is in turn secured to a fixed part of the machine. F and F^1 indicate the upper and lower bearings on the pressing roller B. An upright bar G is supported by and free to move laterally between the carriers B and C. This bar is provided with three projections, G^1, G^2 and G^3. The first two rest normally in respective contact with the upper and lower bearings F and F^1. A lever H, pivoted in the bottom carrier D, rests normally against the projection G^3, whilst its free end passes through the slotted part I of the carrier C. A threaded bolt J is adjusted into contact with the free end of the lever H; the bolt J passes freely through the end of the cap K of carrier C. A spiral spring L, circumscribing the bolt J, is confined between the cap K and a nut M adjustable on the threaded part of the bolt J. By adjusting the nut M and compressing the spring L force is applied to the end of the lever H which in turn operates on the projection G^3 of bar G, the lateral movement of which applies the requisite amount of pressure simultaneously to both ends of the pressing roller B.

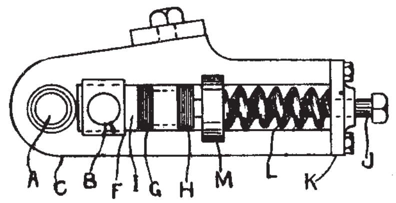


Fig. 143.

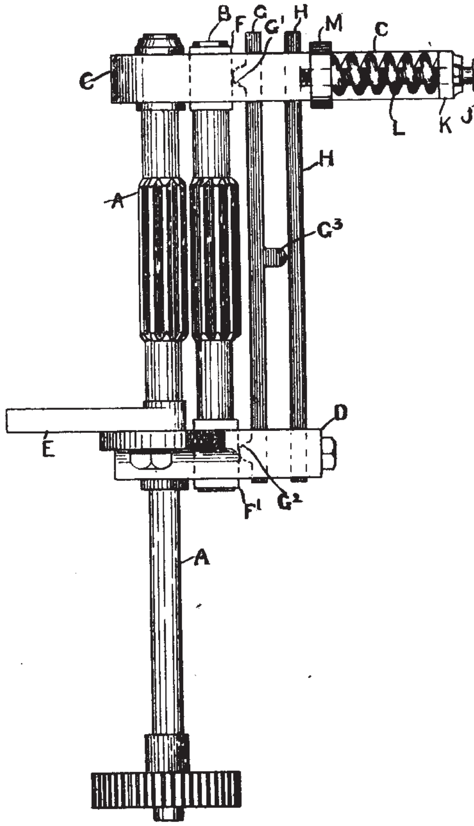


Fig. 142.

Double Springs to Drawing-off Rollers.

Fig. 144 is a sectional plan ; Fig. 145 an elevation of the method introduced and adopted by Prince Smith & Son, for "weighting" the drawing-off rollers at each end, by a pair of spiral springs. Similar letters of reference in each diagram indicate corresponding parts of mechanism.

A indicates the shaft and drawing-off roller ; B the shaft and pressing roller ; C a floating box with a sleeve bearing D, which fits over the end of the pressing roller shaft B. The box C is supported by, and free to move slightly along a fixed arm E. A recessed link piece F, having a collar bearing G, fits over the end of the drawing-off shaft A. The recessed part encloses the shaft B below the bearing D. Compounded with the opposite end of the link F is a threaded stud H, which passes freely through the end piece of the box C, and also freely through a cross piece I, which contains the two studs J with reduced ends K. See also Fig. 146. These pass freely through the ends of the floating box C. The reduced parts K fit into the spiral springs L and the shoulders of the normal diameters J abut against their ends. The springs are suitably contained in the box C, as shown. An internally threaded sleeve M, provided with a small milled edge wheel N and ratchet wheel O, is screwed on to the threaded part of the projecting stud H and adjusted into close contact with the face of the cross piece I. A pawl P, pivoted on the fixed stud Q, normally rests in the teeth of the ratchet wheel, and serves to prevent any backward rotation after its adjustment. The lower ends of the drawing-off rollers are similarly connected and adjusted.

By turning the threaded sleeve M clockwise, the requisite amount of pressure and adjustment is applied to the

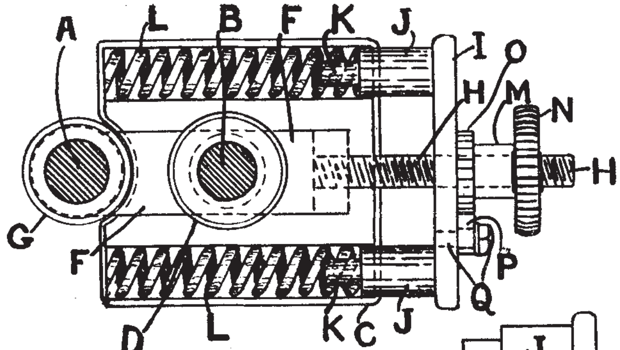


Fig. 144.

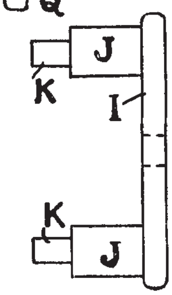


Fig. 146

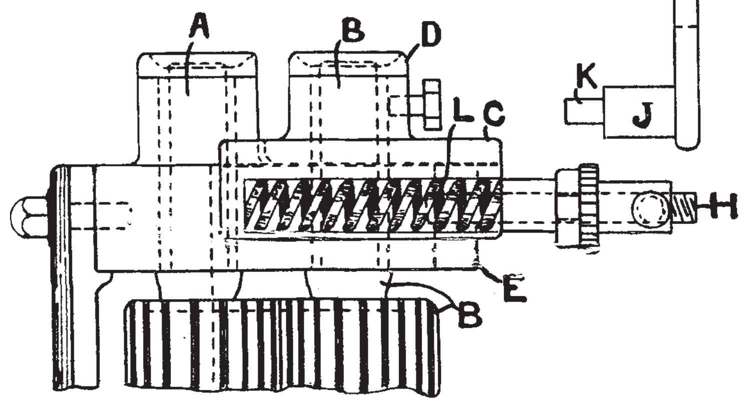


Fig. 145.

pressing roller B to place it in frictional contact with the drawing-off roller A, by which means the cross piece I, with studs J, compresses the spiral springs L. These in turn exert the necessary influence through the floating box C and its bearing D on the shaft of the pressing roller B. Any hard or foreign substance in the sliver overcomes the pressure of the springs and passes forward without detriment to the mechanism.

An improved stand is now used for supporting the drawing-off rollers; the number of parts have been reduced; there are no parts which can work loose and drop into the comb circles, as in some of the older types of stand.

Ball Bearings Applied to the Drawing-off Rollers.

This is a recent arrangement in which ball bearings are provided for the vertical spindles of the pressing and drawing-off rollers, the objects being to reduce the power required to rotate the spindles and rollers, and to prolong their life as well as that of the leathers. The writer saw a considerable number of these drawing-off rollers in operation at Hollingrake and Clegg's, Halifax, whose experience confirms the above claims of the makers—Taylor and Wordsworth, Leeds.

Fig. 147 is a sectional elevation showing the essential details of this mechanism. Fig. 148 is a plan through X Y, Fig. 147. The numerals of like denomination occurring in the different diagrams refer to the same details.

1 is the spindle of the drawing-off roller, positively driven as previously described. 2 is the fluted drawing off roller, compounded with the spindle shaft 1. 3 is the fluted pressing roller, compounded with the vertical shaft

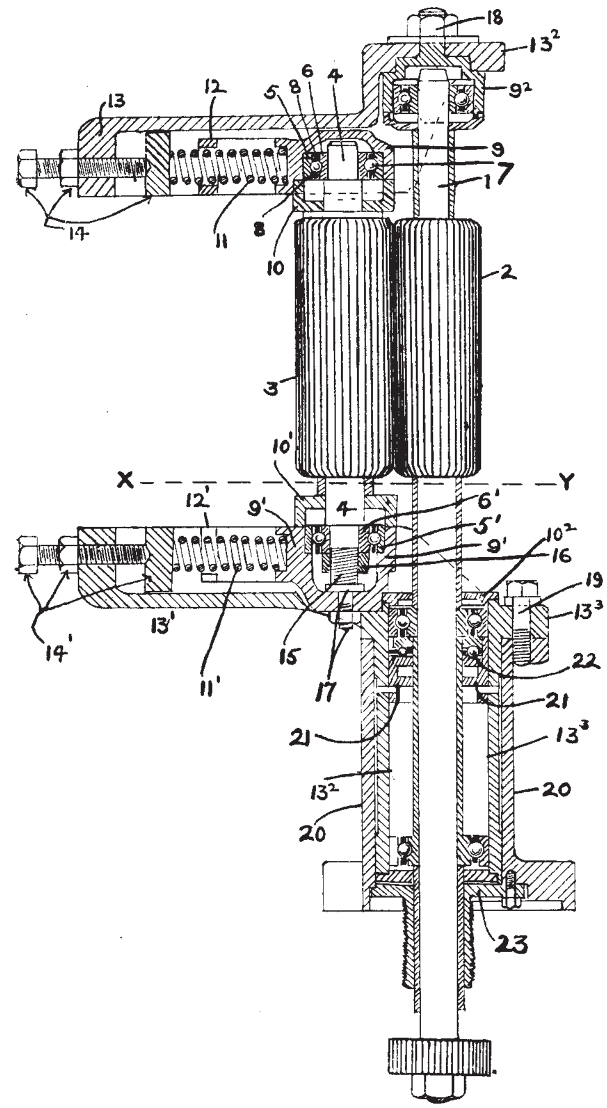

18
13^2
9^2
13
12
5
8
6
4
9
7
1
14
11
8
10
2
3
10'
X
Y
12'
9'
4
6'
5'
9'
16
10^2
19
13^3
14'
13'
11'
15
17
22
21
21
13^3
13^2
20
20
23

Fig 147.

4, which is supported as usual. The roller 3 is kept in adjustable contact with the roller 2, as subsequently described.

A concentric inner groove ring 6 fits tightly to the upper part of the pressing shaft 4. A second concentric outer groove ring 5 fits loosely over the ring 6. The balls 7 are inserted into the grooves of the rings 5 and 6. The interstices between the rings 5 and 6 are filled in by "cage" rings 8. A box or housing chamber 9 is constructed with a circular recess on the under side for the upper part, and conversely as at 9^1 for the lower part of the spindle. The diameter of the recess is slightly greater than that of the outer groove ring 5. This design permits the rings and balls to slide sideways, and so prevents the balls from jamming. A recessed cap piece 10 fits over the spindle 4 and encloses the recess opening of chamber 9. The remaining spaces above and below the rings 5 and 6 and balls 7 are filled in with a semi-solid lubricant, so that the balls, rings and bearing parts are kept constantly lubricated.

The housing chamber 9 on the left side is recessed so as to retain one end of the spiral spring 11, the function of which is to press the roller 4 towards the drawing-off roller 1. The box chamber 9 forms part of a "sliding piece" 12, also recessed to receive the spring 11. The "sliding" piece is carried in the projecting arm of a duplex or compound bracket 13. A bridge 13^4 indicated in the plan, Fig. 148, combines the upper and lower arms of the duplex bracket 13, carried from or about the drawing-off shaft 1. The spiral spring 11 is adjusted and kept under pressure in contact with the recessed left side of chamber 9, by the set screw, lock nut and abut-

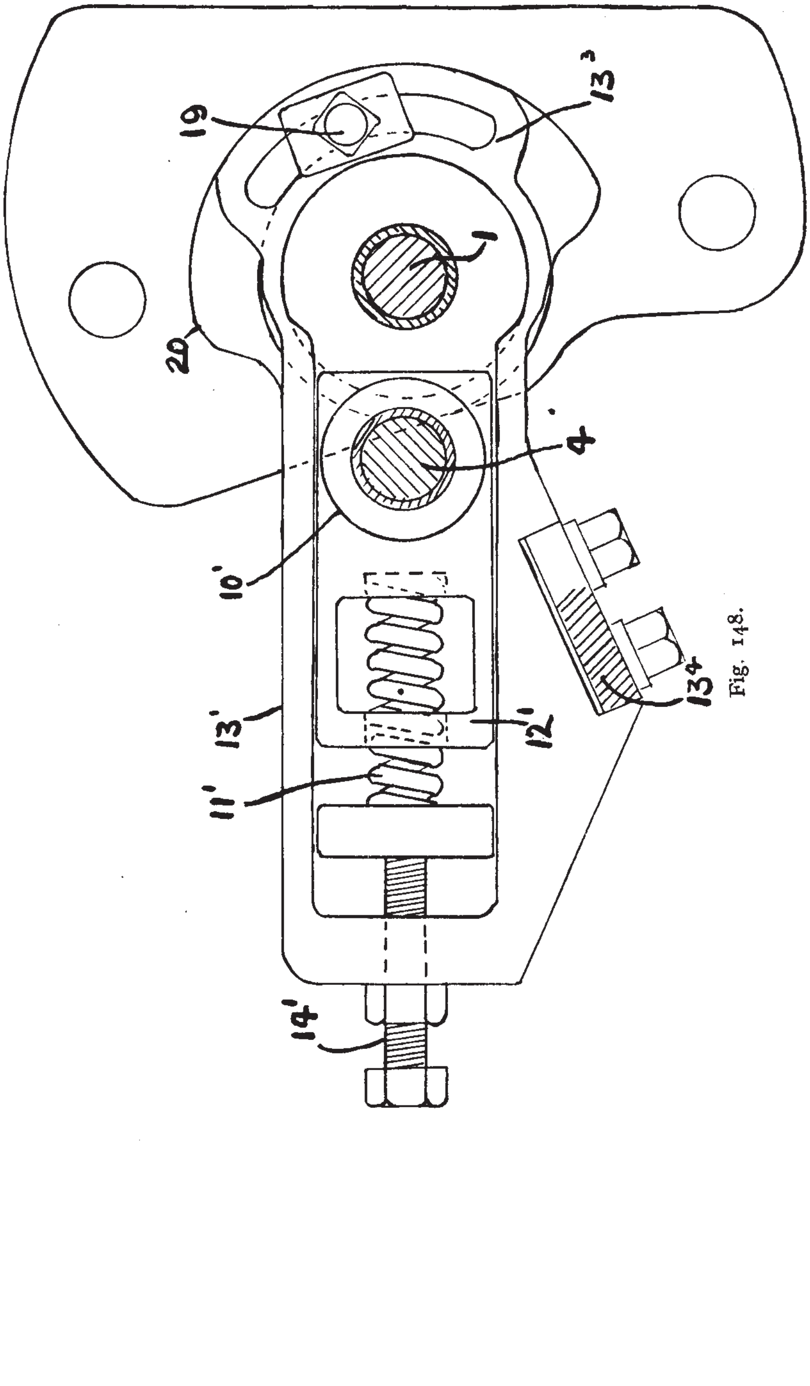


Fig. 148.

ting piece 14, as shown. The base end of the shaft 4 is reduced in diameter to less than the part which fits into the grooved ring 5, thus serving to secure the ball bearing to the lower end of the pressing shaft 4. The base of the shaft rests on the flanged head of a small stud 17, the threaded shank of which passes through the base of the chamber 9^1, being adjusted and secured by the nut as shown. In all other respects the details of the bearing for the lower part of the shaft coincide with those described for the upper part. The upper and lower parts of the shafts 4 are slightly reduced to permit the free removal of the rings, balls, and housing chambers. The application of this principle of bearing to the drawing-off roller is optional, since the objections of the ordinary plain bearings apply chiefly to the pressing rollers. The additional mechanism is nevertheless illustrated and described.

The upper bracket part 13^2 is constructed with a small ring centre at the top, and a large recessed centre on the under side, into which is fitted the reduced portion of the upper part of the housing chamber 9^2, which terminates in a threaded bolt, on which a nut 18 compounds the housing 9^2 to the bracket part, 13^2. The lower part of the bracket 13^3 is of cylindrical formation. It fits internally and is secured by the stud bolt 19 to a supporting cylinder 20, which in turn is bolted to the "motion plate" 23 of the machine. The side bearings and balls are shown but not indicated by numerals. They correspond with those described above. A short supplementary cylinder 21, constructed with a closed bottom, is fixed internally in the bracket cylinder 13^3. It supports an extra set of ball bearings 22, which "thrust" as shown against the normal and side or steadying ball bearings.

NON-LEATHER DRAWING-OFF ROLLERS.

With the object of obviating the use of leathers, Milson and Stetson, Boston, U.S.A., recently introduced the use of a roller termed a "clearer," in addition to the two usual drawing-off rollers. The drawing-off roller is constructed with a cushioning material which yields slightly to pressure at the points where the fibres are nipped, the object being to prevent cutting or injuring the fibres during the drawing-off operation.

Fig. 149 is a side elevation of the drawing-off rollers.

Fig. 150 is a plan of the rollers in their supports.

Fig. 151 is a sectional plan through O P in Fig. 149.

Fig. 152 is an enlarged side view, partly in section, of the drawing-off roller.

Fig. 153 is a transverse section, in plan, through X Y in Fig. 152; Fig. 154 a detail to which reference will be made; and Fig. 155 is an elevation to show the ratchet wheel and pawl lever.

The drawing-off roller 1, together with the pressing roller 2 and a supplementary roller 3, denominated the "clearer," are supported in position by the upper and lower frame or carrier pieces 4 and 5, which are adjustably linked through their ear pieces by a rod 6. The lower frame 5 carries a plate 7 which is secured to the main frame of the comb.

The ends of the pressing roller 2 are provided with bearings in a floating box 8 and its duplicate in the lower frame 5, each of which is free to move laterally in the frames 4 and 5 respectively. An adjustable threaded bolt 9 passes freely through the end cap 10, while its threaded part is screwed through a loose head piece 11, by which a modified amount of tension can be applied to the pressing roller 2. A ratchet wheel 13 is loosely keyed on the stud bolt 9, on which it is free to slide, but compounded to turn with it. The teeth of the ratchet wheel engage in a pawl lever 14, which combination prevents any partial rotation of the bolt 9 after adjustment.

The ends of the shaft of the fluted clearer roller 3 are mounted in bearings 15, which are free to slide laterally, being controlled and operated in a somewhat similar way to shaft 2. The function of this shaft is to keep the fibres from lapping round the drawing-off rollers.

The drawing-off roller shaft 1 is positively driven from its base as usual. The fluted, or drawing-off part of this roller is of special construction and constitutes the chief feature of the mechanism. It is made in the form of a cage, the upper and lower ends of which are provided with gear teeth 16. A series of thin iron bars 17, Fig. 154, provided with serrated teeth 18, links together the upper and lower gears 16. The cage is fitted tightly over a cushion roller 19, in turn circumscribing and compounded with the vertical shaft of the drawing-off roller 1. The cushion roller is made of raw hide, leather, or any fibrous material which yields to pressure. The periphery of the cushion 19 between the teeth of the thin iron bars 17 is grooved, as shown. The teeth 21 of the pressing roller 2 press the sliver 20 that is being drawn off against the grooved or rounded portion. The fringe of sliver to be drawn off is stroked towards the nip of the rollers by a wheel rotating near them, but not shown in the illustration.

The ribs of the drawing-off roller 1 and the pressing roller 2 grip the sliver firmly. The flexible and cushioning material described yields to this pressure. The sliver

Fig. 149.

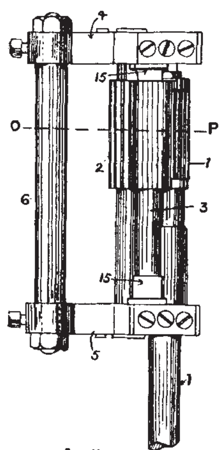


Fig. 155.

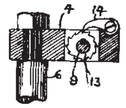


Fig. 150.

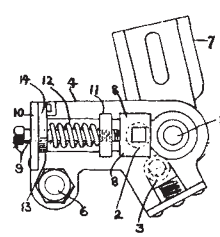


Fig. 151.

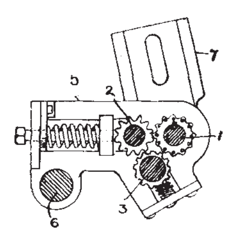


Fig. 152.

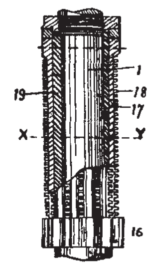


Fig. 154

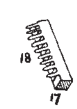
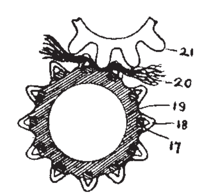


Fig. 153



is then taken by the clearer roller 3 and conveyed to a trumpet, through which it passes to join the fringe that is being drawn off from the small circles. The combined slivers are then similarly drawn off and passed through a second trumpet to the coiling can.

Traverse Motion for Drawing-off Leathers.

An important accessory arrangement was designed by Lister & Batty and introduced in the year 1893, to obviate the foregoing difficulty by causing the drawing-off leathers to reciprocate slowly in a vertical plane, so that the bearing surface of the leathers in respect to the sliver is constantly changing.

The principle of the mechanism, which is applied to all modern Noble combing machines, is illustrated and described as follows :—

Fig. 156 is a sketch in perspective and elevation of the reciprocating mechanism.

Fig. 157 is an elevation in part of the reciprocating table, together with an operating cam and bowl ; partly in section.

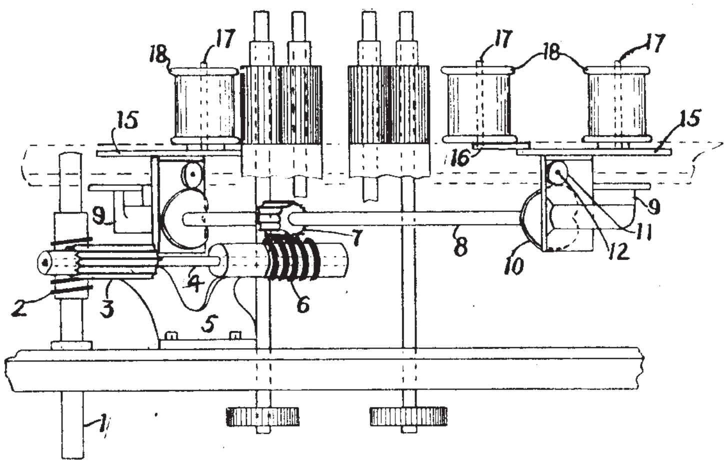
Fig. 158 is a plan of the essential parts, and shows their relation to the comb circles.

Fig. 159 is a front elevation of the cam, bowl and table.

The same numerals occurring in the different diagrams refer to the same details.

Compounded with the pillar shaft 1 is a worm 2 which gears into a worm-wheel 3, keyed fast to a short cross shaft 4 carried by a bracket 5, in turn supported from the gearing plate of the machine. A worm 6 on shaft 4 gears into a worm-wheel 7, secured to the horizontal shaft 8 which is carried in the sleeves of brackets 9, in turn secured to a fixed part of the machine. The shaft 8 is free to rotate in the sleeves of brackets 9. It carries a fixed but adjustable cam 10 which is free to

Fig. 156.



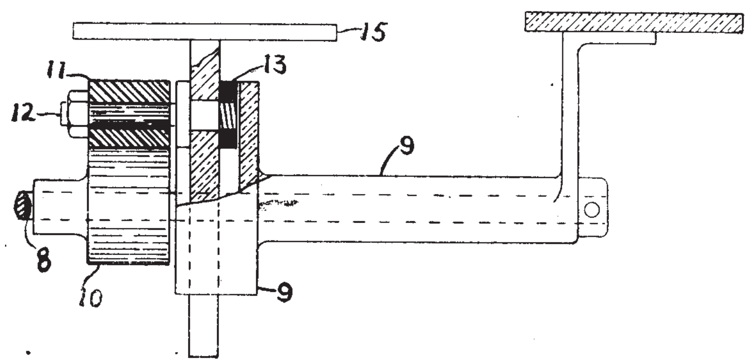
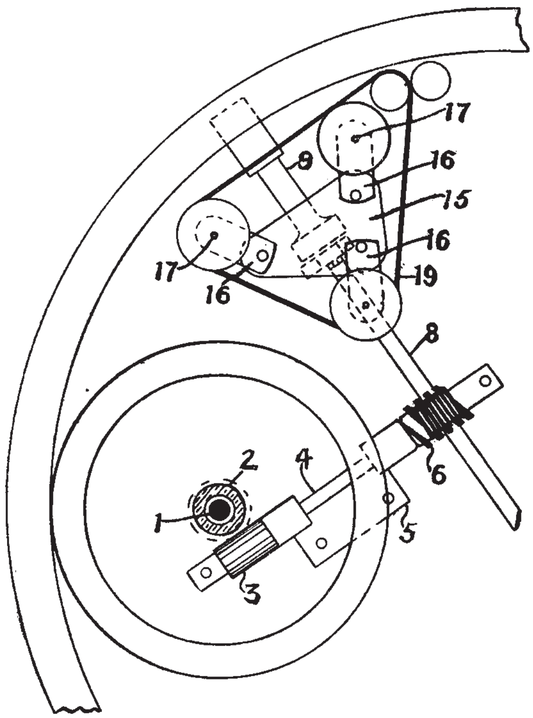


Fig. 157.

Fig. 158.



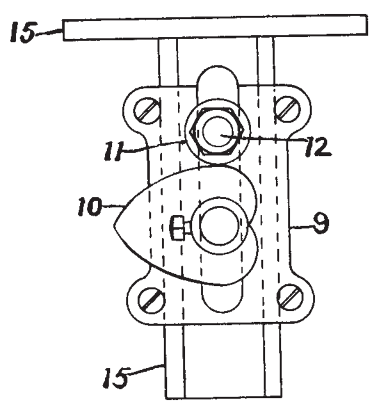


Fig. 159.

rotate in rolling contact with an antifriction roller 11, mounted and free to rotate on a stud 12. This stud is bolted and secured by the nut 13 to the depending part of a "table plate" 15, which is free to reciprocate in bracket 9, at right angles to it and the horizontal shaft 8. The horizontal or table part 15 is provided with adjustable slotted pieces 16, which in turn carry vertical studs or spindles 17. Mounted and free to rotate on each of the spindles 17 is a flanged roller 18, around which and the usual fluted rollers, the drawing-off leather 19 is passed. The continuous rotation of shaft 1 and worm 2 produces, through worm-wheel 3, a like continuous, but slower, motion in shaft 4. This in turn communicates, through worm 7, a continuous, but decreased, motion to the horizontal shaft 8 and the cam 10. The uniform rotation of the latter, operating in rolling contact with bowl 11, produces a reciprocating motion in stud 12, table 15, spindles 17, rollers 18 and leather 19. Then, since the sliver from the comb circle is always taken off in the same plane, the position of the leather is constantly varying relative to this plane. The wear on the leathers is consequently distributed over a greater area of them. The cam 10 is constructed so as to produce the smallest amount of dwell in the reciprocating table and leathers at each end of their traverse.

"Twisted" Flutes on Drawing-off Rollers.

For long wools, some combers employ drawing-off rollers where the flutes run diagonally. These specially "twisted" fluted rollers are designed by the makers Prince Smith & Son, to increase the life of the leathers. The experience of users coincides with this claim.

Problems on Draft and Dabbing in the Noble Comb.

Drafting on the Noble comb is complex. The feeding, as previously explained, is intermittent from the different balls of four slivers at diametrically opposite sides of the machine. The fibres are continuously drawn off by four separate pairs of rollers and combined into one small rope-like sliver and conveyed to the coiler rollers, where it receives a further but very slight draft.

Given the following speeds, sizes of rollers and wheels for Figs. 95, 96 and 97, ascertain the following particulars in relation to the draft and dabbing in the Noble comb.

Speed of pulley shaft 2	=451 rev. per min.	Pillar Shaft
Bevels 3 on shaft 2	=18 teeth	
Bevels 4 on top pillar shaft 5	=31 ,,	
Annular pinion 16 ,, ,, ,,	=15 ,,	
,, wheel 15 ,, ,, 5a	=17 ,,	
Wheel 44 on bottom of pillar shaft 5a	= 24 teeth	Driving large circle
,, 46 on bottom of rack pinion shaft 47	= 50 ,,	
,, 48 on top of rack pinion shaft 47	= 10 ,,	
Rack 31 on inside of large circle	=264 ,,	
Large circle	= 43in. dia.	
Wheel 49 on rack pinion shaft 47	= 13 teeth	Driving small circles
,, 50 ,, shaft 51	= 16 ,,	
,, 52 ,, ,, 51	= 12 ,,	
Rack 13 on periphery of small circles	= 94 ,,	
Small circles	= 16in. dia.	

Wheel 45 on bottom of pillar shaft 5a	= 56 teeth	Outside drawing-off rollers
,, 54 on bottom of outside drawing-off roller shaft 55	= 52 ,,	
Drawing-off roller 56	= $2\frac{1}{2}$in. dia.	

Wheel 54a on bottom of inside drawing-off roller 55a	= 39 teeth	Inside drawing-off rollers
Drawing-off roller 56a	= 2in. dia.	

Pulley driving coiler	= 8in. dia.	Coiler
,, on ,,	= 10in. ,,	
Coiler rollers	= 3in. ,,	

Pulley driving dabbing motion, 9in., 10in., or 11in. dia.
Pulley on dabbing motion, 6in. dia.

1. Draft between *large* circle and outside drawing-off rollers =

$$\frac{\text{More}}{\text{Less}} \quad \frac{\overset{\text{Dia. roller 56}}{2\frac{1}{2}} \times \overset{\text{Whl. 45}}{56} \times \overset{\text{Whl. 46}}{50} \times \overset{\text{Rack 31}}{264}}{\underset{\text{Dia. large circle}}{43} \times \underset{\text{Whl. 54}}{52} \times \underset{\text{Whl. 44}}{24} \times \underset{\text{Whl. 48}}{10}} = 3{\cdot}44$$

2. Draft between *large* circle and inside drawing-off rollers =

$$\frac{\text{More}}{\text{Less}} = \frac{\overset{\text{Dia. roller 56a.}}{2} \times \overset{\text{Whl. 45}}{56} \times \overset{\text{Whl. 46}}{50} \times \overset{\text{Rack 31}}{264}}{\underset{\text{Dia. large circle}}{43} \times \underset{\text{Whl. 54a}}{39} \times \underset{\text{Whl. 44}}{24} \times \underset{\text{Whl. 10}}{10}} = 3{\cdot}67$$

3. Draft between inside and outside drawing-off rollers

$$= \frac{3{\cdot}67}{3{\cdot}44} = 1{\cdot}55 \text{ or } \frac{\overset{\text{Dia. roller 56a.}}{2}}{\underset{\text{Roller 56}}{2\frac{1}{2}}} \times \frac{\overset{\text{Whl. 54}}{52}}{\underset{\text{Whl. 54a}}{39}} = 1{\cdot}55$$

4. Draft between small circle and inside drawing-off rollers

$$= \frac{\overset{\text{Dia. roller 56a}}{2} \times \overset{\text{Whl. 45}}{56} \times \overset{\text{Whl. 46}}{50} \times \overset{\text{Whl. 50}}{16} \times \overset{\text{Rack 13}}{94}}{\underset{\text{Dia. small circle}}{16} \times \underset{\text{Whl. 54a}}{39} \times \underset{\text{Whl. 44}}{24} \times \underset{\text{Whl. 49}}{13} \times \underset{\text{Whl. 52}}{12}} = 3{\cdot}60$$

5. Revs. of large circle per minute.

$$= \frac{\overset{\text{Revs. shaft 2}}{451} \times \overset{\text{Whl. 3}}{18} \times \overset{\text{Whl. 16}}{15} \times \overset{\text{Whl. 44}}{24} \times \overset{\text{Whl. 48}}{10}}{1 \times \underset{\text{Whl. 4}}{31} \times \underset{\text{Whl. 15}}{17} \times \underset{\text{Whl. 46}}{50} \times \underset{\text{Rack 31}}{264}} = 4{\cdot}2$$

6. Surface speed of large circle in inches per minute.

$$= \frac{\overset{\text{Rev.}}{4{\cdot}2} \times \overset{\text{Dia.}}{43''} \times \overset{\pi}{22}}{7} = 567{\cdot}6\text{in.}$$

7. Revs. per minute of small circles.

$$= \frac{\overset{\text{Rev. shaft 2}}{451} \times \overset{\text{Whl. 3}}{18} \times \overset{\text{Whl. 16}}{15} \times \overset{\text{Whl. 44}}{24} \times \overset{\text{Whl. 49}}{13} \times \overset{\text{Whl. 52}}{12}}{1 \times \underset{\text{Whl. 4}}{31} \times \underset{\text{Whl. 15}}{17} \times \underset{\text{Whl. 46}}{50} \times \underset{\text{Whl. 5}}{16} \times \underset{\text{Rack 13}}{94}} = 11{\cdot}5$$

8. Surface speed of small circles

$$= \frac{\overset{\text{Rev.}}{11{\cdot}5} \times \overset{\text{Dia.}}{16} \times \overset{\pi}{22}}{7} = 578{\cdot}29\text{in.}$$

9. Surface speed of outside drawing-off rollers.

$$= \frac{\overset{\text{Rev. shaft 2}}{451} \times \overset{\text{Whl. 3}}{18} \times \overset{\text{Whl. 16}}{15} \times \overset{\text{Whl. 45}}{56} \times \overset{\text{Circe. rollers 56}}{2\tfrac{1}{2}''} \times 22}{1 \times \underset{\text{Whl. 4}}{31} \times \underset{\text{Whl. 15}}{17} \times \underset{\text{Whl. 54}}{52} \times 7} = 1955\text{in.}$$

10. Surface speed of inside drawing-off rollers

$$= \frac{\overset{\text{Rev. shaft 2}}{451} \times \overset{\text{Whl. 3}}{18} \times \overset{\text{Whl. 16}}{15} \times \overset{\text{Whl. 45}}{56} \times \overset{\text{Circe. roller 56a}}{2} \times 22}{1 \times \underset{\text{Whl. 4}}{31} \times \underset{\text{Whl. 15}}{17} \times \underset{\text{Whl. 54a}}{39} \quad 7} = 2085\text{in.}$$

11. Alternative solution of draft between large circle and outside drawing-off rollers.

$$\frac{\overset{\text{Surface speed of outside drawing-off roller}}{1955}}{\underset{\text{Rev. large circle}}{567{\cdot}6}} = 3{\cdot}44 \text{ draft.}$$

12. Alternative solution of draft between large circle and inside drawing-off rollers.

$$\frac{\overset{\text{Surface speed of inside drawing-off rollers}}{2085}}{\underset{\text{Rev. large circle}}{567{\cdot}6}} = 3{\cdot}67 \text{ draft.}$$

13. Draft between inside drawing-off rollers and calender rollers on coiler is very small—approximately 1·2.

14. Number of dabs per minute equals

$$\frac{\overset{\text{Rev. shaft 2}}{451} \times \overset{\text{Pulley on same}}{10}}{1 \times \underset{\text{Pulley on dabber}}{6}} = 751{\cdot}66$$

15. The lineal traverse of the circles for each dab of the dabbing brush

$$a.\ \text{Large circle} = \frac{\overset{\text{Surface speed of circle.}}{567{\cdot}6}}{751{\cdot}66} = 0{\cdot}755\text{in.}$$

$$b.\ \text{Small circles} = \frac{578{\cdot}29}{\underset{\text{Dabs per min.}}{751{\cdot}66}} = 0{\cdot}769\text{in.}$$

CHAPTER XXVIII.

SLIVER FUNNELS, CAN COILER, CIRCLE CLEANING, AND STOP MOTION.

SLIVER FUNNELS.

AFTER the slivers emerge from the drawing-off rollers adjacent to both small circles, they are combined, and the combined sliver, denominated the "combed top" enters the mouthpiece of a rotary funnel, through which the "top" passes. The function of this funnel is to roll the slivers into a rope-like form, and simultaneously impart to them an artificial twist, which temporarily increases the strength of the top and enables it to hold together until the next operation. See Fig. 160. The funnel for gathering in the sliver may be of the ordinary type as at Fig. 160, or modified and enclosed within a cover bracket as in the subsequent illustration, Fig. 161, which arrangement was introduced about a year ago by F. Briggs, Baildon. The object of this modification is to counteract any tendency of the slivers or "fluff" to accumulate and adhere to the revolving funnel, which, if permitted to occur, tends to arrest the rotation of the funnel.

Fig. 161 shows a plan of the delivery of the combed sliver, from the last two pairs of drawing-off rollers into the first funnel.

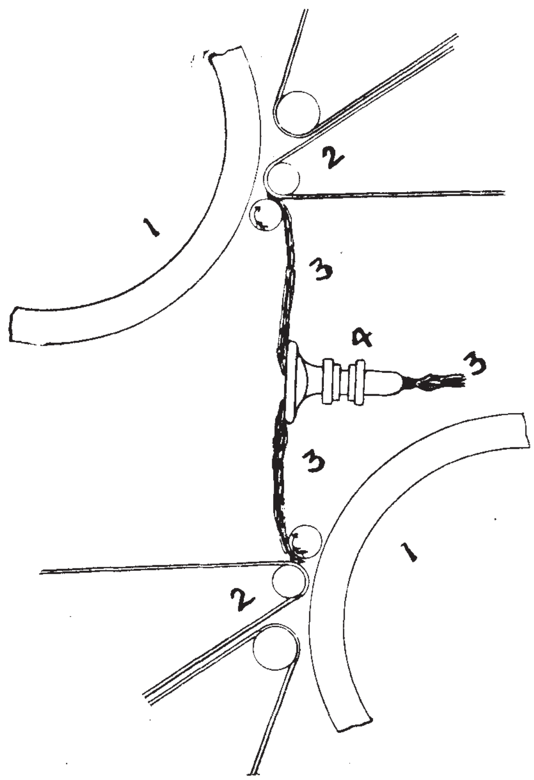
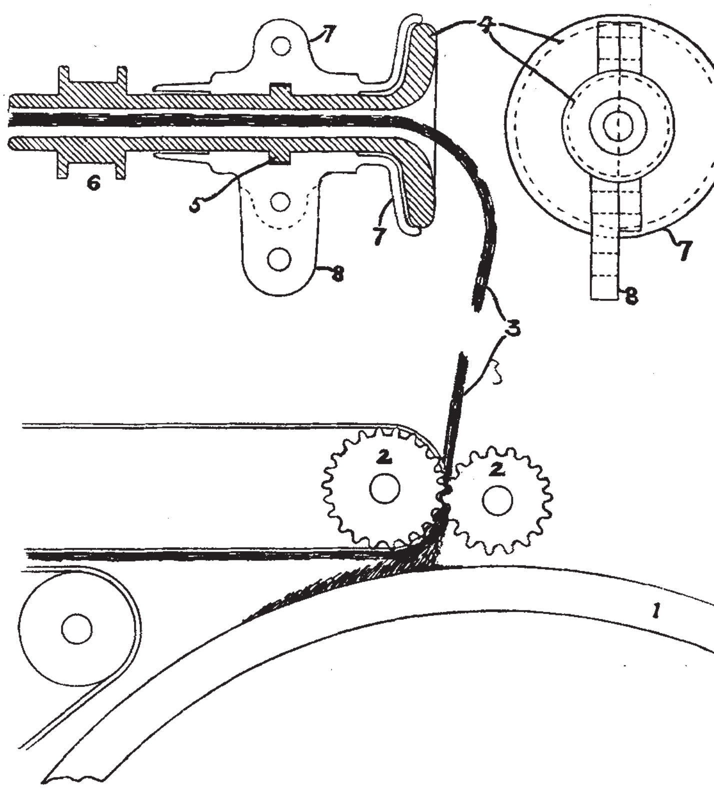


Fig. 160.

Fig. 162 is an elevation of the funnel opposite the mouthpiece.

The same numerals occurring in the different diagrams refer to the same details of mechanism.

Fig. 161. Fig. 162.



1 indicates an arc of the small circle; 2 the drawing-off rollers, and 3 the combed sliver or top. 4 is the revolving funnel, provided with a collar 5, which tends to keep

the funnel from lateral oscillation. A small flange pulley 6 is also compounded with the funnel, and is driven by a small strap from the top or main driving shaft of the machine. 7 is a stationary split cover bolted together so as to enclose the funnel 4 and prevent any fluff or sliver from accumulating around it. One part of the cover is provided with a bracket arm 8, through which the whole is supported and attached to the machine.

Can and Coiler.

From the funnel just described the combed top is conveyed to a second funnel rotating over the coiler and sliver can. Into this can it is deposited in a specially coiled form, and it can be readily withdrawn without any disarrangement of the fibres, or any adhesion between them and contiguous lengths of sliver, or breakage of the top. An additional advantage of the coiling arrangement is that the cans will take a larger quantity of sliver than do the ordinary cans.

Fig. 163 is a sectional elevation of the sliver can coiler and its gearing.

Fig. 164 shows a plan of *one* series of coils as they lie in the can, with a plan of the gearing to the can plate.

Fig. 165 illustrates in diagrammatic form the principle of the coiling mechanism.

The coiler consists essentially of two plates—the coiler plate and the can plate. These plates rotate in opposite directions and are eccentric to each other. Referring to Fig. 163, 9 is an iron case in which the gearing is enclosed. 10 is a horizontal shaft, uniformly and positively rotated from the pillar or drawing-off shaft of the combing machine, so as to ensure that the coiler shall start or stop in sympathy with the movement of the comb, as any lead on the part of the calendar or feed rollers of the coiler would immediately break the top. 11 is a bevel wheel keyed on the end of shaft 10 and gearing into a second bevel 12, compounded with the vertical shaft 13. From this shaft four distinct operations are controlled, viz., the rotation of (1) the second funnel, (2) the delivery or calendar rollers, (3) the coiler plate and (4) the can plate.

(1) A bevel wheel 14 on shaft 13 gears into and drives the bevel 15 mounted on the stud shaft 16. A pulley 17 on this shaft rotates, through belt 18, the funnel 19, supported and free to rotate at the top of frame 9.

(2) A bevel wheel 20, keyed fast near the top of shaft 13, gears into a bevel 21 mounted on the end of the calendar roller shaft 22. There are two fluted calendar rollers, only one of which is shown at 23. The second roller is driven at the same speed from the spur pinion 24.

(3) A spur pinion wheel 25, compounded with the shaft 13, gears into spur teeth formed on the periphery of the coiler plate 26. The latter is constructed with an opening 27 in the centre of the plate, and directly underneath the conductor opening 28 formed on the top of the gearing cover 9. From the opening 27 an inclined conducting tube 29 leads to the exit 30, near the periphery of the coiler plate.

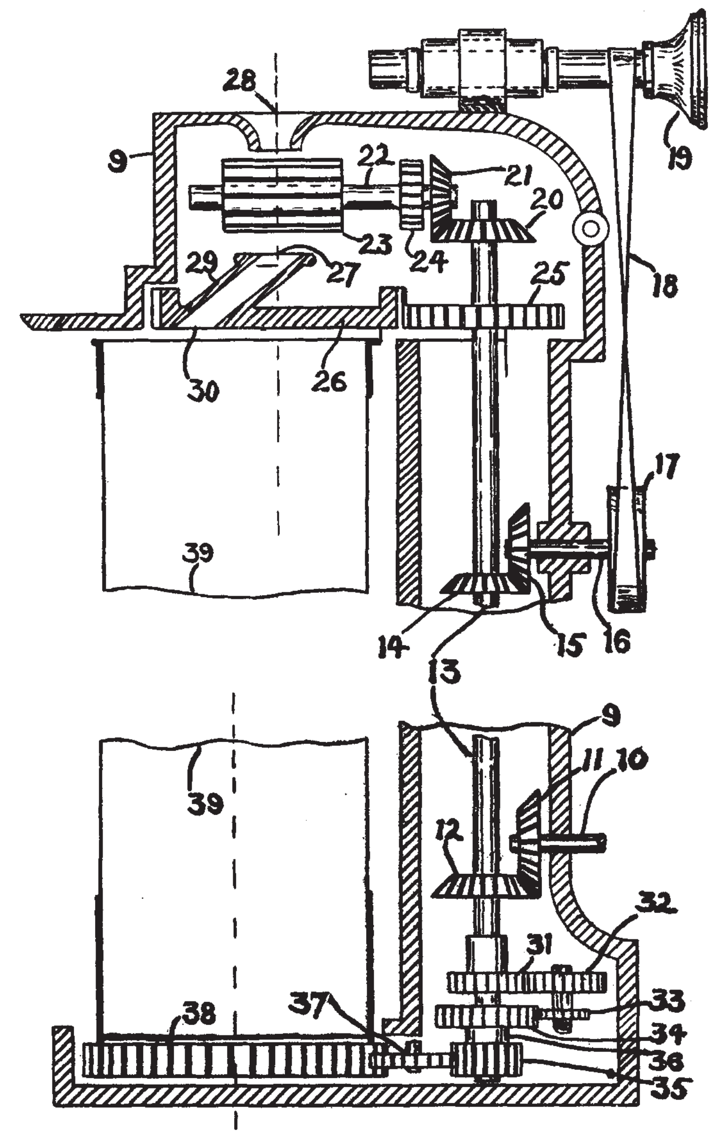

28
9
22
21
20
19
23
24
29
27
25
18
30
26
17
39
14
15
16
13
9
11
10
39
12
32
31
33
37
38
34
36
35

Fig. 163.

(4) A pinion wheel 31, near the base of shaft 13, drives the stud wheel 32 and stud pinion 33, which in turn gears into and drives the intermediate stud wheel 34 compounded with the stud pinion 35 on sleeve 36, which is free to rotate on the shaft 13. The wheel 35 drives, through a single intermediate wheel 37, the spur wheel formed on the periphery of the can plate 38, on which the sliver can 39 rests and rotates at about one twentieth the speed of the coiler plate 26.

The combed top, as it leaves the rotating funnel 4, is conveyed to the second rotating funnel 19. On emerging from this, it passes down the conductor 28, through the calendar rollers 23, into the central opening 27, and through the inclined conducting tube 29 and the exit 30, which is eccentric to the periphery of the can 39, where the top is deposited in compound spiral coils. To accomplish this, a very slow rotary motion is imparted to the can in the reverse direction to that of the coiler, and consequently the centre of the coil is left free, as shown in Fig. 164, which also shows the arrangement of the twenty coils for one complete revolution of the can. If the can were permitted to remain stationary, the sliver would be deposited in the form of a simple spiral coil, and would readily become entangled, but with this arrangement a combed top of the finest quality can be withdrawn without injury.

In the example given at Fig. 163, the shaft 13 makes 60 revolutions per minute. The value of each train of wheels is as follows :—

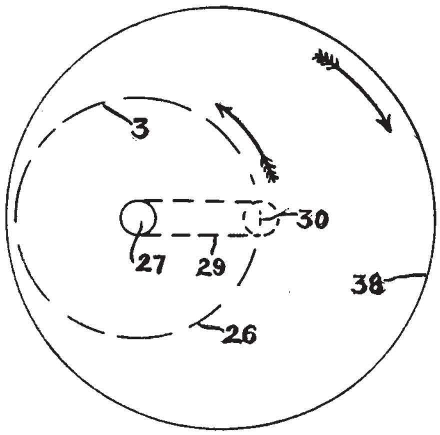


Fig. 165.

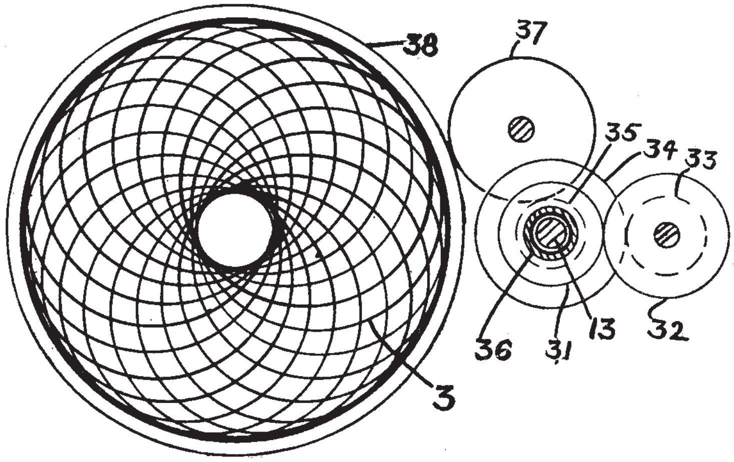


Fig. 164.

Coiler wheels number	25	26
Teeth in same	36	108

Can wheels number	31	32	33	34	35	38
Teeth in same	26	48	16	52	10	100

Then the speed of the coiler

$$= \frac{\text{Drivers}}{\text{Driven}} = \frac{60}{1} \times \frac{36}{108} = 20 \text{ Revolutions per minute.}$$

and the speed of the can

$$= \frac{\text{Drivers}}{\text{Driven}} = \frac{60}{1} \times \frac{26}{48} \times \frac{16}{52} \times \frac{10}{100} = 1 \text{ revolution per minute}$$

The result shows that for *one revolution* of the can the coiler makes *twenty* and consequently places twenty coils into the can for each revolution of the can.

Modern Method of Driving the Can and Coiler. A large number of combs are still in use which transmit motion from a bevel wheel, fixed on the pillar or drawing-off roller shaft through a horizontal shaft rotating near the floor of the room, to the can and coiler, through mechanism illustrated at Fig. 163.

Many of the older types of combs are being modified to coincide with those of recent date, which are constructed to transmit motion from a grooved pulley fixed on the top shaft of the comb (see Fig. 89), to a small grooved pulley suitably supported near the top of the framework of the can and coiler. A thick cotton twine or preferably a twisted leather strap is employed as the vehicle of motion.

Fig. 166 shows in elevation the modern method of driving the can and coiler.

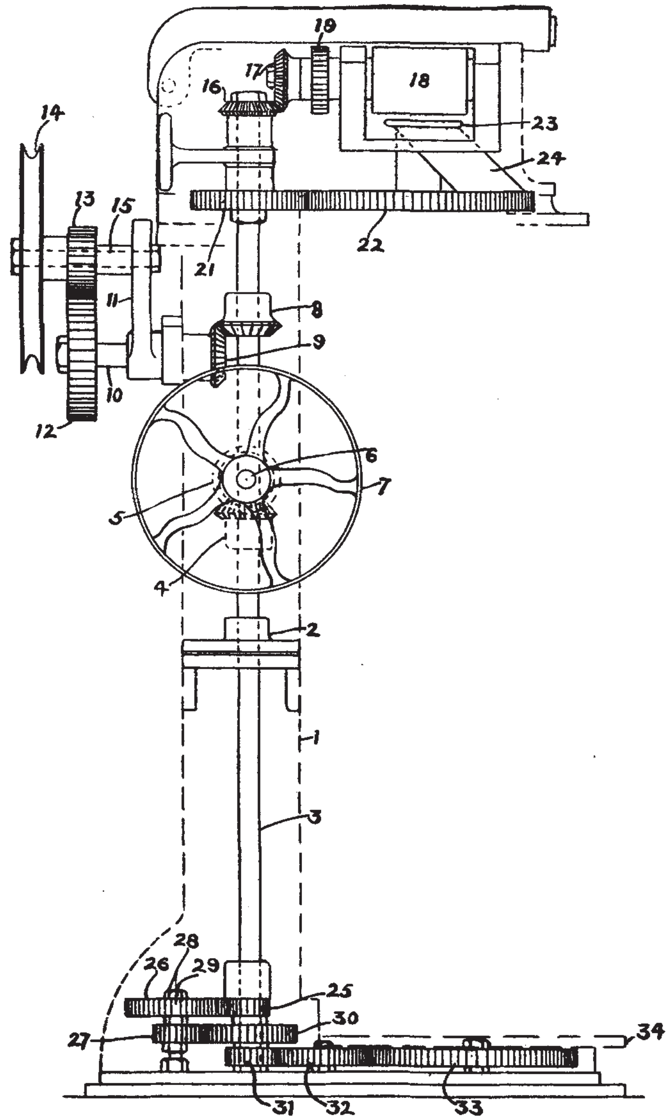

19
17
18
16
14
23
24
13
15
22
21
8
11
9
10
12
6
7
5
4
2
1
3
28
26
29
25
30
27
34
31
32
33

Fig. 166

Fig. 167 is a plan of the calendar or conducting rollers for same.

Both diagrams have been prepared from Prince Smith & Son's machine.

The main framework which is indicated at 1 carries a supporting and bearing bracket 2 for the main and vertical shaft 3. A bevel wheel 4 compounded with the shaft 3 is geared with a like bevel wheel 5 mounted on the short stud shaft 6. A grooved pulley 7 mounted on the end of this shaft receives a constant motion in sympathy with the comb from the top shaft of same as already explained.

A bevel wheel 8 on shaft 3, drives a like bevel wheel 9 mounted on stud shaft 10, suitably supported by the framework 1 and supporting an adjustable bracket 11. A spur wheel 12 compounded with shaft 10 gears into and drives a spur pinion 13 compounded with a grooved pulley 14, both of which are free to rotate on the fixed stud 15 carried by the bracket arm 11. Motion is transmitted from the pulley 14 to the usual funnel adjusted over the coiler.

A bevel wheel 16 mounted at the top end of shaft 3 drives a like bevel wheel 17 compounded with the end of calendar roller 18. A spur pinion 19 on the same shaft transmits, through a like spur pinion 19^1, motion to the second calendar roller 18^1. Pressure is regulated to the roller through the medium of two adjusting screws 20 (Fig. 167). A spur pinion 21 compounded with the shaft 3 drives the coiler plate through the teeth 22 formed on its periphery. 23 indicates the central opening in the coiler plate through which it receives the sliver delivered by the calendar rollers 18 and 18^1 and 24 denotes the inclined tube which conducts the sliver into the can in coiled form.

The gearing mechanism to the can is arranged as follows :—A spur pinion 25 is compounded with shaft 3 and gears into and drives the stud wheel 26 compounded

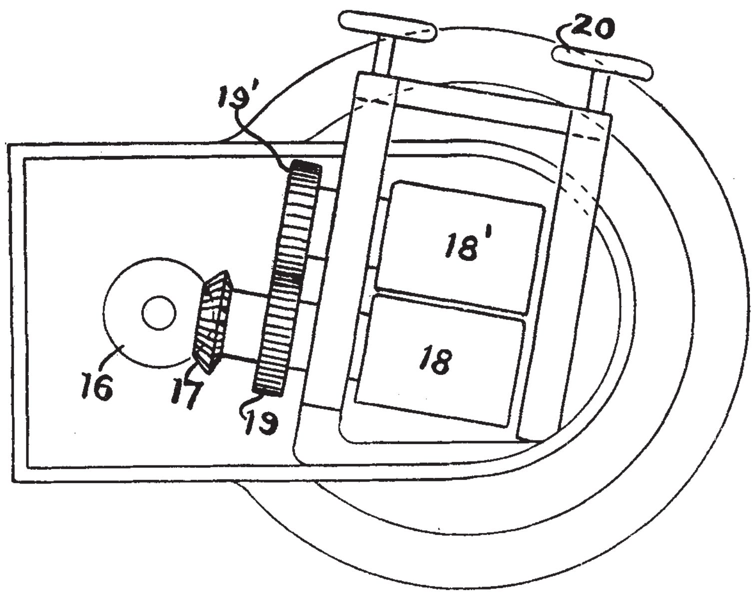


Fig. 167.

with the stud pinion 27 on sleeve 28 which is free to rotate on the fixed stud 29. The stud pinion 27 intermeshes with the teeth of the intermediate stud wheel 30 compounded with the spur wheel 31 which are free to rotate independently of shaft 3. The pinion 31 drives, through a single intermediate spur wheel 32 the can plate wheel 33 compounded with the can plate 34.

The relative purchase value of the various trains of wheels for the coiler and can is as follows :—

Coiler wheels number	21	22
Teeth in same	41	80

Can wheels number	25	26	27	30	31	33
Teeth in same	14	35	14	35	14	82

Example : Assume it is required to ascertain the velocity ratio of the can to the coiler—

Let x = the speed of the vertical shaft 3

$$\text{The speed of coiler } = \frac{x}{1} \times \frac{41}{80}$$

$$\text{And speed of can } = \frac{x}{1} \times \frac{14}{35} \times \frac{14}{35} \times \frac{14}{82}$$

∴ Ratio of

$$\frac{\text{Can}}{\text{Coiler}} = \frac{x}{1} \times \frac{14}{35} \times \frac{14}{35} \times \frac{14}{82} \times \frac{80}{41} \times \frac{1}{x} = \frac{1}{18{\cdot}76}$$

The can therefore makes approximately one revolution to nineteen of the coiler which consequently places this number of coils into the can for each revolution.

Cleaning the Comb Circles.

In addition to the noil knives previously explained, a small circular brush is adjustably placed near the pins of each respective comb circle, in such a manner that as the comb revolves, each respective brush rotates on its own axis and operates to completely *clean* the comb circles, by lifting to the tops of the pins, the noil, "chives," hard lumps and "motes" remaining in the combs of the large and small circles.

Noil Brush Details. The principle of the modern type of noil brush was introduced in the year 1892 by Greenwood and Farrar, Bradford. The details of the noil brush mechanism selected for illustration include the recent modification of this principle by G. T. Hemsley, Bradford.

Fig. 170 is a side elevation, in section, of the noil brush in working position with the comb circle.

Fig. 171 is an elevation of the brush as seen from the back. Similar letters in the diagrams refer to corresponding details.

The illustrations also incidentally demonstrate the modifications made to remove or reduce the tendency of the wool fibres to " lap " round the enlarged head of the stud, or the collar on same.

The respective details of the mechanism are as follows :—A indicates the fixed part of the comb ; B, a portion of the support for the small circle ; C, the foundation plate for the comb pins ; and D, the pins in the small circle. The disc foundation of the brush is shown at E ; it is studded with bristles F, which are arranged in contact with the pins D. The shank G of the brush is cylindrical and mounted on a spindle H which is provided with a thread as at I, and through the medium of nut J is combined to the supporting vertical arm of bracket K, in turn bolted fast to a fixed part of the machine as at L.

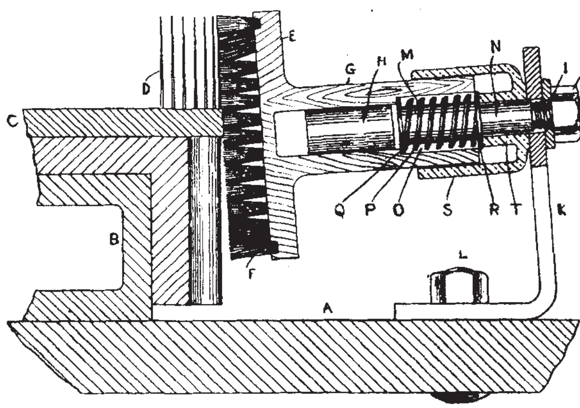
The diameter of spindle H is reduced twice, first as at M, and second as at N. The orifice of the brush shank near its terminal is, on the contrary, increased as at O. The orifice part O and the spindle part H coincide so as to form an annular cavity. A spiral spring P circumscribes the spindle part M and fills up the cavity in orifice O. The function of the spiral spring P is to keep the brush in frictional contact with the pins of the comb. Washers Q and R are respectively placed over the spindle at the inner and outer extremities of the spring P. The washer Q abuts in contact with the shoulder of the orifice O formed within the brush shank. A sleeve S provided with an annular internal ring T circumscribes the reduced part of the spindle N. The washer R abuts in contact with the annular ring T. The extreme end of the sleeve T abuts in contact with the bracket arm K. U represents in an enlarged form the loose and short fibres, etc., completely lifted to the surface of the comb pins.

The centre of the spindle H together with that of disc E, is arranged in the mounting so as to be below the base of the pins in the comb; it is also adjusted at a slight angle to the radius of the comb.

The bristles F are adjusted into frictional contact with the comb pins above which they slightly project. If the brush is correctly adjusted it will be in constant rotary contact with the pins from the roots to the tips. The rotary movement of the brush is produced automatically through its correct adjustment and frictional contact. The result of this combination and action is to thoroughly cleanse the internal and external peripheries of the large circle and small circles respectively and to lift from the roots to the tips of the pins all the waste, short fibres, motes, dirt and foreign matter remaining in the circles immediately after passing the drawing-off rollers.

In the foregoing arrangement it will be perceived that the end of the spindle H does not project into or through

Fig. 170.



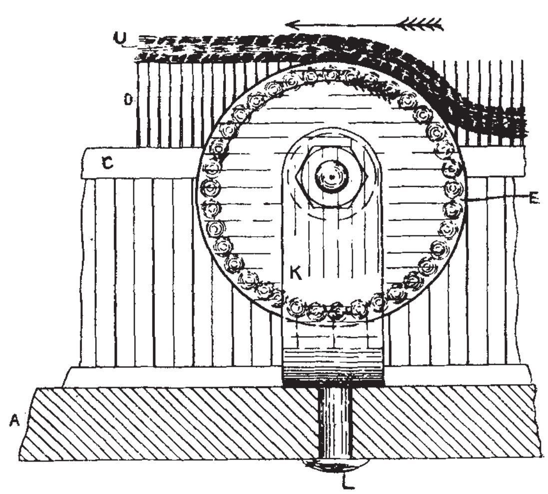


Fig. 171.

the head of the brush E and further that all the rotating parts are constructed apart from the brush. The object of this design is to reduce to a minimum any inert tendency of the fibres to "lap" or choke the free rotation of the brush.

Four noil brushes are used with each Noble comb and approximately arranged as shown in the plan, Fig.94.

Stop Motions for Combing Machines.

Stop motions are provided to operate in connection with the Noble comb whenever the slivers are much reduced in thickness or break during their passage between the small circles and the coiler. Broken sliver rapidly accumulates or wraps round the drawing-off rollers, causing waste, loss of time and damage to the machine if it is not instantaneously stopped.

There are numerous mechanisms in common use, designed to accomplish the above object, the fundamental principles of which are essentially identical. The following arrangement was introduced by John H. Rogers, which being simple in construction, will serve to illustrate the principle.

Fig. 172 is an elevation of the arrangement when the belt is on the fast pulley and the machine in motion.

Fig. 173 is an elevation of the same when the belt is on the loose pulley.

The same letters in each diagram refer to similar details.

A is a portion of the fixed cross rail of the machine to which is attached the escapement apparatus. B is the

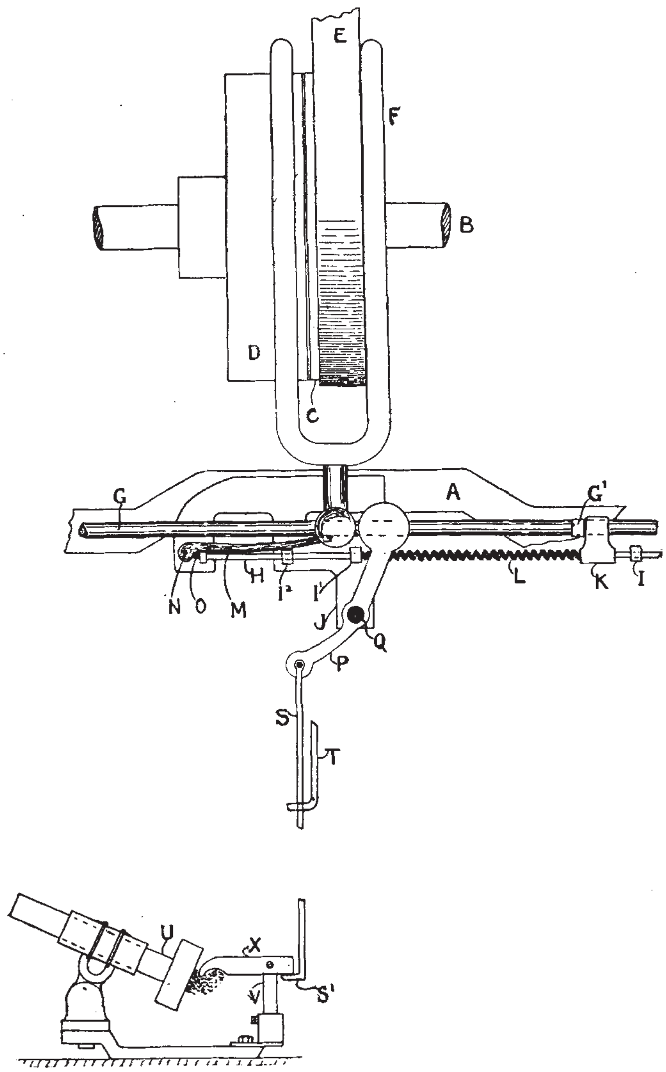


Fig. 172.

main driving shaft which carries the fast and loose pulleys C and D respectively. E is the driving strap and F the fork for controlling the same. The base of the fork F is adjustably set screwed to the horizontal rod G which in turn is carried by bearings (not shown) attached to the framework A and is also free to move laterally to the right or left.

A second horizontal rod H is supported and free to move laterally in the fixed bearings I, I^1 and I^2. A sleeve K, secured to the rod H is constructed with two prongs or short arms which enclose part of the rod G. The prongs are kept in close contact with a collar G^1 fixed on shaft G, through the action of a spiral spring L which circumscribes the rod H and has one end attached to the fixed bearing I^1 and the other linked to the sleeve K fixed on the rod H.

A simple "lever catch" M pivoted at N is provided with a notch or indent O. When the machine is in motion this indent fits over one end of the rod H and holds the spring L in tension. See Fig. 172. The belt E, rod G and sleeve G^1 when moved to the right carry with them the bifurcated sleeve K together with rod H likewise to the right a sufficient distance to permit the indent O to drop and fit over the end of the rod H. This outward movement of the rod H extends the coiled spring L as shown.

A weighted balk lever P is pivoted at Q in the fixed bracket J. The left and lighter arm of lever P supports and carries a vertically suspended rod S, the base or lower end of which is turned slightly to form a hood S^1. The rod S is maintained in a vertical plane through the influence of a guide rod T supported in suspension from the bracket J.

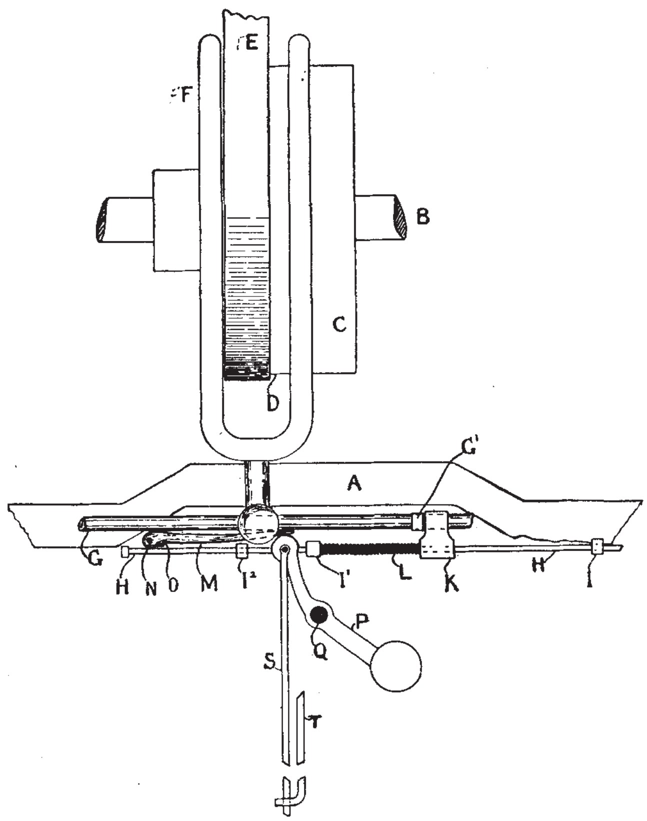


Fig. 173.

Suitably fixed and adjusted to a stationary part of the machine and in front of the sliver funnel U, is a small standard V to which are pivoted two detectors or tumbler levers X—one only is shown. Each has a long and a short arm. The longer arms rest normally on the sliver as it passes into the funnel while the shorter arms which are bent inwards towards each other, are adjusted over the hook part of S^1 by which means the rod S is retained in its lowest position and through mechanism described tends to keep the driving strap E on the fast pulley C. When the machine is in motion the spiral spring L is in tension as at Fig. 172.

Immediately one of the slivers breaks or becomes too thin, the long arm of either detector X falls by gravity and sets free the hook S^1, when the weighted arm of lever P descends and the opposite and lighter arm rises and strikes against the underside of the holding lever catch M by which means it lifts S and sets free the rod H. The spiral spring L then moves the sleeve K and rod H instantaneously to the left. The prongs of the sleeve K likewise move the fixed collar G^1, the rod G and the belt fork to the left which last operates to transfer the belt from the fast to the loose pulley as in Fig. 173.

Modified Detectors. Figs. 174 and 175 show in elevation and plan respectively a simple modification of the detectors or "feeler" levers designed to assist the long arms of the levers to respond readily to any variation or breakage of the slivers. This arrangement was introduced by E. J. Smith, Bradford, and Charles Swaine, Halifax.

The main features of the mechanism may be described as follows :—A, A^1 are fixed standards on which the two respective detectors B and B^1 are pivoted as shown ; C and

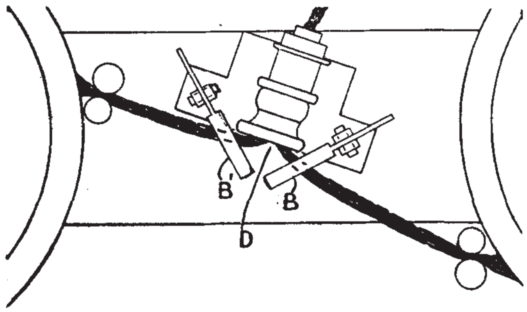


Fig. 175.

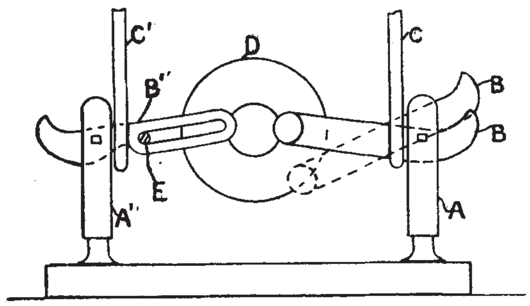


Fig. 174.

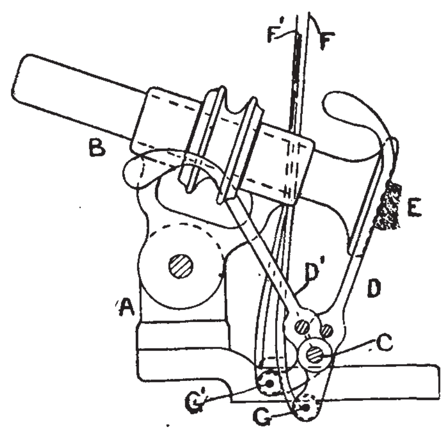


Fig. 176.

C¹ represent rods which link the detectors to the escapement mechanism adjacent to the belt fork. D indicates the mouthpiece of the usual sliver funnel. The special feature of the detectors is that the long arms are cylindrical, and in each a small steel ball E is placed. Immediately the sliver is much reduced in thickness or breaks, the detector arm tends to fall and the steel ball rolls towards the long and free end, and so assists the detector to operate with greater certainty and rapidity on the belting transferring apparatus.

Fig. 176 shows in elevation the form of detectors and their method of attachment to the vertical links which connect them with the escapement apparatus of the knocking-off motion, employed by Prince Smith & Son.

A indicates the fixed standard, B the sliver funnel, C the common pivot for the detectors D and D^1. A portion of the sliver is indicated at E in contact with which is shown the detector D. The short arms of detectors D and D^1 are respectively compounded to the vertical links F and F^1 by the studs G and G^1, which arrangement appears preferable to the hook form shown in Figs. 172 and 173.

CHAPTER XXIX.

THE SET OVER AND THEORY OF PINNING.

THE "set over" of a comb circle represents the radial distance occupied by the pins across the brass foundation plate.

The fineness, closeness of setting and number of rows of pins are governed by the fineness, quality and kind of material to be combed.

It is necessary therefore to adapt the comb circles to the class of wool to be worked, since any attempt to comb a long lustrous variety with circles designed for short merino would not only seriously damage the fibres but also break the pins.

The combing process is the last operation designed to complete the "cleansing" of the fibres, and is a factor which largely contributes towards a spun yarn of the highest count.

All succeeding processes are especially designed to gradually reduce the number of fibres in the cross section so as to enable a thread to be spun which contains the minimum number of fibres compatible with regularity of thread. The particulars for the different comb circles at present in use for any given class of wool have been largely determined as a result of practice, experiment and observation.

A brief consideration of the factors involved will be of assistance to a clear understanding of the particulars now in use and serve as a guide for future experiments. See also pages 298 to 300 inclusive.

Fig. 177 is a plan of the "set over" for the large and small circles. The impression is taken from a set of circles combing long wool, and is reduced to half the actual size. A indicates the large circle and B the adjacent small circle.

Fig. 178 shows in elevation the same "set over," also reduced to half the actual size.

Fig. 179 shows in elevation an alternative design of pin, to which subsequent reference is made.

For the large circle the set over is $3\frac{3}{4}''$, the length of pins $2\frac{1}{8}''$, and the thickness of the brass foundation A, is $\frac{3}{4}''$. For the small circles the set over is $\frac{3}{4}''$, the length of pins $2''$, and thickness of the brass foundation B, $\frac{5}{8}''$.

The number of concentric rows of pins in the large circle varies from seven to eleven inclusive and for the small circles from four to seven. The order of numbering the pins for the *large comb* circle commences with the row nearest to the internal periphery of the foundation plate and for each *small circle* with the row nearest the external periphery. The first row in each of these respective circles is frequently denominated the *combing point*. The space between each successive concentric row of pins gradually increases from the combing point to the outer periphery of the large circle and conversely to the inner peripheries of the small circles.

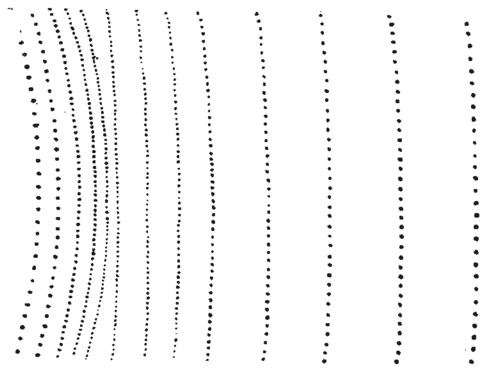


Fig 177.

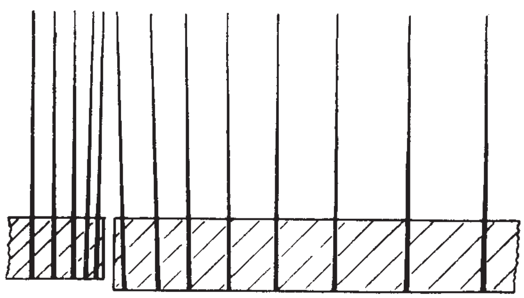


Fig. 178.

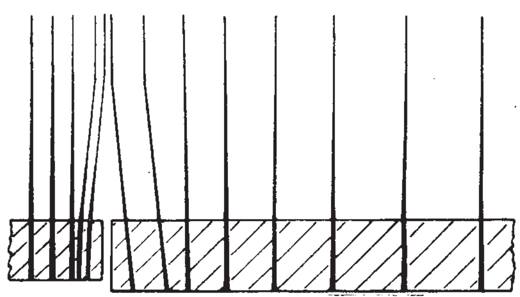


Fig. 179.

The pins of each row should *alternate* as much as possible with those of the contiguous rows; this arrangement tends to impart a waved effect in the fibres and produce a cleaner and better top than if they were drawn between pins set in parallel lines.

The pins in each successive row from the combing point are reduced in number but increased in diameter; these modifications facilitate the alternate setting and contribute to produce the above waved effect.

There should be a gradual *increase* in the amount of space between the contiguous pins in each successive row from front to back. Care should be exercised to ensure that the greater space due to reduction in number of pins is *not* neutralised by the increased diameter of same. Each greater space in the remoter rows must necessarily accommodate an increased number of fibres and also some " shorts " and foreign matter which cannot very well pass between the pins of the front rows.

All the fibres in the front rows must also lie in the spaces of the remoter rows, otherwise they could not be cleaned or combed at all.

A brief reflection on these data will demonstrate that the *aggregate* amount of unoccupied space per inch or other unit should not be less—preferably more, in the back than in the rows towards the front notwithstanding that a group of fibres will occupy a relatively smaller space diametrically, than the same number when severally treated.

A slight departure may be made in respect to the first two or three rows of " flat " pins where the *aggregate*, but not the individual amount of space is seldom less than in the following two or three rows of round pins.

The probable explanation for this departure is that in addition to the normal fibres to be combed, the fringes of the fibres projecting from the small circles have to be temporarily accommodated between the pins of the *front* rows of the large circle, and conversely, the fringes from the large circle have to be temporarily accommodated between the pins in the *front* rows of the respective small circles.

The bulk of the work is therefore thrown on to the pins in the *front* rows, hence the necessity for the *flat pins* which have a greater combing surface and are stronger than the round ones. *e.g.* A flat wire 15×21 has the same combing area as a round wire of size 18, but twenty of these flat wires per inch may be employed to fifteen of the round wires and yet the approximate space between the pins is the same while the aggregate amount of space per inch of setting is slightly in favour of the flat pins notwithstanding its twenty combing pins and spaces per inch as compared with fifteen of the round—see Table II.—large circle, row 4 and small circle, row 2.

The area for any of the " flat pins " may be ascertained as follows :—

$$\frac{\pi}{4} \text{ (major axis} \times \text{minor axis)}$$

or

$$\frac{11}{14} \text{ (major axis} \times \text{minor axis.)}$$

In order to thoroughly comb the finest wools, the pins should be as fine as possible and as great in number per unit of space as is compatible with the requisite strength to resist the strain of combing and to correspondingly secure the maximum number of spaces and individual treatment of the fibres.

There is of course a limit to the number of pins per unit of space and a minimum amount of space between the contiguous pins, beyond which it is impossible to go and still comb effectively. The fibres which are deposited between the pins of the small circle, from the ends of the slivers, are *fewer* in number than those simultaneously deposited into the pins of the large circle, for which reason the number of pins and spaces in the small circles may be relatively increased, involving a reduction in the diameter of the pins and the amount of space between them.

The space between the contiguous pins in the front row must bear some relation to the diameter of the fibre and load to be combed. Take for example the average diameter of a fine Botany wool and compare it with the space between the pins in actual operation, particulars of which are supplied in Table VI., page 454.

It will be seen that the number of pins contained in the first row is 41 and the size of the wire for same is 17×27.

The diameter for No. 27 is $0{\cdot}0164''$.

The aggregate amount of free space in one inch is $\therefore$

$$1'' - (41 \times {\cdot}0164) = 0{\cdot}3276$$

and the individual space =

$$\frac{0{\cdot}3276}{41} = 0{\cdot}008 = \frac{1''}{125}$$

For the small circles the number of pins in the first row is 45 and the wire is 18×28.

The diameter across the minor axis of wire is 0·0148″.

The aggregate amount of unoccupied space in one inch=

$$1 - (45 \times \cdot 0148) = \cdot 334''$$

and the individual space =

$$\frac{\cdot 0334}{45} = \cdot 0074 = \frac{1''}{135}$$

The average diameter of an Australian merino is about $\frac{1''}{1270}$

The diameter of fine Silesian wools averages $\frac{1''}{1700}$

The average diameter of Botany wool of medium quality, spinning to 64s, is about $\frac{1''}{1100}$

From these data, which, as previously demonstrated, are not the only factors that control the setting, it will be evident that given a well prepared or carded sliver which has been run through a gill box immediately preceding the comb, there is ample room between the pins for the Botany fibres. In the above example from 6 to 8 fibres could lie easily side by side between the pins apart from any overlapping. Of course, no matter how correctly the set over of a comb may be designed and the space between the pins regulated, it is possible to neutralise both by simply increasing the thickness of the sliver, increasing its weight and *overloading* the pins in an endeavour to increase the turn off.

The *load* of sliver should always bear some definite relation to the number and diameter of pins, together with the amount of space between them.

Every attempt in this direction results in an increased ratio per cent. of noil to top, and risks the fibres being drawn over the points of the pins without receiving any combing whatever. Incidentally the ratio per cent. of noil to top is greater whenever an increased amount of uncombed sliver is fed over the pins by lowering the feed knife (see Fig. 108). This modification causes the uncombed fibres to extend a greater distance over the small comb with the result that many, even if not thrown beyond the front row of pins, are out of reach of the drawing-off rollers and therefore can only be removed as noil. Briefly, the more perfect the combing, the smaller will be the turn off, and the less the noil.

From what has been said with regard to the construction of the circles, it will be evident that the whole of the fibres are not combed throughout their entire length owing to the fact that however fine the setting, there must always be an appreciable space between the edge of the foundation and the inner rows of pins in the large circle, and similarly also, between the edge and the outer row in the small circle, and though the brasses may touch each other when the combs meet, a short length of the fibre is not combed at all. Although the space is very small, it is sufficient to allow the "neps" to pass forward into the top. Several attempts have been made to obviate this by means of intersecting combs, but with little success. With the object of neutralising this space, the pins in the front rows of each circle are inclined from the foundation to the point. In an alternative arrangement the "incline" ceases about $\frac{1}{2}$in. to $\frac{3}{4}$in. from the point (see Fig. 179).

Another defect proceeding from the foregoing cause, but which only applies to *prepared* wool, is that there always exists a number of short staples which have not been thoroughly opened out by the fallers in the preparing boxes and when these are laid across both circles, and each end combed and straightened, that portion which happens to be placed between them still remains matted and crossed. The fibres do not draft freely in the subsequent operations, and the consequence is that slubs and lumps are formed which have to be removed by "picking," or they interfere with the soundness of the yarn. By setting the drawing-off rollers farther away from the circles, these short staples may be prevented from entering the top, but as this increases the quantity of noil it is not a desideratum.

Set Over Particulars.

Generally speaking, the sizes of wires for hackling, preparing, carding and combing most textile fibres are based upon the "Imperial Standard Wire Gauge." There are a few exceptions. Some makers have a special gauge of their own but the difference is very slight.

The diameters and sectional areas for wire numbers 5 to 36 inclusive are supplied under Table I.

From these given sizes and areas of pins a complete tabulated list of aggregate and individual spaces for any reasonable range of pins per inch of each size of wire may be prepared. From this the *set over* for any required class of wool may be selected and graduated as desired.

The combing particulars for five different varieties of wool are supplied at Tables II. to VI. inclusive.

In these tables the aggregate and individual amount of spacing together with the combing area of the pins for same are tabulated with the size of wire and number of pins per inch. Where the fraction is less than ·1 the equivalent vulgar fraction is also given.

In Table VII. additional examples of set overs, in common use, for four different qualities of wool are given.

From the practical details of set overs given, the following factors may be determined: (1) the aggregate amount of space per inch in each row of pins; (2) the individual amount of space between the contiguous pins in each row; (3) the combing area for the given pins, and (4) the correctness or otherwise of these practical particulars as compared with the foregoing theory.

TABLE I.

Imperial Standard Wire Gauge.

Wire Number	Diameter in inches	Sectional area in inches	Wire Number	Diameter in inches	Sectional area in inches
5	·212	·03530	21	·032	·0008042
6	·192	·02895	22	·028	·0006158
7	·176	·02433	23	·024	·0004524
8	·160	·02011	24	·022	·0003801
9	·144	·01629	25	·020	·0003142
10	·128	·01287	26	·018	·0002545
11	·116	·01057	27	·0164	·0002112
12	·104	·008495	28	·0148	·0001720
13	·092	·006648	29	·0136	·0001453
14	·080	·005027	30	·0124	·0001208
15	·072	·004072	31	·0116	·0001057
16	·064	·003217	32	·0108	·0000916
17	·056	·002463	33	·0100	·0000785
18	·048	·001810	34	·0092	·0000665
19	·040	·001257	35	·0084	·0000554
20	·036	·001018	36	·0076	·0000454

TABLE II.

Long wool circles—Length of staple 10″ to 15″. Range of spinning numbers 20s to 32s worsted. *Large circle*—set over 4 inches—length of pins $2\frac{1}{8}$″, 3 rows of flat and 5 rows of round pins. *Small circle*—set over $\frac{3}{4}$″ —length of pins = 2″, 2 rows of flat and 3 rows of round pins.

Row	Pins per inch	Size of wire	Dia. of wire in inches		Total space between the pins in thousandths of an inch.	Space between pins in inches		Combing surface of pins in inches	
			Decimal fraction	Vulgar fraction		Decimal fraction	Vulgar fraction	Decimal fraction	Vulgar fraction
1	20	14×21 flat	·032	$\frac{1}{31}$	360	·018	$\frac{1}{56}$	·00201	$\frac{1}{498}$
2	19	14×21 ,,	·032	$\frac{1}{31}$	392	·020	$\frac{1}{50}$	·00201	$\frac{1}{498}$
3	17	15×20 ,,	·036	$\frac{1}{28}$	388	·023	$\frac{1}{43}$	·00203	$\frac{1}{493}$
4	15	18 round	·048	$\frac{1}{21}$	280	·019	$\frac{1}{53}$	·00181	$\frac{1}{553}$
5	13	17 ,,	·056	$\frac{1}{18}$	272	·021	$\frac{1}{48}$	·00246	$\frac{1}{406}$
6	11	16 ,,	·064	$\frac{1}{16}$	296	·027	$\frac{1}{37}$	·00322	$\frac{1}{310}$
7	10	15 ,,	·072	$\frac{1}{14}$	280	·028	$\frac{1}{36}$	·00407	$\frac{1}{246}$
8	8	14 ,,	·080	$\frac{2}{25}$	360	·045	$\frac{1}{22}$	·00503	$\frac{1}{199}$
1	22	14×21 flat	·032	$\frac{1}{31}$	296	·013	$\frac{1}{76}$	·00201	$\frac{1}{499}$
2	20	15×21 ,,	·032	$\frac{1}{31}$	360	·018	$\frac{1}{55}$	·00181	$\frac{1}{553}$
3	16	15×20 ,,	·036	$\frac{1}{28}$	424	·026	$\frac{1}{38}$	·00203	$\frac{1}{493}$
4	10	16 round	·064	$\frac{1}{16}$	360	·036	$\frac{1}{28}$	·00322	$\frac{1}{310}$
5	8	15 ,,	·072	$\frac{1}{14}$	424	·053	$\frac{1}{19}$	·00407	$\frac{1}{246}$

For higher counts and finer *prepared* sliver the number of pins per inch for the front rows of the large and small circles may be increased to 26 and 28 respectively.

TABLE III.

Long wool circles—Length of staple 10 to 15 inches. Range of spinning numbers 28s to 36s worsted. *Large circle*—set over 3 to 4 inches—length of pins $2\frac{1}{8}''$, 3 rows flat and 4 rows of round pins. *Small circle*—set over $\frac{3}{4}''$—length of pins 2″, 2 rows of flat and 3 rows of round pins.

Row	Pins per inch	Size of wire	Dia. of wire in inches: Decimal fraction	Dia. of wire in inches: Vulgar fraction	Total space between the pins in thousandths of an inch	Space between pins in inches: Decimal fraction	Space between pins in inches: Vulgar fraction	Combing surface of pins in inches: Decimal fraction	Combing surface of pins in inches: Vulgar fraction
1	20	14 × 22 flat	·028	$\frac{1}{36}$	440	·022	$\frac{1}{46}$	·00175	$\frac{1}{571}$
2	20	14 × 22 ,,	·028	$\frac{1}{36}$	440	·022	$\frac{1}{46}$	·00175	$\frac{1}{571}$
3	18	14 × 21 ,,	·032	$\frac{1}{31}$	424	·023	$\frac{1}{43}$	·00201	$\frac{1}{498}$
4	18	20 round	·036	$\frac{1}{28}$	352	·019	$\frac{1}{53}$	·001018	$\frac{1}{983}$
5	16	18 ,,	·048	$\frac{1}{21}$	232	·015	$\frac{1}{66}$	·001810	$\frac{1}{553}$
6	11	16 ,,	·064	$\frac{1}{16}$	296	·027	$\frac{1}{37}$	·003217	$\frac{1}{310}$
7	9	15 ,,	·072	$\frac{1}{14}$	352	·039	$\frac{1}{26}$	·004072	$\frac{1}{246}$
1	26	14 × 23 flat	·024	$\frac{1}{42}$	376	·014	$\frac{1}{71}$	·00151	$\frac{1}{662}$
2	26	14 × 23 ,,	·024	$\frac{1}{42}$	376	·014	$\frac{1}{71}$	·00151	$\frac{1}{662}$
3	20	20 round	·036	$\frac{1}{28}$	280	·014	$\frac{1}{71}$	·001018	$\frac{1}{983}$
4	16	18 ,,	·048	$\frac{1}{21}$	232	·015	$\frac{1}{66}$	·001810	$\frac{1}{553}$
5	12	16 ,,	·064	$\frac{1}{16}$	232	·019	$\frac{1}{53}$	·003217	$\frac{1}{310}$

TABLE IV.

Medium wool circles—Length of staple 6 to 9 inches. Range of spinning numbers 50s to 60s worsted. *Large circle*—set over $2\frac{1}{4}''$—length of pins $1\frac{3}{4}''$, 3 rows flat and 6 rows of round pins. *Small circle*—set over $\frac{11}{16}''$—length of pins $1\frac{5}{8}''$, 3 rows of flat and 3 rows of round pins.

Row	Pins per inch	Size of wire	Dia. of wire in inches		Total space between the pins in thousandths of an inch	Space between pins in inches		Combing surface of pins in inches	
			Decimal fraction	Vulgar fraction		Decimal fraction	Vulgar fraction	Decimal fraction	Vulgar fraction
1	30	16×24 flat	·022	$\frac{1}{45}$	340	·0113	$\frac{1}{88}$	·00111	$\frac{1}{901}$
2	29	16×24 ,,	·022	$\frac{1}{45}$	362	·0124	$\frac{1}{80}$	·00111	$\frac{1}{901}$
3	26	17×23 ,,	·024	$\frac{1}{42}$	376	·0144	$\frac{1}{69}$	·00105	$\frac{1}{952}$
4	20	20 round	·036	$\frac{1}{28}$	280	·0140	$\frac{1}{71}$	·001018	$\frac{1}{983}$
5	18	19 ,,	·040	$\frac{1}{25}$	280	·0155	$\frac{1}{65}$	·001257	$\frac{1}{796}$
6	16	18 ,,	·048	$\frac{1}{21}$	232	·0145	$\frac{1}{69}$	·001810	$\frac{1}{553}$
7	14	17 ,,	·056	$\frac{1}{18}$	216	·0154	$\frac{1}{65}$	·002463	$\frac{1}{406}$
8	12	17 ,,	·056	$\frac{1}{18}$	328	·0273	$\frac{1}{37}$	·002463	$\frac{1}{406}$
9	10	16 ,,	·064	$\frac{1}{16}$	360	·0360	$\frac{1}{28}$	·003217	$\frac{1}{310}$
1	32	17×25 flat	·020	$\frac{1}{50}$	360	·0112	$\frac{1}{89}$	·00088	$\frac{1}{1136}$
2	30	17×24 ,,	·022	$\frac{1}{45}$	340	·0113	$\frac{1}{88}$	·00097	$\frac{1}{1031}$
3	27	17×23 ,,	·024	$\frac{1}{42}$	352	·0130	$\frac{1}{77}$	·00105	$\frac{1}{952}$
4	22	21 round	·032	$\frac{1}{31}$	296	·0134	$\frac{1}{75}$	·000804	$\frac{1}{1244}$
5	18	19 ,,	·040	$\frac{1}{25}$	280	·0155	$\frac{1}{65}$	·001257	$\frac{1}{796}$
6	14	17 ,,	·056	$\frac{1}{18}$	216	·0154	$\frac{1}{65}$	·002463	$\frac{1}{406}$

TABLE V.

Short Botany wool circles—Length of staple 5 to 7 inches. Range of spinning numbers 60s to 70s worsted. *Large circle*—set over $1\frac{5}{8}''$—length of pins $1\frac{1}{2}''$, 3 or 4 rows of flat and 7 or 8 rows of round pins. *Small circles*—set over $\frac{5}{8}''$—length $1\frac{3}{8}''$ to $1\frac{1}{2}''$, 3 or 4 rows of flat and 4 or 5 rows of round pins.

Row	Pins per inch	Size of wire	Dia. of wire in inches		Total space between the pins in thousandths of an inch	Space between pins in inches		Combing surface of pins in inches	
			Decimal fraction	Vulgar fraction		Decimal fraction	Vulgar fraction	Decimal fraction	Vulgar fraction
1	40	17 × 27 flat	·0164	$\frac{1}{61}$	344	·0086	$\frac{1}{116}$	·00072	$\frac{1}{1389}$
2	40	17 × 27 ,,	·0164	$\frac{1}{61}$	344	·0086	$\frac{1}{116}$	·00072	$\frac{1}{1389}$
3	37	20 × 27 ,,	·0164	$\frac{1}{61}$	393	·0106	$\frac{1}{94}$	·00046	$\frac{1}{2174}$
4 }	32	20 × 25 if flat	·020	$\frac{1}{50}$	360	·0112	$\frac{1}{89}$	·00056	$\frac{1}{1786}$
4 }	34	24 if round	·022	$\frac{1}{46}$	252	·0074	$\frac{1}{137}$	·000380	$\frac{1}{2632}$
5	33	24 round	·022	$\frac{1}{46}$	274	·0083	$\frac{1}{120}$	·000380	$\frac{1}{2632}$
6	30	23 ,,	·024	$\frac{1}{42}$	280	·0093	$\frac{1}{107}$	·000452	$\frac{1}{2210}$
7	28	23 ,,	·024	$\frac{1}{42}$	328	·0117	$\frac{1}{85}$	·000452	$\frac{1}{2210}$
8	24	22 ,,	·028	$\frac{1}{36}$	328	·0136	$\frac{1}{75}$	·000616	$\frac{1}{1622}$
9	22	22 ,,	·028	$\frac{1}{36}$	384	·0175	$\frac{1}{57}$	·000616	$\frac{1}{1622}$
10	20	21 ,,	·032	$\frac{1}{31}$	360	·0180	$\frac{1}{55}$	·000804	$\frac{1}{1244}$
11	18	20 ,,	·036	$\frac{1}{28}$	352	·0195	$\frac{1}{51}$	·001018	$\frac{1}{983}$
1	45	18 × 28 flat	·0148	$\frac{1}{68}$	334	·0074	$\frac{1}{135}$	·00058	$\frac{1}{1724}$
2	45	18 × 28 ,,	·0148	$\frac{1}{68}$	334	·0074	$\frac{1}{135}$	·00058	$\frac{1}{1724}$
3	42	20 × 28 ,,	·0148	$\frac{1}{68}$	378	·0090	$\frac{1}{111}$	·00042	$\frac{1}{2381}$
4 }	37	20 × 27 if flat	·0164	$\frac{1}{61}$	393	·0106	$\frac{1}{94}$	·00046	$\frac{1}{2174}$
4 }	36	24 if round	·022	$\frac{1}{46}$	208	·0058	$\frac{1}{172}$	·000380	$\frac{1}{2632}$
5	30	23 round	·024	$\frac{1}{42}$	280	·0093	$\frac{1}{107}$	·000452	$\frac{1}{2210}$
6	25	22 ,,	·028	$\frac{1}{36}$	300	·0120	$\frac{1}{83}$	·000616	$\frac{1}{1622}$
7	20	20 ,,	·036	$\frac{1}{28}$	280	·0140	$\frac{1}{71}$	·001018	$\frac{1}{983}$

TABLE VI.

Botany wool circles—Length of staple 5″ to 7″ Range of spinning numbers 56s to 70s worsted. *Large circle*—set over 2 inches—length of pins $1\frac{5}{8}$″, 3 rows of flat and 7 rows of round pins. *Small circle*—set over $\frac{5}{8}$″ —length of pins $1\frac{1}{2}$″, 3 rows of flat and 3 rows of round pins.

Row	Pins per inch	Size of wire	Dia. of wire in inches		Total space between the pins in thousandths of an inch	Space between pins in inches		Combing surface of pins in sq. inches	
			Decimal fraction	Vulgar fraction		Decimal fraction	Vulgar fraction	Decimal fraction	Vulgar fraction
1	41	17 × 27 flat	·0164	$\frac{1}{61}$	328	·0080	$\frac{1}{125}$	·00072	$\frac{1}{1389}$
2	40	17 × 27 ,,	·0164	$\frac{1}{61}$	344	·0086	$\frac{1}{116}$	·00072	$\frac{1}{1389}$
3	37	19 × 26 ,,	·018	$\frac{1}{56}$	334	·0090	$\frac{1}{111}$	·00056	$\frac{1}{1786}$
4	28	23 round	·024	$\frac{1}{42}$	328	·0117	$\frac{1}{85}$	·000452	$\frac{1}{2210}$
5	25	22 ,,	·028	$\frac{1}{36}$	300	·0120	$\frac{1}{83}$	·000616	$\frac{1}{1622}$
6	22	21 ,,	·032	$\frac{1}{31}$	296	·0134	$\frac{1}{74}$	·000804	$\frac{1}{1244}$
7	20	20 ,,	·036	$\frac{1}{28}$	280	·0140	$\frac{1}{71}$	·001018	$\frac{1}{983}$
8	18	19 ,,	·040	$\frac{1}{25}$	280	·0150	$\frac{1}{66}$	·001257	$\frac{1}{795}$
9	17	19 ,,	·040	$\frac{1}{25}$	320	·0190	$\frac{1}{53}$	·001257	$\frac{1}{795}$
10	15	18 ,,	·048	$\frac{1}{21}$	280	·0190	$\frac{1}{53}$	·001810	$\frac{1}{553}$
1	45	18 × 28 flat	·0148	$\frac{1}{67}$	334	·0074	$\frac{1}{135}$	·00058	$\frac{1}{1724}$
2	44	18 × 28 ,,	·0148	$\frac{1}{67}$	349	·0079	$\frac{1}{126}$	·00058	$\frac{1}{1724}$
3	40	19 × 27 ,,	·0164	$\frac{1}{61}$	344	·0086	$\frac{1}{116}$	·00051	$\frac{1}{1961}$
4	28	23 round	·024	$\frac{1}{42}$	328	·0117	$\frac{1}{85}$	·000452	$\frac{1}{2210}$
5	22	21 ,,	·032	$\frac{1}{31}$	296	·0134	$\frac{1}{75}$	·000804	$\frac{1}{1244}$
6	19	20 ,,	·036	$\frac{1}{28}$	316	·0166	$\frac{1}{60}$	·001018	$\frac{1}{982}$

TABLE VII.

	Qualities 44s to 50s		50s to 56s		56s to 60s		60s to 70s		
Row	Pins	Size	Pins	Size	Pins	Size	Pins	Size	
1	29	16×24	32	16×25	36	17×26	42	17×27	LARGE CIRCLES
2	28	17×24	31	17×25	35	18×26	41	18×27	
3	26	18×23	27	18×24	32	19×25	39	19×27	
4	23	22	22	22	27	23	36	21×26	
5	20	21	18	20	24	22	28	23	
6	18	20	16	19	22	22	27	23	
7	14	18	14	18	20	21	23	22	
8	11	17	12	17	17	19	20	21	
9	10	16	12	17	14	18	20	21	
10	9	15	10	16	12	17	16	19	
11	—	—	—	—	—	—	14	18	
	3 ins.		$2\frac{3}{8}$ ins.		$2\frac{1}{2}$ ins.		$1\frac{3}{4}$ ins.		Set over
	$1\frac{3}{4}$ ins.		$1\frac{5}{8}$ ins.		$1\frac{5}{8}$ ins.		$1\frac{5}{8}$ ins.		Length of pins
	$3\frac{3}{4} \times \frac{1}{2}$ ins.		$3\frac{1}{2} \times \frac{1}{2}$ ins.		$3\frac{1}{4} \times \frac{7}{16}$ ins.		$2\frac{3}{4} \times \frac{7}{16}$ ins.		Brass foundation
1	34	16×25	36	16×26	41	17×27	46	18×28	SMALL CIRCLES
2	32	17×25	35	18×26	40	19×27	45	20×28	
3	27	18×24	31	18×25	36	20×26	40	20×27	
4	23	22	22	22	32	20×25	35	21×26	
5	18	20	18	20	27	23	28	23	
6	14	18	12	17	20	21	27	23	
7	—	—	—	—	14	18	23	22	
8	—	—	—	—	—	—	20	21	
	$\frac{5}{8}$ ins.		$\frac{5}{8}$ ins.		$\frac{5}{8}$ ins.		$\frac{5}{8}$ ins.		Set over
	$1\frac{5}{8}$ ins.		$1\frac{1}{2}$ ins.		$1\frac{1}{2}$ ins.		$1\frac{3}{8}$ ins.		Length of pins
	$1\frac{3}{4} \times \frac{7}{16}$ ins.		$1\frac{3}{4} \times \frac{7}{16}$ ins.		$1\frac{3}{4} \times \frac{7}{16}$ ins.		$1\frac{3}{4} \times \frac{13}{32}$ ins.		Brass foundation

CHAPTER XXX.

COOPER'S NOBLE COMB.

THIS modified combing machine was introduced into practice in the year 1906. It is constructed to accommodate either three or four small circles within the large circle.

During more recent years the inventors and users have favoured the "four circle" comb which gives *four* separate drawings and an increased production of combed top.

The essential features of the mechanism include the adoption of four rotating discs the peripheries of which are constructed with saw like teeth which are inserted between the rows of pins in the comb circles and rotate with their backs or smooth sides in contact with the sliver and in the direction of its traverse at approximately the same surface speed but preferably a little faster—sufficient to keep the material under control from the feed boxes to the comb pins.

Two of these serrated discs rotate—one between the first and second rows and one between the third and fourth rows of pins in the small circle. The *two* remaining discs rotate—one between the second and third and one between the sixth and seventh rows of pins of the large circle.

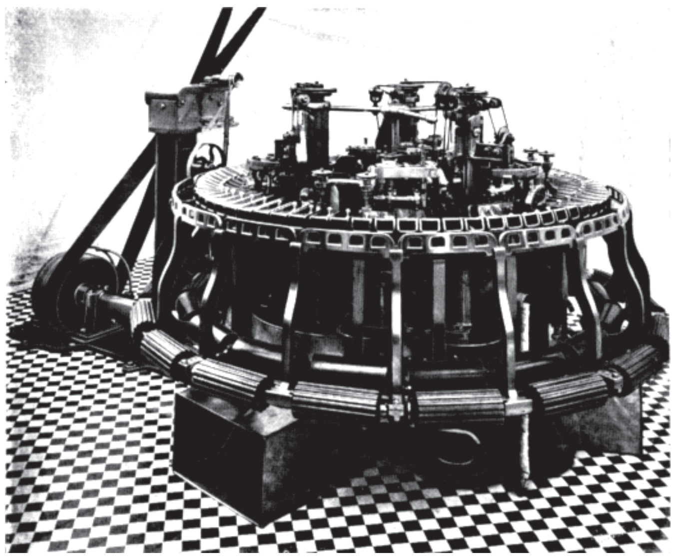


Fig. 183.
COOPER'S THREE CIRCLE NOBLE COMB.

They are constructed and mounted in such a manner as to coincide at all points with the path of motion of the comb, and without the peripheries of the discs striking the pins of either comb circle.

The function of these discs is to *lightly* lay hold of the wool as it emerges from under a pair of "leading" discs (to which reference will be made later) and press it as it is brought forward by the large circle into the interstices intervening between the pins. This part of the feeding operation is completed by the aid of three stationary steel blades which are concentric with the comb circles—two of these blades are used for the large circle and one is fixed between the two circles but adjacent to the small circle, see Fig. 184.

The rotating discs together with the leading discs for each circle and final "press" knives are carried on separate studs or spindles each of which is capable of independent adjustment.

The employment of the foregoing discs and stationary knives obviates the necessity for dabbing brushes and the overhead gearing with all its consequent disadvantages.

The main driving shaft is placed, as shown in the subsequent illustration, under the gearing plate of the machine. About $2\frac{1}{2}$ H.P. is required to drive a three circle comb as compared with $3\frac{1}{2}$ H.P. for the standard comb.

The removal of the dabbing brush apparatus makes it possible to increase the speed of the comb to and beyond the point which allows sufficient time for an attendant to repair any broken slivers without stopping the machine. Broken slivers can be conveniently repaired when the machine is making as many as $4\frac{1}{4}$ or $4\frac{1}{2}$ revolutions per minute.

The usual method of transmitting motion to the various parts of the machine by toothed gearing has been supplanted and is performed by sprocket wheels and chains as subsequently illustrated and described.

Whatever may be the ultimate outcome of this modified Noble comb, it is well worthy of a permanent record in any treatise which deals somewhat exhaustively with the Noble wool combing machine.

Details of the Mechanism and Operation. Fig. 183 is a perspective view of the Cooper comb containing three small circles within the large circle.

Fig. 184 shows the rotary disc mechanism which replaces the dabbing brushes of the standard comb.

Fig. 185 is a vertical elevation of part of the comb enclosing one small circle.

Fig. 186 shows in plan the method of transmitting motion to the various parts of the machine.

Fig. 187 shows in elevation the arrangement for driving the large and small circles.

Fig. 188 is a part plan of the large and one small comb circle.

Fig. 189 shows in elevation the arrangement of the rotating disc mechanism in relation to the comb circle and its supports.

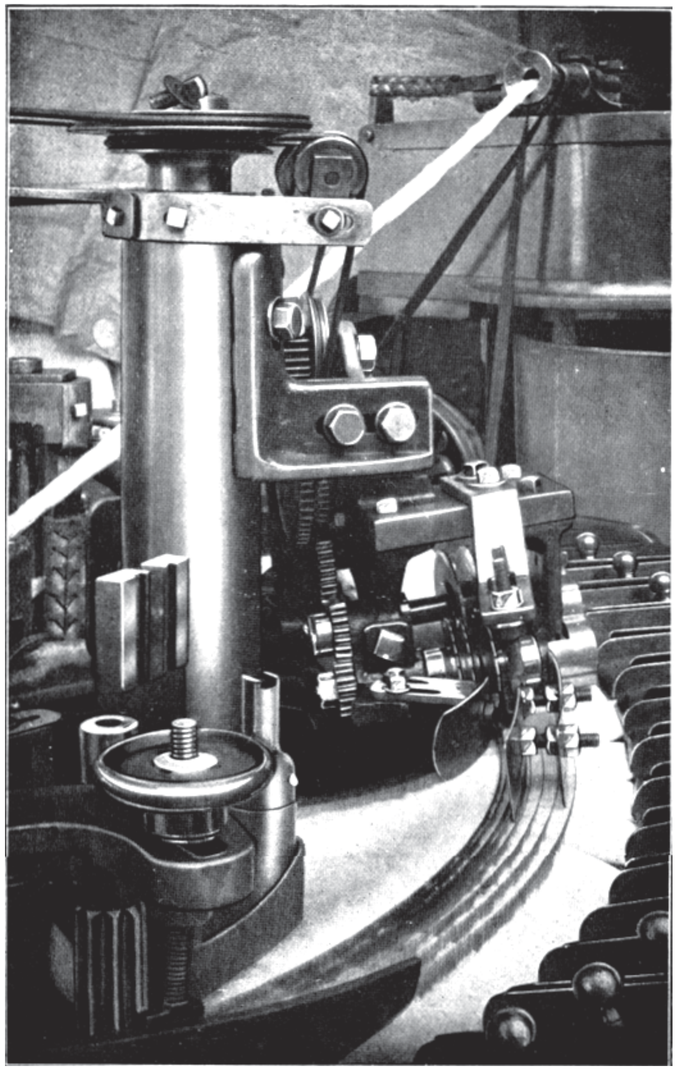


Fig. 184.
Cooper's Comb, showing Rotary Disc Mechanism.

Fig. 190 shows the disc mechanism partly in perspective and detached.

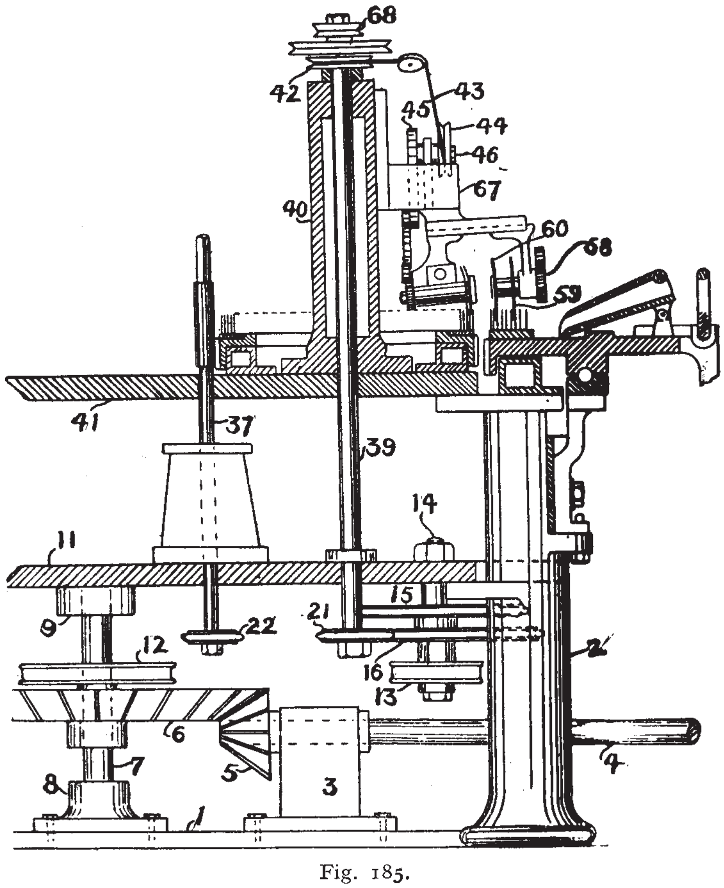


Fig. 185.

Fig. 191 is a plan on a larger scale of the disc mechanism in relation to the large and small circles at the point where they converge.

Similar numerals in the various diagrams refer to corresponding details.

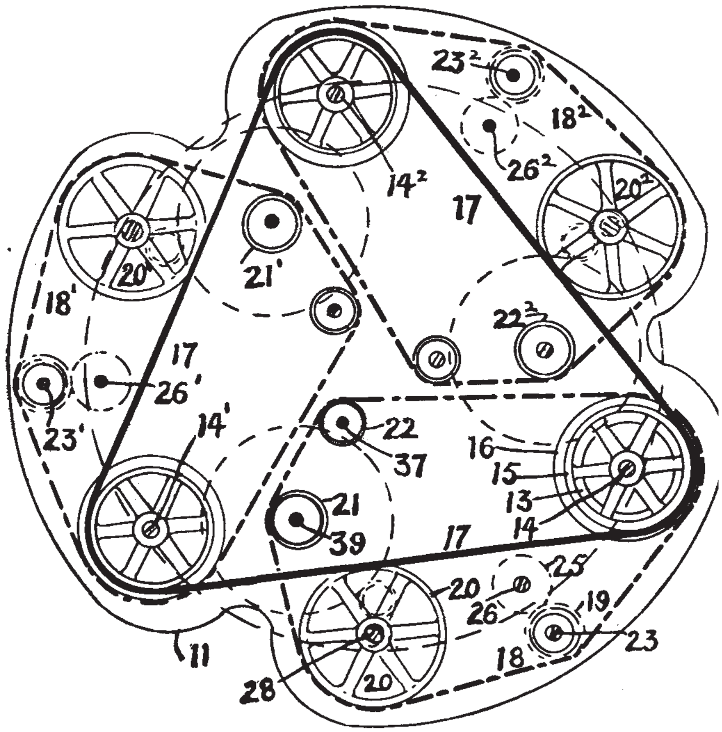


Fig. 186.

No specific reference or description is given in these diagrams to details which occur also in the standard comb.

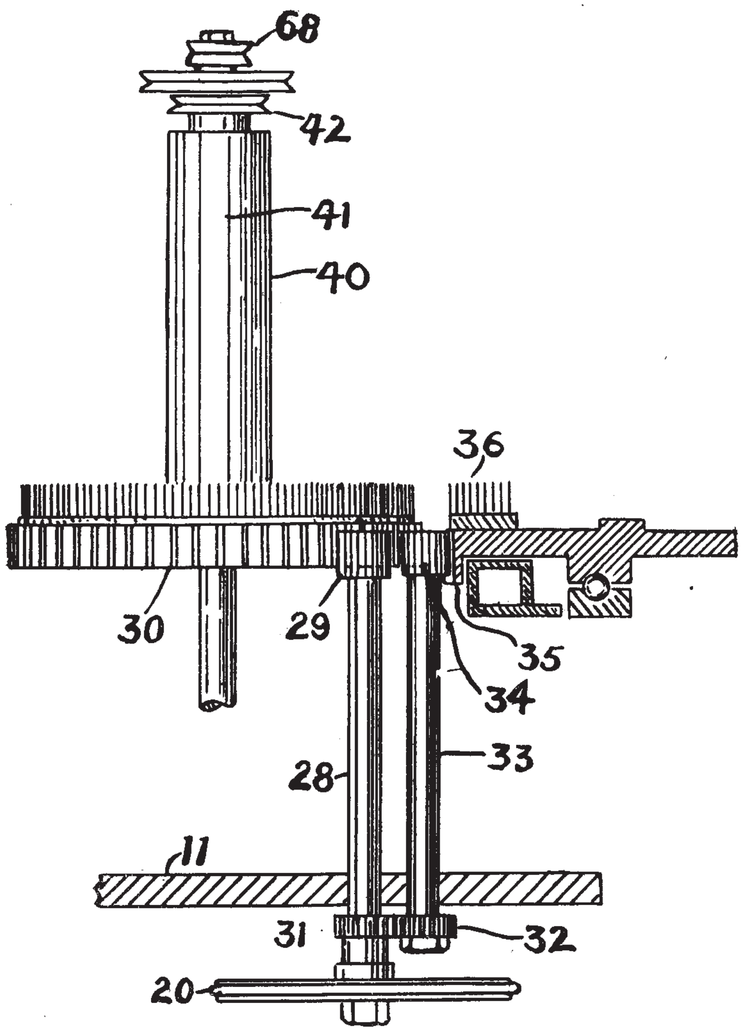


Fig. 187.

The bed or comb plate 1 compounded with the legs 2, supports a carrying bracket 3. This bracket in turn supports one end of the main driving shaft 4 which contains the ordinary fast and loose pulleys—see Fig. 183. A bevel wheel 5 keyed fast to the end of shaft 4 gears into and drives a second bevel wheel 6 on the vertical shaft 7 which is supported between the bearings 8 and 9 attached respectively to the bed plate 1 and the gearing plate 11. A pulley 12 on shaft 7 rotates in sympathy with the bevel wheel 6, and transmits motion by a belt to the pulley 13 mounted loosely on the stud 14 fixed to and depending from the gearing plate 11. Mounted loosely on the same stud and compounded with the sleeve of pulley 13 are two sprocket wheels 15 and 16, the former of which drives duplicate double sprocket wheels on studs 14^1 and 14^2 and from the latter wheel 16 motion is transmitted to the duplicate parts of the machine. The two additional studs 14^1 and 14^2 are bolted fast to the gearing plate 11. On each stud double sprocket wheels 15^1, 16^1 and 15^2, 16^2 are respectively and loosely mounted, being duplicates of wheels 15 and 16. See Fig. 186.

An endless sprocket chain 17 transmits motion of uniform velocity from the sprocket wheel 15 to its duplicates 15^1 and 15^2.

An endless sprocket chain 18 transmits motion from the sprocket wheel 16 to sprocket wheels 19, 20, 21 and 22.

The sprocket wheel 19 is mounted on a stud shaft 23 combined with which is a spur pinion 24 which gears into and drives a spur pinion 25 on the vertical drawing off roller shaft 26 *adjacent to the large circle.* The pressing

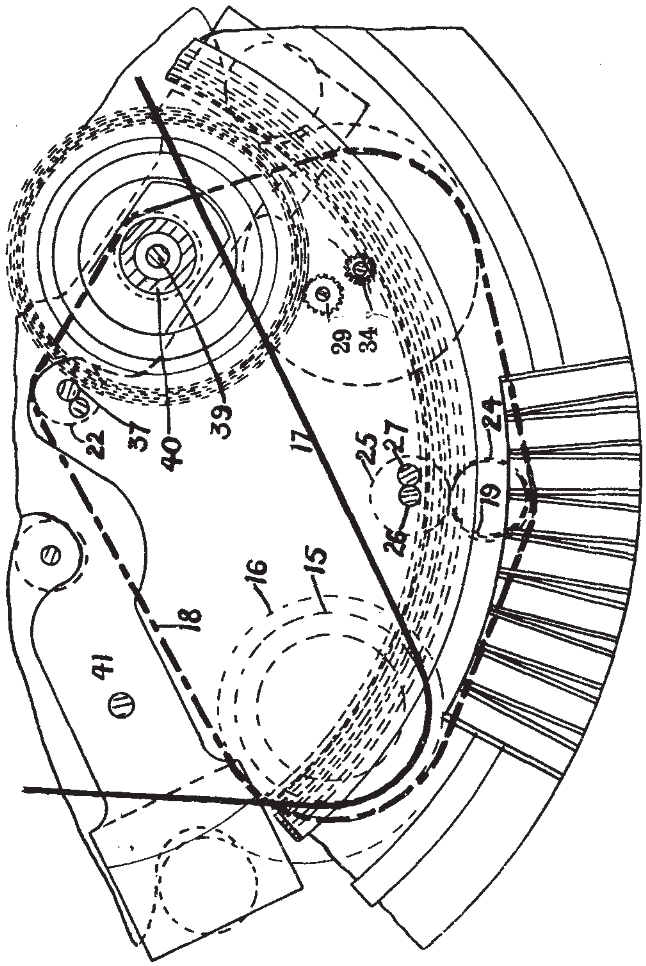


Fig. 188.

roller linked with same is indicated at 27. See also Fig. 188.

The sprocket wheel *20* is compounded with the vertical shaft 28 supported in the gearing plate 11.

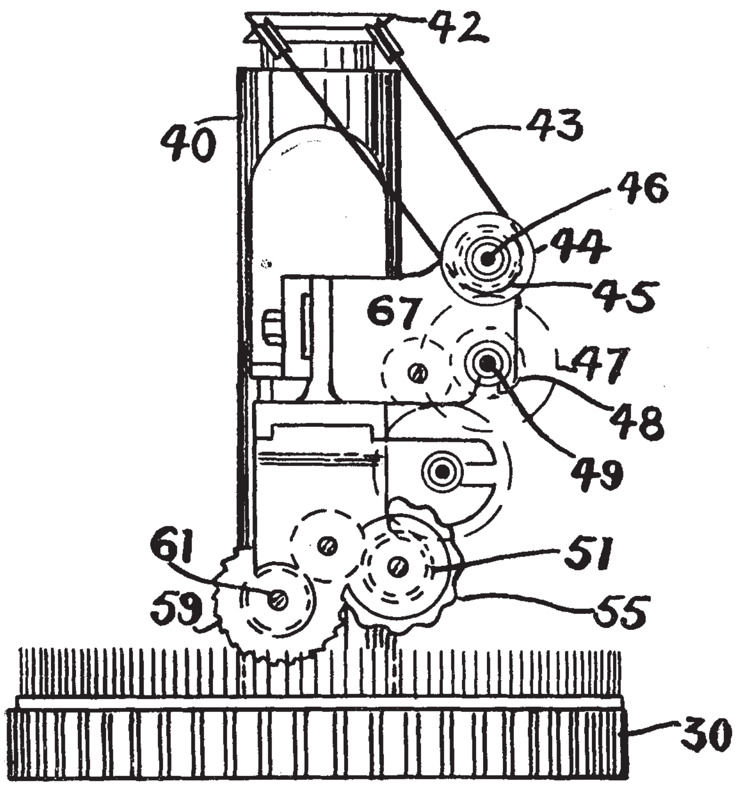


Fig. 189.

Compounded with and near the top of shaft 28 is a spur pinion 29, the teeth of which intermesh with those of the annular rack 30 formed on the external periphery of the small circle and by which means it is rotated. Fig. 187.

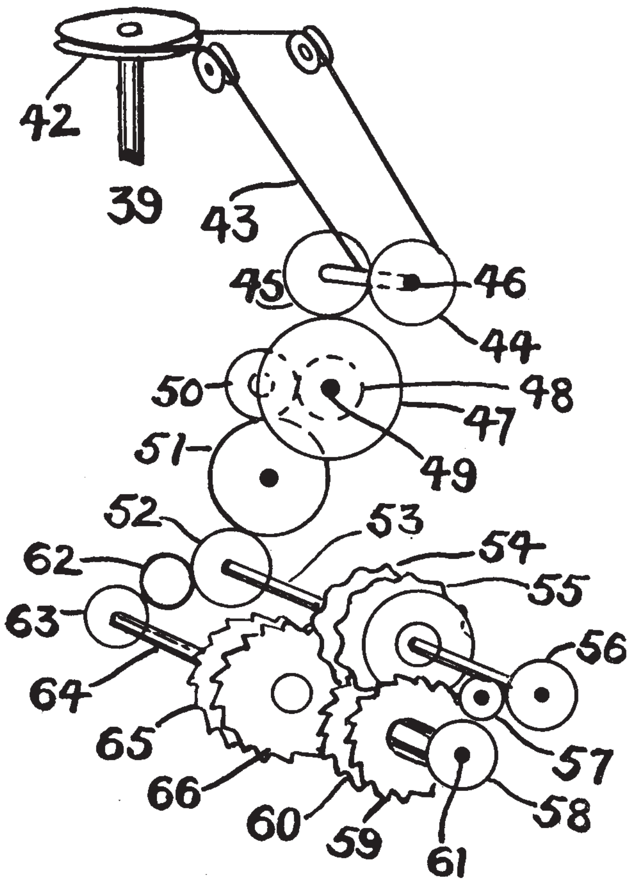


Fig. 190.

A second pinion 31 mounted on shaft 28 gears into a spur pinion 32 mounted near the base of the vertical shaft 33. This shaft carries a spur pinion 34 which gears into the teeth of the annular rack 35 formed on the internal periphery of the *large circle* 36 and by which means it is *rotated*.

The sprocket wheel *22* is compounded with and rotates the *drawing off* shaft 37 *adjacent* to the *small circle*; the pressing roller for same is indicated at 38. See also Fig. 188.

Rotary Disc Mechanism and Motion. The sprocket wheel 21 is keyed fast near the lower end of the vertical shaft 39 (Fig. 185). This shaft which is designated the central pillar shaft passes through the pillar 40 bolted fast to the upper surface of the plate 41 fixed below the small circle. The plate 41 forms one of *three* wings or arms each of which is bolted fast to its adjacent leg support 2 or its duplicate. The pillar 40 with shaft 39, passes up and through the centre of the small circle. See also Figs. 190 and 191.

When four small circles are used the plate 41 is made with *four* arms radiating from the centre to carry each circle and pillar.

A small grooved pulley 42 is compounded with and near the top of the pillar shaft 39. It transmits motion through a strap or twisted band 43 to a second grooved pulley 44 compounded and free to rotate in sympathy with the spur pinion 45 mounted on shaft 46. The pinion 45 gears into and drives through the double stud 47 and 48 on stud 49 and intermediates 50 and 51, a spur pinion 52 mounted near the remote end of a stud shaft 53. This shaft carries two "leader" serrated disc wheels 54 and 55 whose function it is to gradually assist the wool forward by rolling contact, and thus neutralise any tendency on its part to accumulate.

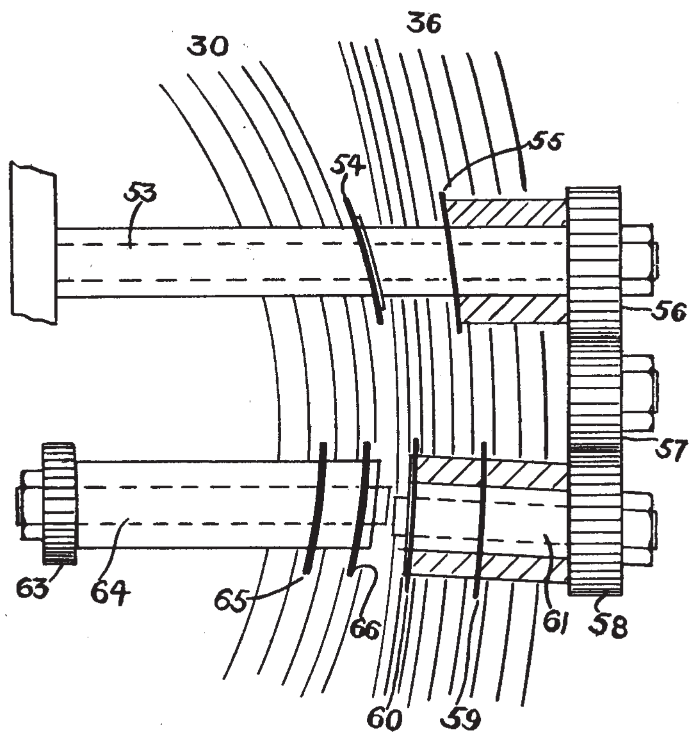


Fig. 191.

Compounded with the near end of shaft 53 is a spur pinion 56 which gears, through a single intermediate 57, a spur pinion 58 compounded and free to rotate in sympathy with two discs 59 and 60, the peripheries of which are formed with saw like teeth. These rotate clockwise between the pins of the large circle. The spur pinion 52 drives through a single intermediate 62 a spur pinion 63 compounded with the short shaft 64 on which are mounted two discs 65 and 66 having serrated teeth; these rotate clockwise between the pins of the small circles. The whole of the disc mechanism is carried by the bracket 67 affixed to the pillar 40 as shown. The small grooved pulley 68 keyed near to the pillar shaft 39 communicates, through a twisted band, the requisite rotary motion to the usual star wheel or divider.

Each additional small circle requires duplicates of all details from 13 to 64 inclusive.

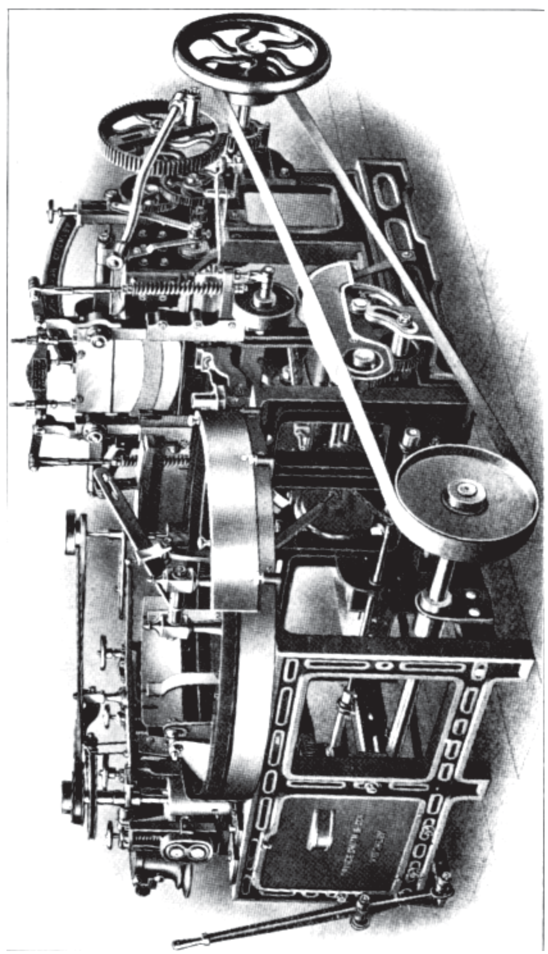


Fig. 192.
The Lister or Nip Comb.

CHAPTER XXXI.

THE LISTER OR NIP COMB.

AFTER the foregoing and somewhat exhaustive treatment of all the essential principles of wool combing as exemplified in the Noble comb, it is not proposed to likewise illustrate and describe in detail any of its contemporaries.

The modern Noble comb has practically supplanted all its rivals as far as combing wool is concerned. Most other combs are chiefly used for specific purposes.

The Lister or Nip comb is especially suitable for long lustre wool and mohair. Since it was standardised by the inventors, nearly half a century ago, very little attention, relatively, has been devoted to modifying and perfecting the details of its mechanism.

The chief features of the Lister comb are :—

1. **A Gill Box** of the ordinary type, minus the front or drawing-off rollers. It consists of a pair of " back " or feed rollers and a set of fallers, each of which is studded with one row of flat and two rows of round pins set as close together as possible in order to secure the greatest amount of treatment for the individual fibres.

The fallers and pins, in elevation, are concave for reasons to be subsequently explained. A lever dabbing brush operates above the fallers to press the sliver into the pins of same and a coil of gas pipes or other means of heating is arranged immediately underneath the fallers and slivers, the object being to make the fibres more pliable and easier to draw, and reduce the possible number of breakages.

The uncombed sliver is fed from cans through the feed rollers and carried forward by the gills which contain three rows of pins varying in number from 12 to 22 per inch. Immediately the last faller drops to the lower screw, an end of uncombed sliver is left projecting which is at once gripped by a special part of mechanism, denominated the nip.

2. **The Nip Arrangement** constitutes the chief feature of this machine. It takes the place of the front rollers, but intermittently draws lengths of wool through the pins of the fallers by which means it performs the first and principal operation of combing.

The nip consists of two plates—an upper and a lower—combined with a rectangular frame pivoted near its base and free to vibrate, being eccentrically linked through a connecting rod to a large spur wheel, which rotates continuously near the back of the gill box.

The *lower plate* is fixed to the pivoted frame and vibrates in sympathy with it. This plate is concave to coincide with the fallers and is formed with a groove along its upper edge.

The upper plate is conversely convex and its base is reduced in thickness and rounded so that it can freely enter the grooved part of the lower plate. It is suspended from simple levers which are vibrated by a rotating cam through connections to be subsequently described. It is compound in its action and vibrates in sympathy with the lower plate and reciprocates in a plane perpendicular to the groove in it.

As the wool to be combed is brought forward by the fallers, the nip part vibrates towards it ; the jaws simultaneously open and then close over the wool with sufficient tightness to carry it forward to the next part of the machine known as the " porter " or carrier comb.

3. **The Carrier Comb** is studded with two rows of comb pins, set over 16¼ins., containing 16 pins per inch, of 19s wire, each 4ins. long and standing 3⅝ins. out of the comb stock. The pins are arranged in concave form, corresponding to the lower jaw of the nip and to the fallers. Its function is to meet the nip at the forward end of its traverse, then rise up to pierce the uncombed and projecting part of the wool, and immediately carry it forward and deposit it on pins of a large comb circle which is rotating in a direction at right angles to the traverse of the carrier comb.

The concave arrangement of this comb is designed to exactly coincide with the periphery of the comb circle upon which it consequently deposits the sliver with uniform distribution. Each fresh layer of sliver is deposited so as to overlap its predecessor, approximately two-thirds or three-quarters of its width. Consequently the tufts depending from the comb circle are three or four layers in thickness.

4. **The Comb Circle** is usually studded with five concentric rows of pins, graduating as a rule from 10 to 20 per inch, the first two rows being flat. It is supported

and free to rotate over a steam chest after the manner described under the Noble comb.

At the juncture where the carrier comb deposits its load, a lever dabbing brush descends to depress the uncleaned end of the wool into the pins of the comb circle. In sympathy with the direction of rotation of the comb circle a blast of air, mechanical stroker or traversing leather is employed to force the fibres in the same direction, preparatory to reaching the drawing-off rollers.

Directly opposite these rollers a set of thin steel blades is inserted, adjusted and fixed between the several rows of pins in the comb; their function is to depress the wool thoroughly into and between the pins so as to enable the rollers to draw off a continuous sliver and thus complete the cleaning and combing process.

5. **The Drawing-off Rollers** are placed in a horizontal plane and tangential to the periphery of the comb circle. The linear distance of any range of points from the nip of the drawing-off rollers, to the periphery of the comb circle is a constantly varying factor. This arrangement causes the *longest* fibres, in successive tufts of wool, projecting from the comb circle, to be *first* caught up by the drawing-off rollers at the points most remote from the comb circle.

As a natural consequence, the shorter fibres are gradually seized by the drawing-off rollers as the distance between them and the comb circle is reduced. The practical result of this arrangement of mechanism is a gradual decrease in the length of fibres across the full width of the "draw" which now constitutes the combed top. This characteristic distribution of the fibres is technically and expressively denominated a " *hen winged sliver.*"

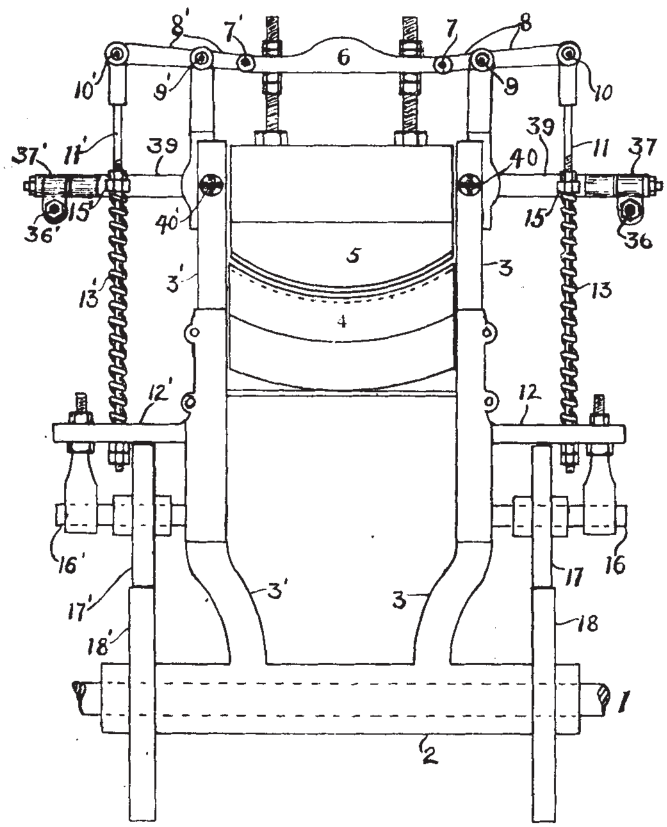


Fig. 193.

The subsequent process of mixing in the finishing gill boxes does not sufficiently distribute these fibres throughout the sliver.

The combed top from the drawing-off rollers is conveyed through a revolving funnel, a pair of calender rollers and a coiler into the sliver can.

The noil, foreign matter and portions of wool which have not been drawn off by the above rollers, are removed from the comb circle by a set of oscillating noil knives, triangular in shape, which are inserted between the pins of the comb.

Details of the Mechanism.

Fig. 192 is a perspective view of the Lister Nip comb as made by Prince Smith & Son.

Fig. 193 shows a front elevation of the nip details of mechanism.

Fig. 194 is a line diagram which shows in elevation, the chief parts from the feed to the comb circle.

Fig. 195 shows a front elevation of one of the concave fallers, pins and dabbing brush.

Fig. 196 shows in elevation, Smith's arrangement for driving the drawing-off rollers.

Fig. 197 shows an end elevation of the drawing-off rollers in relation to the comb circle.

Fig. 198 is a part plan of the comb circle with rack and pinion which drive it.

The same numerals occurring in the different diagrams relating to this comb refer to corresponding details.

Gill Box and Nip Mechanism and Action.

1 is a shaft extending and supported between the machine gables and free to rotate; 2 is a sleeve on shaft 1 with which is combined the two arms or standards 3 and 3^1 of

the nip ; 4 is the lower jaw $18\frac{1}{4}$ins. wide fixed between arms 3 and 3^1 and 5 is the upper jaw $16\frac{1}{4}$ins. wide,

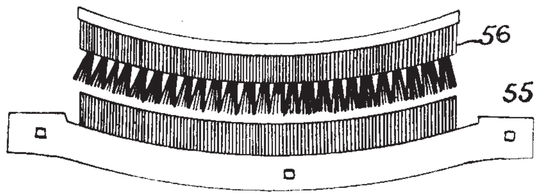


Fig. 195.

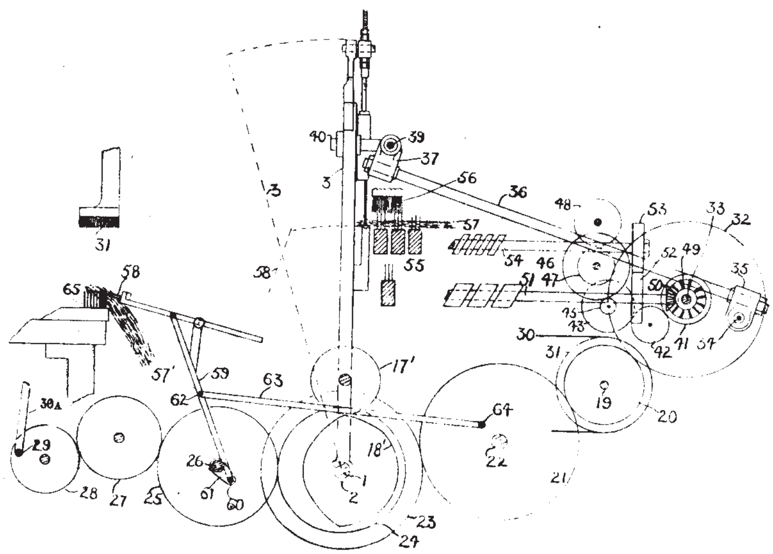


Fig. 194.

adjustably supported in suspension by the bolts and nuts as shown, from the cross bar 6 ; it is free to reciprocate in the same plane as the nip frames 3 and 3^1 and alternate in sympathy with them. The bar 6 is linked through knuckle joints or loose bolts 7 and 7^1 to the respective inner and shorter arms of the balk levers 8 and 8^1 pivoted respectively as shown on the studs 9 and 9^1. Suspended from the outer and longer arm of lever 8 and bolt 10, is a vertical rod 11 which passes freely through the extended arm piece 12 which forms part of a bracket casting attached to and free to reciprocate in the same plane as the nip frame 3 and likewise to alternate with it.

A strong spiral spring 13, circumscribing the rod 11 is contained between the arm piece 12 and adjustable lock nuts 15 on rod 11. Compounded with the slide bracket and arm piece 12 is a projecting stud 16 on which is mounted an anti-friction bowl 17, which rests in rolling contact with a cam or tappet 18 mounted on shaft 1. The constant rotation of this tappet reciprocates the stud 16, slide 12, spring 13, and rod 11 which last through details 10, 9, 8, 7 and 6 likewise reciprocates the nip plate 5 all in the same plane and parallel with the nip frame 3. The spiral spring 13 exercises a modifying influence of pressure on the nip plate 5.

Motion is imparted to the shaft 1 and tappet 18 by a train of wheels carried on the remote side of the machine, Fig. 194. The shaft 19 is supported by and extends across the gables at the feed end of the machine. It is driven from the main driving shaft of the machine by a belt 30 passing over a pulley 31 secured to the shaft 19.

A duplicate of spur pinion 20 on shaft 19, at the remote side of the gill box, gears into and drives, through an intermediate spur wheel 21 on stud 22, the stud and pinion wheels 23 and 24 mounted on shaft 1.

Alternating Movement of the Nip Frame.

The spur pinion 20 on shaft 19 gears into and drives a large spur wheel 32 on shaft 33. A stud 34 with a swivel link 35 is eccentrically adjusted to the wheel 32 which is linked through the rod 36 and swivel link 37 to one end of a "bar" rod 39 which in turn is bolted, as at 40, to the upright standards of the nip frame 3, Fig. 193. Obviously, the constant rotation of wheel 32 produces through details described the requisite vibratory movement to the nip frame.

Driving the Feed Rollers, Screws, and Fallers.

The spur pinion 41 on shaft 33 drives the feed rollers 47 and 48, through a train of wheels 42, 43, 45 and 46. Wheel 46 is keyed fast to the shaft of the bottom fluted feed roller 47. The screws are driven from the same source. A bevel wheel 49 fast on shaft 33 gears into and drives a like bevel wheel 50 fast on the end of the lower screw shaft 51.

A spur pinion 52 on this screw drives a like spur pinion 53 mounted on the upper screw 54. The position of the fallers 55 for the upper and lower screws is indicated in the diagram together with the dabbing lever brush 56 and the uncombed sliver 57 in the gills. The upper and lower jaws have just gripped the sliver and are in position to draw a tuft of wool through the gills and convey it forward to meet the porter comb.

The Porter or Carrier Comb Mechanism.

The carrier comb 58 is adjustably mounted on a lever rod 59 to which an elliptical or compound motion must be given, viz. :—An alternating movement between the nip and the comb circle, and a slight rise when approaching the nip to relieve it of its load and conversely a slight fall when nearing the comb circle where it deposits the load or tuft of wool. The lever rod 59 is supported and receives its rise and fall from a stud 60 in crank 61 on shaft 26 uniformly rotated by spur wheel 25 geared with stud pinion 24.

The rod 59 is further connected for its requisite alternating motion through stud 62 and link 63 which is eccentrically connected through stud 64 with wheel 21. The tuft of wool 57^1 is pressed into the pins of the comb circle 65 by a lever dabbing brush 31 which receives its reciprocating motion through a rod 30A, eccentric stud 29, pinion wheel 28 and the intermediate wheel 27 geared with wheel 25.

Driving the Drawing-off Rollers.

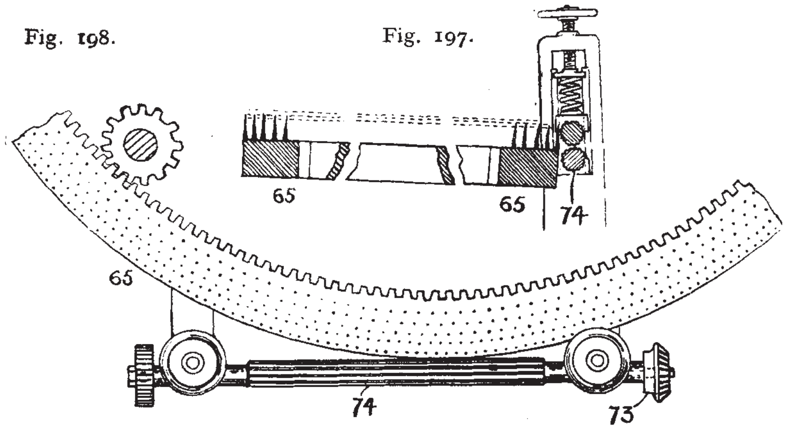
The spur pinion 66 mounted on shaft 67 is driven from the main driving shaft of the machine. It is supported by a sleeve bracket 68 to the machine gable. A bevel wheel 69 on shaft 67 transmits motion through like bevels 70 and 71 on the upright shaft 72, to the bevel wheel 73 keyed fast to one end of the bottom or drawing-off roller 74.

The diameters of the bottom and top rollers, are $1\frac{7}{8}$in. and $2\frac{1}{2}$in. respectively, and are supported between the fixed pillars 75. Pressure is applied to the upper roller by screws after the usual manner. The position of the rotating funnel is indicated at 76. 77 indicates the traversing leather, which assists in carrying the ends of the fibres towards the drawing-off rollers.

Briefly summarising the principle of combing on this machine the operation consists in collecting the whole of

Fig. 198.

Fig. 197.



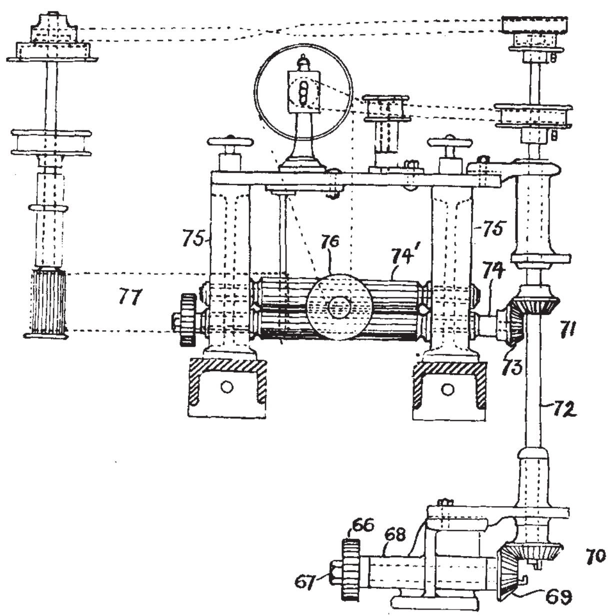


Fig. 196.

the noil in the front faller, so that it is transferred to the circle pins, while the portion combed hangs in a fringe from the outside of the circle. To do this properly it is essential that the pressure upon the top jaw should be sufficient to enable it to retain the wool left by the faller, for if it misses any it has to be taken at the next journey, and consequently it is thrown farther over the circle, and the amount of noil is increased ; only those fibres which project far enough to reach the nip are drawn off, consequently there is a more equal distribution of the various lengths of fibre than is found in the sliver from the Noble circles. Care must be taken that the edge of the pressing jaw is not too sharp, or it will cut the fibres. It is made adjustable by means of screws, so that its retaining power may be altered either way. The two jaws must perfectly coincide, so that one fits exactly into the other equally at all points of contact. The nip should close and begin to move forward just before the faller has begun to descend, or otherwise a short distance of the fibres remains uncombed. When it is shut too soon it does not nip far enough, and a small part of the staple is again missed. The setting of the carrying comb is quite as important as the nip, because if it is pushed into the wool before the jaws begin to open, the pins are almost certain to get damaged or broken. To obviate this in some measure the tappet is so constructed as to release the jaws a little, just at the moment when the comb is sliding up the face of the nip. It must only press very lightly against the lower jaw, or otherwise the fibres will be forced too far into the pins, and some difficulty will be experienced in getting the material properly on to the circle, in which case a portion may be disturbed or carried back again.

Gearing and Speed Details.

1. Speed of machine :—

Line shaft 124 revs. ; drum 20in. ; pulleys 15in.

$$\therefore \text{Speed of machine pulleys} = \frac{124 \times 20}{15} = 165\tfrac{1}{3} \text{ revs.}$$

2. Strokes of nip frame per min. for *wool* :— Change wheel on pulley shaft 27 teeth, geared into spur wheel on horizontal shaft containing 60 teeth. Side pulley on same 18in. dia., carrying belt 30 (Figs. 192 and 194) and driving pulley 31 on lower back shaft 19, $9\frac{5}{8}$in. dia. Wheel 20 on lower back shaft contains 22 teeth and crank wheel 32 contains 72 teeth.

$$\therefore \text{Strokes per min. of nip frame} = \frac{165\frac{1}{3}}{1} \times \frac{27}{60} \times \frac{18}{9\frac{5}{8}} \times \frac{22}{72} = 40\tfrac{3}{5}$$

N.B.—The wheel 23 (Fig. 194) on cam shaft 1, driven from back shaft wheel 20, must always contain the same number of teeth as the crank shaft wheel 32, so that the *nips* correspond to the number of strokes per minute. For a similar reason the size of the wheels 21 and 23 must be equal, and the size of wheels 24 and 25 must correspond so that the carrier comb 59 shall make the same relative number of strokes per min. as the nip frame.

2a. For *mohair* the change wheel on pulley shaft is reduced to 20 teeth, and side pulley on same is increased to 22 inches diameter.

$$\therefore \text{strokes per min.} = \frac{165\frac{1}{3}}{1} \times \frac{20}{60} \times \frac{22}{9\frac{5}{8}} \times \frac{22}{72} = 36.$$

2b. For strong, coarse *alpaca* the change wheel contains 22 teeth and the size of the driving pulley is 22in. diameter.

$$\therefore \text{Strokes per min.} = \frac{165\frac{1}{3}}{1} \times \frac{22}{60} \times \frac{22}{9\frac{5}{8}} \times \frac{22}{72} = 40.$$

For finer sorts of wool the change wheel is reduced to 21 or 20 teeth, according to the fineness of the fibre.

3. Back rollers and fallers :—

Wheel 41 on upper back shaft contains 20 teeth. Double stud wheels 43 and 45 contain 60 and 14 teeth respectively. Wheel 46 on back roller 47 contains 80 teeth.

Diameter of back roller = 3in. Bevel wheels 49 and 50 (driving screws and fallers) each contain 18 teeth. Pitch of screw = $\frac{5}{8}$in.

$$\therefore \text{Lead of fallers} = \frac{40\frac{5}{8}}{1} \times \frac{5}{8} \times \frac{1}{40\frac{5}{8}} \times \frac{60}{20} \times \frac{80}{14} \times \frac{7}{3 \times 22} = 1 \cdot 14$$

4. Drawing-off and draft :—

The comb circle 65 (Fig. 198) is 48in. in diameter and contains 350 rack teeth. Rack pinion driving same contains 17 teeth. This rack pinion is at the base of an upright shaft which carries, near its top, a spur pinion containing 20 teeth. This is rotated from the same source and at the same speed as the bottom drawing-off roller. The diameter of this roller is 2in.

$$\therefore \text{Amount of draft} = \frac{48}{2} \times \frac{350}{17} \times \frac{38}{16} \times \frac{38}{20} = 3 \cdot 9$$

TABLE VIII.

Combing and set-over particulars :—

Fallers—Length $24\frac{1}{4}$in. ; Set-over $16\frac{1}{4}$in. $\times$ $\frac{3}{8}$in. ; 17 up and 7 down.									
Coarse strong wool.				Medium Wool.			Fine Wool.		
Row	Pins	Size	Length	Pins	Size	Length	Pins	Size	Length
1	16	11×20	2″	18	13×21	2″	22	16×23	2″
2	16	19	$1\frac{7}{8}$″	18	20	$1\frac{7}{8}$″	22	21	$1\frac{7}{8}$″
3	16	19	$1\frac{3}{4}$″	18	20	$1\frac{3}{4}$″	22	21	$1\frac{3}{4}$″
Coarse circles. Set-over $\frac{3}{4}$ in.				Medium Circles. Set-over $\frac{9}{16}$ in.			Fine circles. Set-over $\frac{1}{2}$ in.		
1	16	17	$2\frac{1}{8}$″	18	20	2″	26	23	$1\frac{1}{2}$″
2	16	17	$2\frac{1}{8}$″	18	20	2″ & $2\frac{1}{8}$″	26	23	$1\frac{1}{2}$″ & 2″
3	15	16	$2\frac{1}{8}$″ & $2\frac{5}{8}$″	18	20	2″	26	23	$1\frac{1}{2}$″
4	14	16	$2\frac{1}{8}$″	18	20	2″	26	23	$1\frac{1}{2}$″
5	12	15	$2\frac{1}{8}$″	18	20	2″	26	23	$1\frac{1}{2}$″
6	12	15	$2\frac{1}{8}$″	—	—	—	—	—	—

In case of *double* combing, first comb with the coarse comb and finally with the medium or fine comb, according to the fineness of fibre.

General Details.

Dia. of Back Roller, $2\frac{1}{2}$″ ; width 19″—fine flutes.
Barrelled Wood Rollers, 5″ to $1\frac{3}{4}$″ $\times$ 18″.
Gill Screws—Single Threads.
Pitch of Screws, $\frac{3}{4}$″ ; dia., $2\frac{1}{4}$″ ; Centres, $2\frac{13}{16}$″.
Upper Nip Plate, $16\frac{3}{4}$″ $\times$ $10\frac{1}{4}$″.
Lower ,, $18\frac{1}{8}$″ $\times$ $5\frac{1}{2}$″.
Feed Comb—Set over, $16\frac{1}{4}$″.
Pins per inch, 16.
Size of Wire, 19s.
Length of Pins, 4″ ; Projection, $3\frac{5}{8}$″.
Drawing-off Rollers, $1\frac{7}{8}$″ $\times$ 22″ wide.
Press Rollers, $2\frac{7}{8}$″ $\times$ $15\frac{3}{4}$″.

CHAPTER XXXII.

THE SQUARE MOTION COMB.

THIS comb, which is commonly known as Holden's, is chiefly used by the large firm of wool combers of that name. The late Lord Masham is credited with the paternity of the idea, and the late Sir Isaac Holden, Bart., together with members of his family and their employees, with its ultimate development and practical application. In this treatise it is only proposed to briefly describe and illustrate the chief features and functions of this machine.

The square motion comb is specially suited for combing *fine* wools of moderate length. There are *three* distinct combing operations performed on this type of machine.

First, the wool is fed from a number of cans or balls, in two thick slivers, through a pair of feed rollers ; each group of slivers is next passed through a separate pair of small and narrow rollers carried in the free arms of reciprocating levers denominated " boxers " because of the peculiar alternating motion which is imparted to them. The boxer levers are carried on two large eccentrics, the rotation of which imparts the necessary reciprocating movement to them. Each pair of small rollers alternately approaches very near to, and recedes from, the pins of the comb circle.

Immediately but directly above the front of the nip of each pair of small rollers, is fixed a small brush, so that as each sliver gradually emerges from the nip it passes just underneath the bristles of the brush. As the boxer rollers approach the comb circle they simultaneously descend with the emerging tuft of wool to place or "lash" it on the pins of the "holding" circle. At this juncture the brush vibrates to press the fibres well into the pins of the circle.

Then as each "filling head" returns, it leaves a small tuft of *drawn* sliver projecting from the pins of the comb circle. Each subsequent layer of sliver thus deposited overlaps its predecessor a distance equal to two-thirds its width. Consequently the thickness of the tufted sliver, projecting from the comb circle, is equivalent to six times that of the sliver carried in either of the filling heads, which arrangement incidentally contributes to produce a uniform tuft of sliver.

In retreating, the filling heads tend to straighten out the tuft of fibres which is left behind, and so produce in some measure the same result as is produced by the fallers and nip in the Lister comb.

Second, the actual combing is performed by a series of comb bars denominated the "square motion," which is the characteristic feature of this machine. The wool after being placed on the comb circle is carried forward until it is met by the comb bars or gills, whose function it is to penetrate the tuft of sliver, *comb* out the fibres and place them as parallel to each other as possible in readiness for the subsequent operation of drawing-off.

These comb bars—about seven in number—are concave in shape and designed so as to coincide with the comb circle. Each bar contains from twelve to fifteen rows of pins, set over about one inch in width by twelve inches in length. The number is least at the initial end of the comb bar, but it gradually increases towards the opposite end.

The comb bars are arranged in two tiers, alternately and vice versa, four at the top and three at the bottom. The upper set, which is in alignment with the comb circle, is free to travel outwards from it. At the limit of the traverse the most remote bar of the set is carried downwards into alignment with the lower set, which is now free to move laterally towards the comb circle until the innermost bar is in position to be lifted—at the rate of about 100 per minute—into alignment with the upper set. Simultaneously with the ascent of each comb bar a dabbing brush descends to meet it and force the fibres well into the gill pins, after which the brush moves out for a short distance in sympathy with the comb bars, and then rises and returns in time to repeat the operation.

The action of the square motion is assisted by a suspended "knife," which fits into and concentrically between the two rows of pins in the comb circle. This knife, known as the presser or nipper, has imparted to it a vibratory vertical movement, combined with a short traverse in the direction of the rotation of the comb circle. The function of this presser is to gradually force the wool down between the pins towards the brass foundation and retain it firmly until the square motion has performed the requisite combing operation on this part of the sliver.

The comb bars move rapidly in a radial direction from the circle to straighten out the tufts, carry off the noil and short fibres and sometimes longer fibres, known as robbings.

The robbings and short fibres may be removed by a small cylinder covered with card clothing, and supplemented with a blade provided with saw like teeth. They are deposited and accumulated in a box to be afterwards recarded and recombed.

The noil, dirt and foreign matter still remaining between the comb pins are removed automatically or manually at regular intervals of time. Any undue neglect of this operation results in the production of bad work.

Third, the final operation of combing is performed by a pair of drawing-off rollers, placed horizontally and tangentially to the comb circle on the same principle as adopted on the nip comb.

After the beard of wool has been combed by the square motion the portion of tuft between the pins and on the outside of them has still to be combed.

At this juncture an inverted segment, provided with two or three rows of depending pins descends and pierces the sliver on the periphery of the comb circle at a point immediately in front of the drawing-off rollers. The operation is assisted by automatically and simultaneously raising the wool slightly in the comb, to meet the intersection by this inverted segment comb.

The drawing-off rollers gradually seize the projecting fibres and draw them through the pins of both the circle and the intersecting comb in the form of a continuous sliver which thus completes the combing and cleaning of the whole length of fibre.

The segments form a complete circle outside the main comb ring; they are supported from the comb plate and free to rotate above and clear of the pins of the comb ring in sympathy with it for about three parts of the circle, after which they gradually descend the incline of a cam plate to intersect the tuft of wool as described.

Long fibres which are not seized by the drawing-off rollers, and which remain together with the noil in and at the back of the comb circle, are known as "backings;" they may be drawn off by separate and special rollers and conveyed by a leather over to the front of the circle where they are combined with the main sliver or combed top. The noil, etc., yet remaining in the comb pins are carried forward and removed by a supplementary cleaning and doffing device.

Chief Details of Mechanism.

The most important details of mechanism are illustrated in the following diagrams, which should be studied with the foregoing description.

Fig. 199 shows in plan the relative positions of the feed rollers, comb circle, square motion, drawing-off rollers and segment cleaning device.

Fig. 200 illustrates in simple diagrammatic form, the principle of feeding the comb.

Fig. 201 represents in sectional elevation the square motion combing bars.

Fig. 202 shows in plan a single combing bar of modified pattern.

Fig. 202A shows in elevation a brush cleaning device for the segment comb.

Fig. 199.

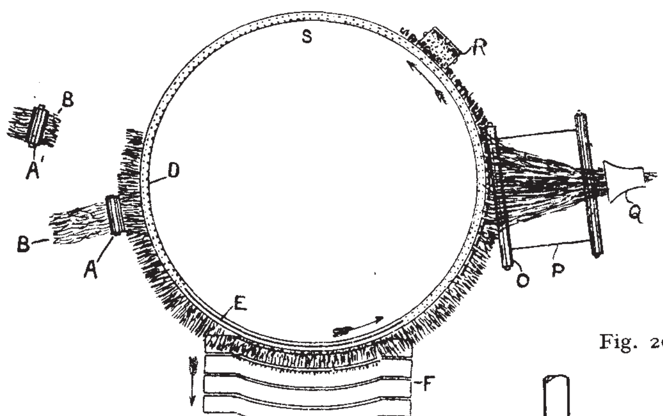
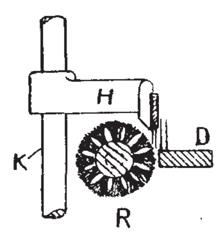


Fig. 202A.



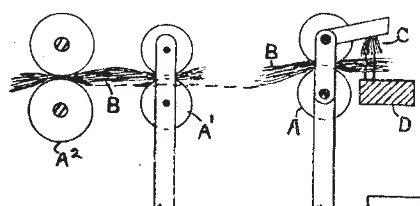


Fig. 200. Fig. 202.

Fig. 203 is a front elevation of the intersecting gills in relation to the comb circle.

Fig. 204 is a transverse section of the comb and segment circles, when the inverted pins of the latter are lifted clear above the upright pins of the former.

Fig. 205 shows the same details when the segment is in combing position.

Similar letters occurring in the several diagrams refer to corresponding details.

A A^1 A^2 indicate the feed rollers; B, the sliver; C the small brush under which the sliver passes, and by which it is effectively pressed into the pins of the comb circle D. E is the pressing knife and F the square motion bars, of which four constitute the upper, and three the lower set. G is the dabbing brush which operates directly over the comb bar nearest to the comb circle and is in position to pierce the fringe of sliver B. The dotted lines G^1 indicate the extent of its traverse outwards.

The segment combs H are attached to the projecting arms of boss or sleeves I, carried by the upright pillars K on which they are free to travel in a vertical plane. The pillars K are secured to the comb plate and rotate in sympathy with it. Combined with the rear of the sleeves I are projecting studs L, each of which carries an anti-friction bowl M, kept in rolling contact with the face of a cam plate N, attached to a stationary part of the machine. O indicates the position of the drawing-off rollers through which the combed top passes, and is conveyed by leathers P to and through the usual funnel arrangements Q and calender rollers into a can.

A brush arrangement for cleaning the segment combs is indicated at R and the usual apparatus for removing the noil and cleaning the circle at S.

The extensive working or combing of the fibres on this machine, chiefly by the square motion, the intersecting gills and the drawing-off mechanism combined with heat, produces a finished top which is relatively better than is obtained from any other machine combing the same quality of material.

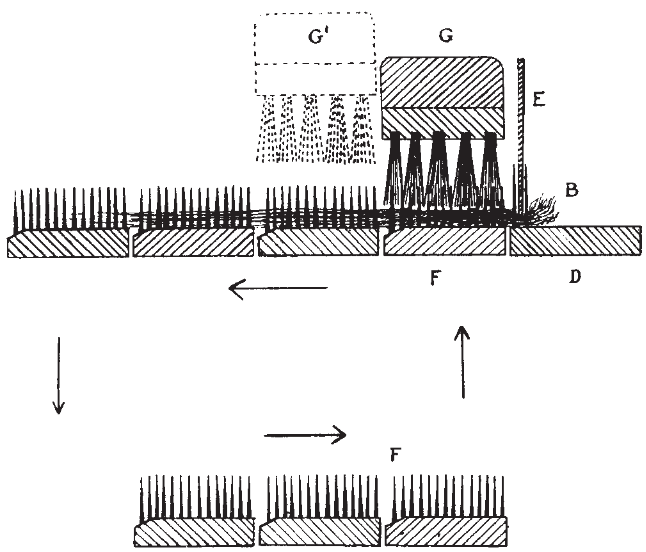


Fig. 201.

The characteristics of the combed top are :—The *full* length of fibre is thoroughly combed. All the " shorts " are completely removed and the top is thoroughly cleansed of all impurities and foreign matter. It is claimed as a consequence that the material will subsequently spin to about 5% higher counts than wool of similar quality combed on the Noble machine. The turn off is approximately 270 to 280 lbs. per day of ten hours.

On the other hand the machine has its characteristic defects. These include :—

(1) The filling heads require to be modified and accurately adjusted for every change in the average length of staple to be combed.

(2) The square motion produces a quantity of " shorts," technically denominated " robbings," in addition to the noil, which being too long to be classed as noil have to be separately removed, re-carded and re-combed. The thorough cleansing of the comb bars of the square motion has always been a very difficult operation.

(3) The horizontal drawing-off arrangement produces, as in the " nip " comb, a " hen winged sliver."

(4) The gearing mechanism generates a considerable amount of noise.

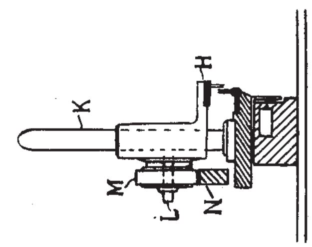


Fig. 205.

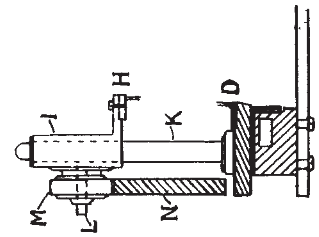


Fig. 204.

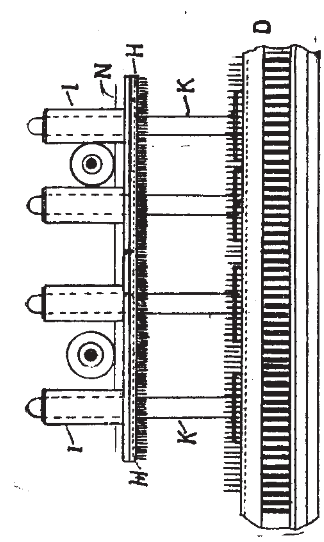


Fig. 203.

CHAPTER XXXIII.

THE HEILMANN COMB.

Schlumberger Model.

THIS comb was invented by Josué Heilmann, a Frenchman, and introduced into England in the year 1846.

At the present time there are several modifications of the original invention for combing wool, cotton and flax tows. The four principal types are :—The Schlumberger, the Société Alsacienne, the Delette, and the Offerman.

Schlumberger, Gebweiler, Alsace, was closely associated with Heilmann in the introduction and perfection of this comb.

In the *worsted* trade of England modifications of this machine are chiefly confined to *re-combing*, and it is usually fed from as many as 24 doublings.

In the *flax* trade the machine is used chiefly for combing *flax tows* where it usually follows the card, though a better result is obtained and a less quantity of noil when the material is first passed through a gill box. The comb is fed from as many as 15 slivers.

The machine is modified in strength of build to suit the various kinds and qualities of material required to be combed.

Enunciation of the Principle and Process of the Heilmann Comb.

There are several types of this comb used in modern practice. Fig. 206 is a perspective view of the Alsacienne Comb as made by Prince Smith & Son.

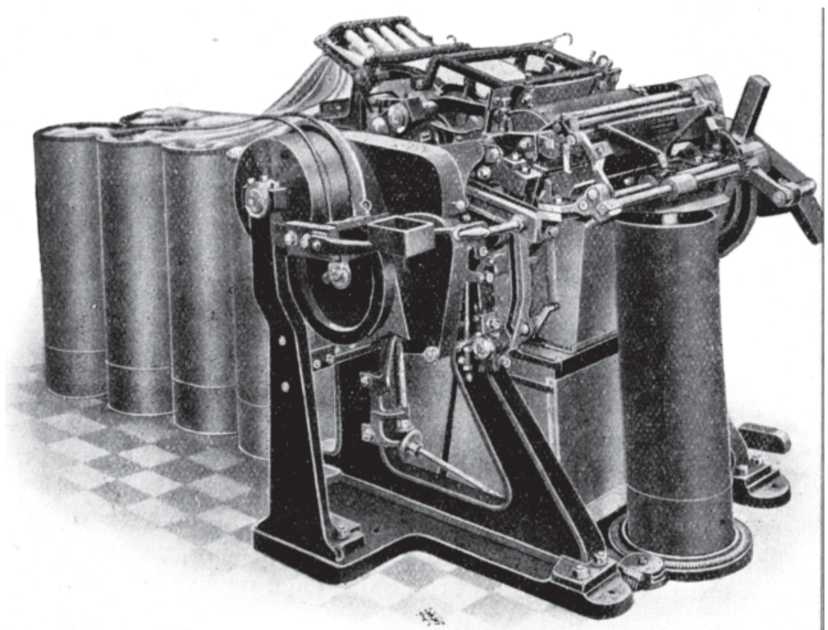


Fig. 206.

Figs. 207-217 are essential details selected from the Schlumberger Comb as now used for wool and flax.

The principle of the Heilmann machine, in every model, consists of two distinct operations of combing, whether for wool, cotton or flax.

First :—A fringe of textile fibres projecting beyond the retaining jaws of a nipper is combed and the noil extracted by several successive rows of pins fixed in a segment of a rotating drum.

Second :—The grip of the nipper is released and a tuft of fibres is drawn from the bulk between the pins of a fixed or intersecting comb which cleans the tail end of the tuft of all short fibres or noil.

Each succeeding tuft is made to overlap its predecessor a distance equal to about one third its length, so as to form a continuous sliver of combed and cleaned fibres.

The various essential details of the mechanism and combined actions of this comb are as follows :—

The uncombed material is fed by a number of slivers from cans or balls over guide rolls and through a pair of small feed or retaining rollers, then through a feed box, dabber comb and the jaws of a nipper. The upper jaw closes over the lower jaw to grip the material, the fringe of which projects beyond the jaws. At the same moment the pins of a rotating segment comb, assisted by a brush compounded with the upper jaw, penetrate the fibres from below, comb them and remove the noil.

Meanwhile the dabbing or feed comb opens and recedes, in sympathy with the feed box, from the jaws of the nipper in readiness to carry forward an additional length of uncombed sliver.

Immediately the combing process by the segment is completed, and the feed box with the dabber comb which is now fully open has receded to the limit of its

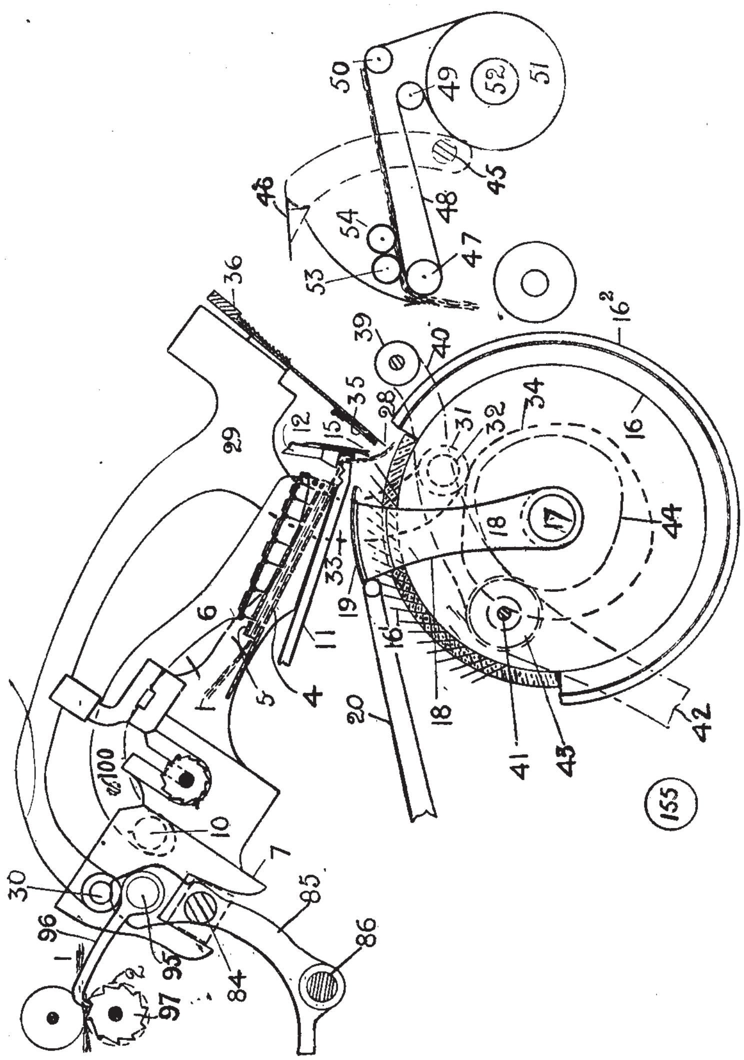


Fig. 207.

backward traverse, a segment steel blade, denominated the "striker" and concentric with the periphery of the cylinder, moves forward to hold up the sliver so that the pins of the fixed or intersecting comb, which is now descending, may pierce the fibres at a point which is close up to the front edge of the striker blade and behind that portion of the tuft already combed. Meanwhile the jaws of the nipper gradually open and the feed box with the dabber comb moves forward towards the open jaws and pushes on the next length of uncombed sliver on the same principle as the fallers in a gill box. Simultaneously a drawing-off roller falls into rolling contact with a rubber or leather segment of the comb cylinder, and a pair of carrier rollers with conveying leathers travel into near contact with the drawing-off roller.

This roller lays hold of the combed fringe and draws, through the feed comb and the pins of the fixed or intersecting comb, a *tuft* or number of fibres which in turn are seized by the nip of the carrier rollers and leather to be conveyed by the latter towards the funnel and calender or delivery rollers.

During this process of drawing off, the "fixed comb" gradually travels in sympathy with the fibres that are being drawn through it towards the drawing-off roller and consequently performs the same function as a gill bar in an ordinary gill box. This operation completes the combing of the tail end of the tuft of fibres.

Feeding, Combing and Drawing-off Details.

Fig. 207 is a sectional elevation of all the essential features of mechanism from the feed to the delivery end.

The comb segment is in position for combing the fore part or fringe of sliver as in the machine used for flax tows.

Fig. 208 shows the drawing-off rollers brought into position for drawing the tail end part of the tuft of sliver through the feed and fixed or intersecting comb. See also Fig. 210.

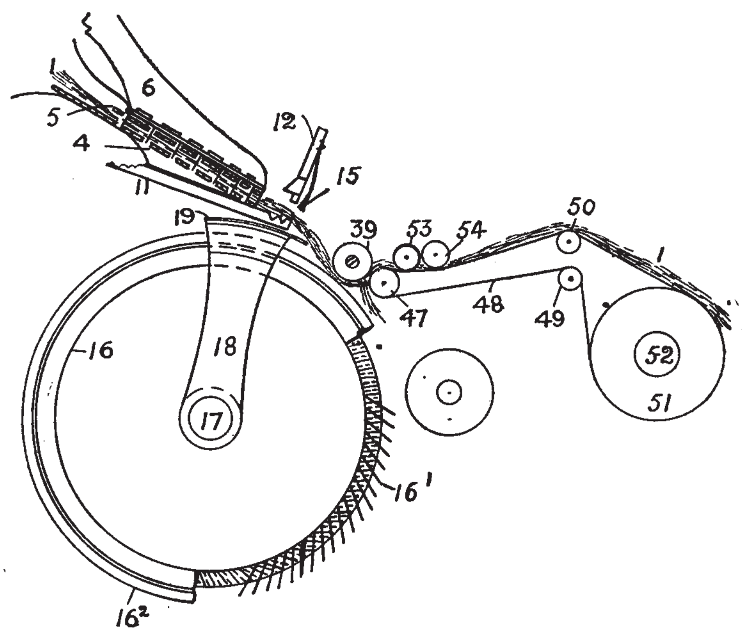


Fig. 208.

Figs. 209 and 210 show the same details as Figs. 207 and 208 respectively, but as used for *wool.*

Fig. 211 shows similar " wool " details of mechanism including a modified arrangement for drawing off the material.

Feeding. The subsequent diagrams in this chapter are illustrative of the usual mechanical means employed for operating the various parts of mechanism involved in the feeding, combing and drawing off referred to above.

Similar numerals occurring in the different diagrams refer to corresponding details. 1 indicates the uncombed sliver and 2 the feed rollers ; parts 4, 5 and 6 constitute the *feed* box. The base part 4 rests freely on the face of the lower jaw 11 ; the part 5 which takes the form of a grid is pivoted to the part 4 so that the free end of 5 can be lifted up to allow the sliver 1 to be placed between parts 4 and 5, after which the " free " end of the part 5 is screwed fast to part 4 and is then in its normal position. The upper part of " feed " comb 6′ is provided with several rows of pins which are free to penetrate the sliver 1 as it lies between the grid parts 4 and 5.

The parts 4, 5 and 6 are combined with a carrier bracket 7 which, in turn, is linked by a stud 84 to the free arm of a short lever 85, the boss of which is free to rock on the shaft 86 carried between the machine gables (see also Fig. 213). The vibration of lever 85 reciprocates, through carrier bracket 7, the feed parts 4, 5 and 6 over the surface of the lower jaw. The feed comb part 6 is pivoted on the stud 10 about which it is free to oscillate so that its several rows of pins may be lifted clear of the sliver 1 each time the feed box recedes in preparation for gripping and bringing forward a fresh supply of sliver and projecting it through the open jaws of the nipper.

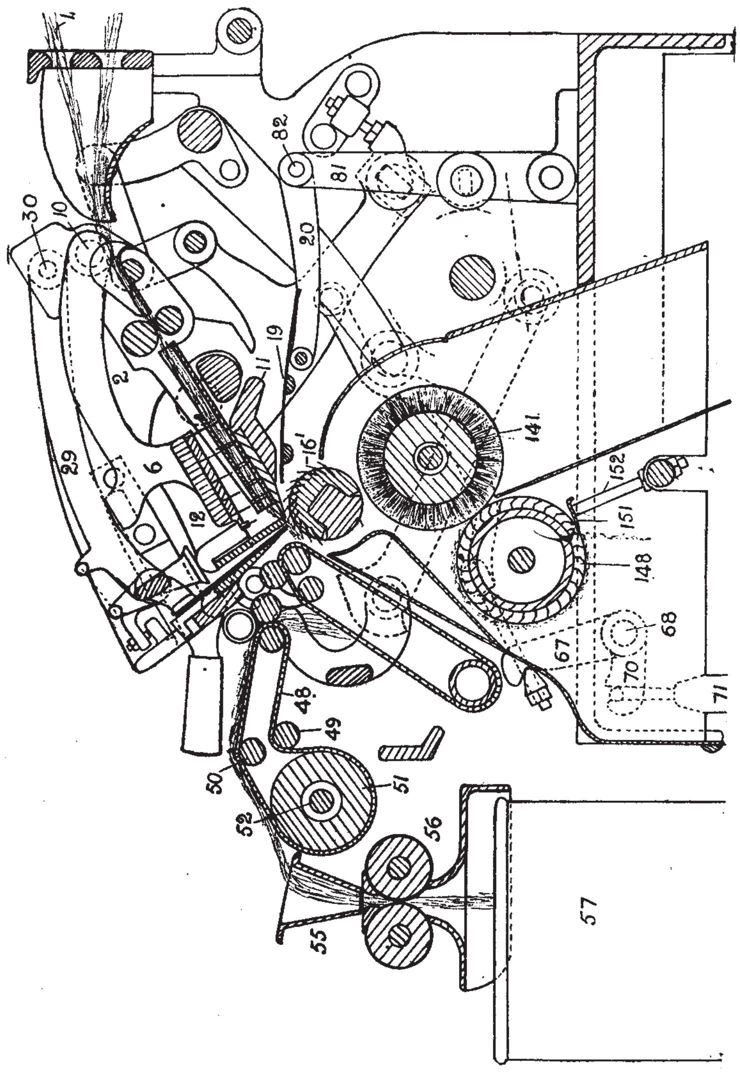

1
30
10
82
81
20
19
11
2
29
6
12
16'
141
152
151
148
68
67
70
71
48
49
50
51
52
56
55
57

Fig. 209.

Combing the Fringe. The nipper consists of two parts—a lower jaw 11 and an upper jaw 12—free to open and close. Their function is to grip and retain the uncombed sliver during the operation of combing the fringe or front part of the tuft of sliver by the segment comb. At the same time they provide a grip that will not readily cut or damage the fibre, and in the case of wool the nip is covered with a cushion of leather strips. The upper jaw is compounded with shaft 13 (see also Fig. 212) which is supported between the machine gables and free to oscillate ; the lower jaw 11 is compounded with a carrier 14 suspended from the shaft 13, about which it is free to oscillate. 15 is a brush fixed to the front of the upper jaw and designed to assist in depressing the fringe of fibres into the pins of the segment comb simultaneously with the closing of the nipper. A cylinder 16, making an average of 50 to 60 revolutions per minute, is mounted on a rotating shaft 17 carried between the machine gables and driven by spur gearing from the pulley shaft 155. The periphery of the cylinder 16 is designed with two distinct sections—a comb segment 16^1 studded with ten or more rows of pins for wool and up to twenty rows for flax tow (see table on page 518) and a remaining segment which is covered with rubber for flax and with leather for wool and clamped as in Fig. 211.

Loosely mounted on and near the ends of shaft 17 are two short lever arms 18 to the free ends of which is fixed a quadrant blade 19. This blade is further linked through the rod 20 to a rocking lever 81 (see Figs. 211 and 212). The blade is denominated the "striker," its function being to move forward simultaneously with the opening of the nipper and hold up the tail end of the tuft of sliver during the period that it is being drawn through the fixed or intersecting comb and completing the combing operation.

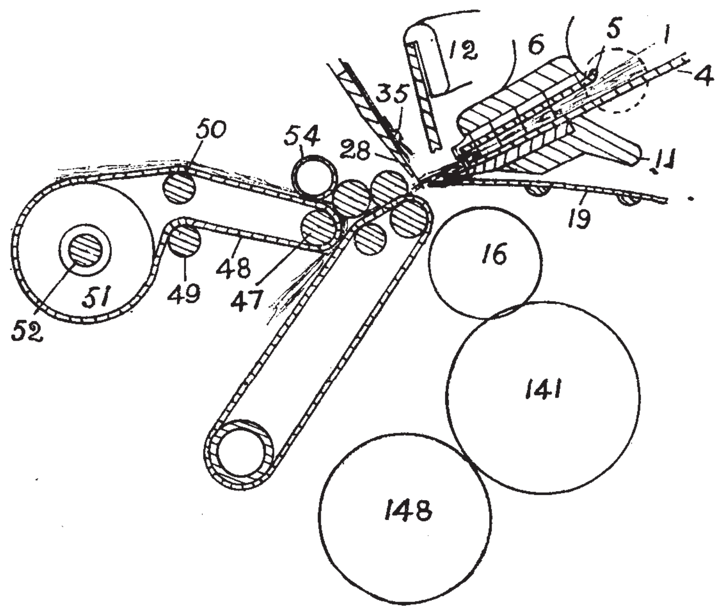


Fig. 210.

Fixed Comb. 28 is an intersecting comb, denominated the fixed comb. It is adjusted to the front of the lever 29 and its duplicate at the opposite side of the machine ; the lever 29 is pivoted on the stud 30 in bracket 7. An antifriction bowl 31 on stud 32 is carried in and near the base of the depending arm 33 ;

the bowl 31 rests in rolling contact with a cam 34 fixed on the cylinder shaft 17. A brush 35 is combined with a horizontal bar 36, contained and free to reciprocate vertically between suitable slotted grooves in the ends of the lever 29 and its duplicate. The bar 36 contains "finger" projections which normally rest on the shoulders of the upper jaw 12. The brush is therefore *free* and rises with the upper jaw levers 12 simultaneously with the descent of the intersecting comb; conversely the brush descends with the upper jaw, coinciding with the ascent of the intersecting comb, by which means it clears the comb 28 of its noil.

Drawing-off Rollers. 39 is a fluted roller, denominated the drawing-off roller; it is carried between the arms of a lever 40 and its duplicate opposite. The boss of this lever is loose on the shaft 41 about which it can oscillate; combined with the same boss is a second lever 42 carrying at its free end an antifriction bowl kept in rolling contact with a cam keyed to the cam shaft.

The lever 40 carries an antifriction bowl 43 which is kept in rolling contact with the cam 44 on the cylinder shaft 17. The combined action of the two cams operates to lift the roller 39 *clear* of the pins when the comb segment is in operation, and to permit the same roller to fall into rolling contact with the rubber or leather segment 16^2 during the period of drawing off; simultaneously the roller 39 travels forward very slightly in sympathy with the periphery of the segment 16^2.

47 is a small fluted roller and 48 an endless leather passing round it. The leather further passes over two "tension" rollers 49 and 50 and finally around a flanged

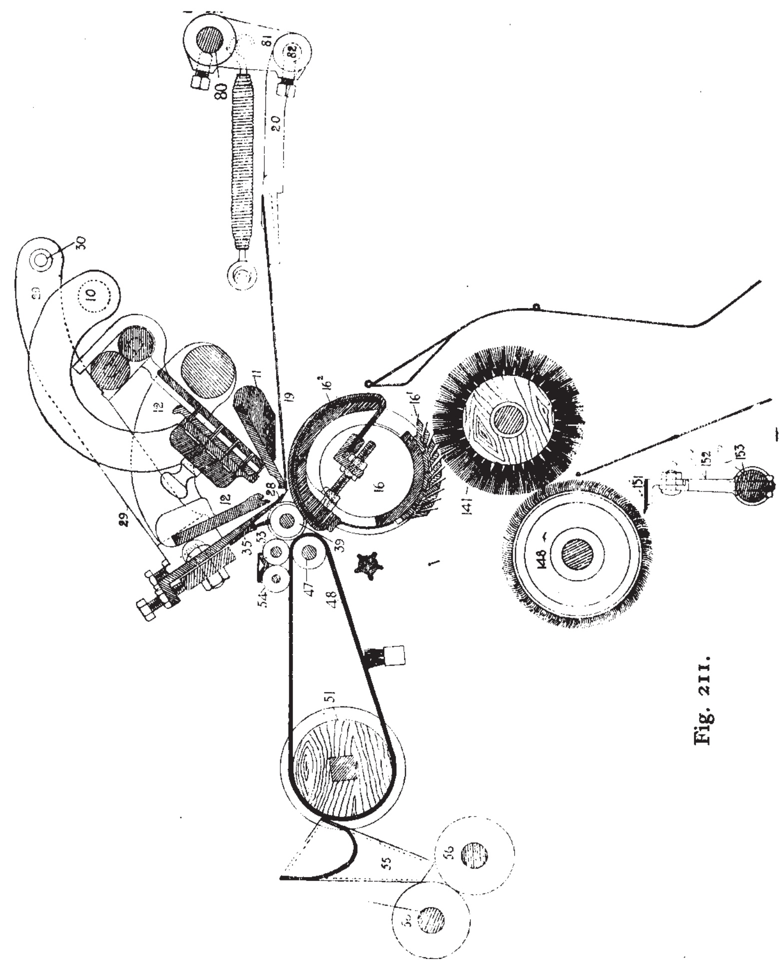

80
81
82
20
30
10
12
11
19
16
141
151
152
153
148
28
29
35
53
39
47
48
51
55
56

Fig. 211.

pulley 51, fixed on shaft 52. A small fluted press roller 53 is kept in rolling contact with the leather 48 and roller 47, and roller 54 is supplemented to act as a clearer to roller 53.

The rollers 47, 53 and 54 are free to reciprocate into near, and out of contact with the drawing-off roller 39. The shaft 52, flanged pulley 51, and leather 48 are rotated intermittingly (see Figs. 214, 215 and 216). The function of rollers 47 and 53 is to receive the tuft of combed fibres and, with their outward traverse and rotation of the leather 48, carry it from the roller 39 towards the funnel 55, calender rollers 56 and can 57.

With each outward traverse of the carrier rollers the *tail* end of each successive tuft of combed fibres hangs downwards behind the carrier roller 47 in sufficient length to permit the next successive tuft to overlap and so splice the combed fibres and form them into a continuous sliver. A divider blade 46 for breaking any excessively long fibres is pivoted on stud 45 and vibrates and falls between the rollers 39 and 47 as the last is carrying off the combed sliver.

A supplementary leather is added for wool (Fig. 211).

Mechanism and Action of the Nipper. Fig. 212 shows in elevation the mechanism which controls the opening and closing of the nipper. A lever 59 is adjustably compounded to the shaft 13; this lever carries at its free end a stud 60 and bowl 61 which latter is kept in rolling contact with the positive cam 62, keyed fast to the cam shaft 63, which rotates at the same speed as the cylinder shaft 17. Compounded with the lower jaw 11 and carrier bracket 14 is a lever 64

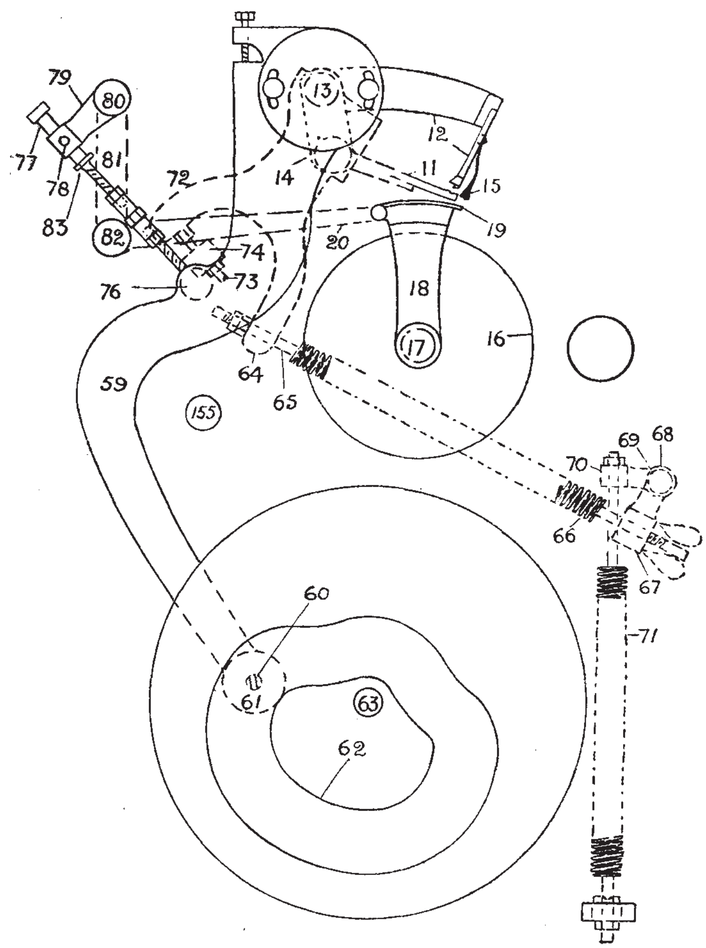

79
80
77
78
81
83
72
82
14
13
12
11
15
19
20
74
73
76
18
17
16
59
64
65
155
69
68
70
66
67
71
60
61
63
62

Fig. 212.

which is linked through a stud 65 and a spiral spring 66 to the lever 67 combined with sleeve 68 free to oscillate on the fixed shaft 69. A second strong spiral spring 71 links the lever arm 70, combined with sleeve 68, to the fixed bracket as shown.

The rotation of cam 62 vibrates through bowl 61 lever 59 and shaft 13, the upper jaw 12.

The springs 66 and 71 are adjusted to hold, through connections described, the heavy lower jaw in equilibrium and to act as a buffer to the pressure of the upper jaw 12. The limit of the upward vibratory traverse of the lower jaw 11 is regulated through an arm 72 which moves into or out of contact with the flanged head of an adjustable set screw 73 in the bracket 74.

Mechanism and Operation of Striker Blade.

A stud 76 (Fig. 212) in lever 59 supports an adjustable link 77, the upper end of which passes freely through the sleeve of a stud 78 which is fixed in the lever 79, keyed fast to a shaft 80, supported between the machine gables and free to oscillate. Keyed fast to the shaft 80 is the rocking lever 81, linked, as shown, by the stud 82 to the rod 20 and striker blade 19.

A collar 83 is compounded with the link 77 and is so adjusted that it abuts against the sleeve of stud 78 for each clockwise oscillation of lever 59 and link 77; the lever 79, shaft 80 and lever 81 are oscillated so as to draw the striker blade 19 *clear* of the segment combing parts and their operation. The forward movement of the blade is accomplished through the energy of a spiral spring (see Fig. 211).

A stop lever and stud are combined with the shaft 80 to limit the amount of its oscillation and the reciprocation of the striker blade 19 (see Fig. 213).

Mechanism and Action of the Feeding Apparatus.

Fig. 213 is an elevation of the parts of mechanism which reciprocate the feed box and vibrate the feed comb. The carrier bracket 7, to which the feed box and comb are attached, is connected by a loose stud 84 to the arm of lever 85, in turn compounded with the shaft 86 which is supported by and free to oscillate between the machine gables.

Adjustably fixed to the shaft 86 is a simple lever 87 which rests in normal contact with the flanged head of an adjustable stud 88 set-screwed into the arm of lever 89. This lever is carried on the stud 90 about which it is free to oscillate.

Compounded with the boss of lever 89 is a lever 91 which carries a stud 92 and an antifriction bowl 93 which is kept in rolling contact with negative cam 94 keyed fast to the cylinder shaft 17. The free arm of lever 85 carries a stud 95 and a pawl lever 96, the catch of which fits over the teeth of a change ratchet wheel 97 fast on the end of the bottom feed roller 2.

The constant rotation of cam 94 vibrates lever 91 and oscillates shaft 90, which in turn vibrates, through lever 89 and stud 88, the lever 87 to rock the shaft 86 which in turn, through lever 85 and stud 84, reciprocates in a *straight* plane the carrier bracket 7 together with the feed comb and box. The arm of lever 85 slightly oscillates about the stud 84 during this operation.

With each complete vibratory movement of the parts described the pawl lever 96 turns the ratchet wheel 97 one tooth and with it the feed roller 2.

The details and operation of the mechanism employed to vibrate the dabber comb 6 are as follows:—The dabber comb must be depressed to penetrate the sliver when the grid or feed box (4 and 5) is at the limit of its backward movement. In this depressed position the dabber comb remains until the feed box has reached the limit of its forward traverse, and in this closed position it remains during the whole of the time the drawing-off roller 39 is kept in contact with the segment part 16^2. During the backward movement of the feed box the dabber comb 6 must be gradually lifted clear of the feed or grid box (4 and 5) in preparation to repeat the above operation.

The stud 10, on which the feed comb 6 is mounted, also serves as a pivot for the balk lever 99, the short arm of which is connected by a stud 100 to the arm of the dabber comb 6.

A stud 101 in balk lever 99 supports, in suspension, a cam lever 102 which carries near its base a stud 103 and antifriction bowl 104 which is kept in rolling contact with a positive cam 105.

The free arm of balk lever 99 is forked as at 106. A T shaped stud 107 fits into the grooved part of the fork and passes freely through it and also through a sleeve 108 formed on the side of the cam lever 102. A spiral spring 109 circumscribes the stud 107 and is compressed between the shank end of the fork 106 and an adjustable collar 110.

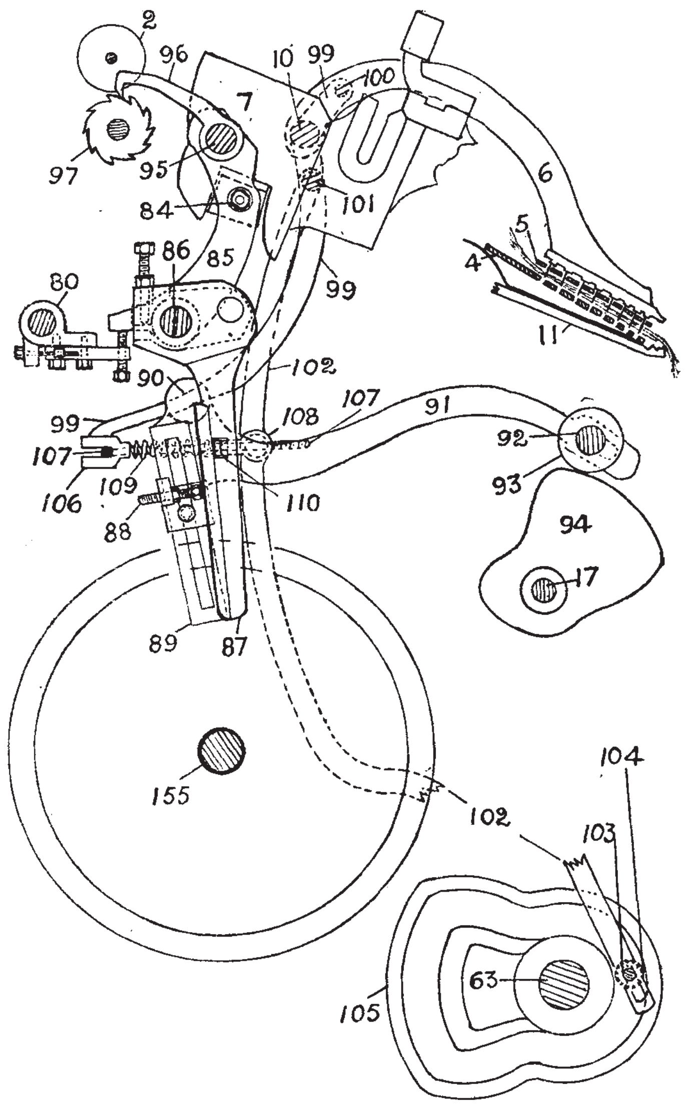

2
96
10
99
100
7
97
95
6
84
101
5
86
85
4
80
99
11
102
90
107
91
99
108
92
107
106
109
110
93
88
94
17
89
87
155
104
102
103
63
105

Fig. 213.

The constant rotation of the cam 105 operates, through bowl 104, lever 102 and T shaped stud 107 to vibrate the lever 99 about the stud 10, and through stud 100 to vibrate the feed comb 6 with its pins into and out of contact with the sliver in the feed box as described.

The rotation and vibration of the Carrier Rollers.

The arrangement for operating the mechanisms which vibrate the carrier rollers into contact with the drawing-off rollers and simultaneously rotate them intermittingly, together with the delivery rollers, is illustrated in sectional elevations at Figs. 214, 215 and 216. In the machine the details are respectively one behind the other for which reason they are shown detached.

Loosely mounted near the end of shaft 52, carrying the flange pulley 51 and leather 48, is a semi-toothed spur pinion 111, the teeth of which intermesh with those of a segment rack 112 formed on the free end of a balk lever 113 which is pivoted on the stud 114. The lower arm of lever 113 carries a stud 115 and an antifriction bowl 116 which is kept in rolling contact with the periphery of a negative cam 117 mounted on the cam shaft 63.

A strong spiral spring 118, linked between the stud 119 in lever 113 and a stud 120 fixed to the machine gable, serves to keep the bowl 116 in close contact with cam 117.

Projecting from the boss of the semi-toothed wheel 111 is a short lever arm 121 carrying a stud 122 on which is freely mounted a small pawl or lever catch 123 designed to engage with the teeth of a *three*-tooth ratchet wheel 124 keyed fast to the end of shaft 52.

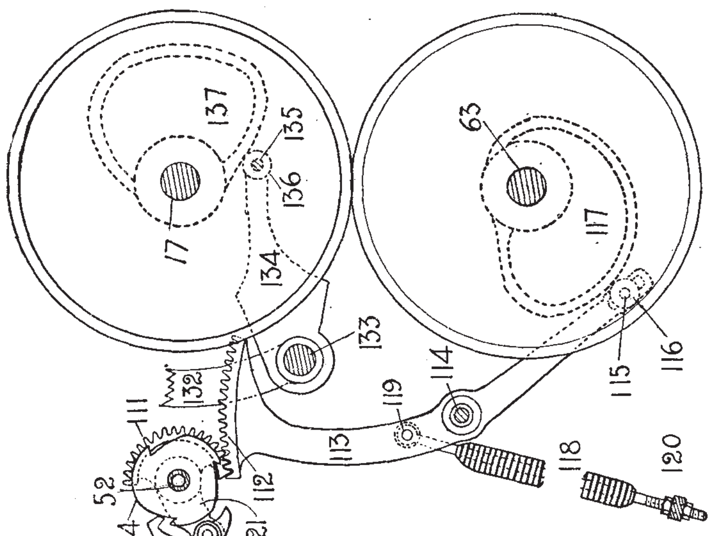


Fig. 214.

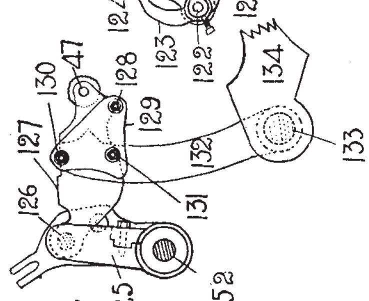


Fig 215

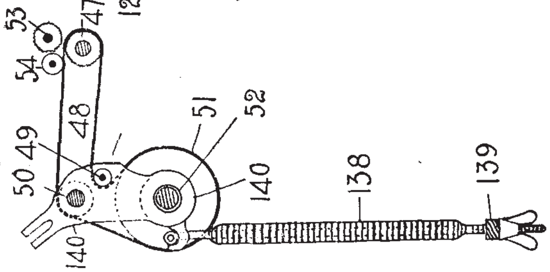


Fig. 216.

The rotation of the cam 117 oscillates the lever 113 clockwise about the stud 114, and partially rotates, counterclockwise, the segment wheel 111 and lever arm 121 with stud 122 and pawl catch 123. The pawl catch 123 in turn rotates in sympathy, through ratchet wheel 124, the shaft 52 with pulley 51 and leather 48.

The leather 48 and carrier rollers 47 and 53 are thus *rotated*, and the combed sliver is carried towards the delivery rollers and can.

The potential energy of the spiral spring 118 oscillates lever 113 counterclockwise and rotates through the mechanism just described the semi-toothed wheel 111, lever 121 and pawl catch lever 123 clockwise, independently of shaft 52, so that the pawl lever catch is carried into position ready to engage with the next successive tooth of the ratchet wheel.

The *vibratory* movement of the *carrier rollers* is accomplished as follows :—A short lever 125 (Fig. 215) is loosely mounted and free to oscillate about shaft 52. The free end of lever 125 supports a stud 126 and bracket 127. The bracket 127 combines the stud 126 and the shaft of carrier roller 47. The same bracket 127 carries a stud shaft 128 to which a triangular bracket 129 is securely bolted. Combined with the bracket 129 by studs 130 and 131 is a simple lever 132 keyed fast to a shaft 133 free to oscillate ; also compounded with the same shaft is a cam lever 134 carrying at its free end a stud 135 and an antifriction roller 136 which is kept in rolling contact with a negative cam 137 compounded with the shaft 17 of the segment cylinder.

A strong spiral spring 138 is fastened to a fixed bracket 139 and the boss of lever 140; the free end of lever 140 carries the tension rollers 49 and 50.

The action of the cam 137 oscillates, clockwise through bowl 136 and lever 134, the shaft 133 which, in turn, through lever 132, bracket 129, stud 128 and bracket 127, moves the carrier roller 47 with the leather 48 to the right and into rolling contact with the drawing-off roller 39.

The stored energy in the spiral spring 138 operates conversely and tends to oscillate the lever 140 counter-clockwise, and through it the tension rollers, with leather 48 and carrier roller 47, are vibrated to the left in sympathy with their rotation, away from the drawing-off roller 39.

Simultaneously, acting through parts 128 to 135 inclusive, the bowl 136 is kept in rolling contact with cam 137.

Noil removing Mechanism. The noil is removed from the segment comb 16^1 by a circular brush, card roller and doffing knife.

Fig. 217 is a side elevation of these parts, and Fig. 218 is a side elevation showing the gearing and driving details for same.

141 is the circular brush, mounted and free to rotate in the boss 142 of a supplementary arm 143 adjustably fixed on the stud 144 and combined by the stud 145 and the adjustable set-screw 146 to the lever 147.

The lever 147 is mounted and free to oscillate about the pulley or main shaft 155 on which the card roller 148 is loosely mounted. An antifriction roller 149 is adjustably combined with the free end of lever 147 as shown. The weight of the brush 141 keeps the roller 149 in rolling contact with a cam 150 keyed fast to the cam shaft 63.

A steel blade or doffing knife 151 is carried by the free arm of a lever 152 mounted and free to oscillate with the shaft 153.

Motion is communicated to these details by the following train of wheels (Fig. 218) :—A spur wheel 154, containing 70 teeth, is keyed fast to the pulley shaft 155 and drives, through the single intermediate wheel 156, a spur wheel 157, containing 40 teeth, which is fast to the shaft of the brush 141. The spur wheel 154 also gears into wheel 158, containing 41 teeth, keyed fast to a rotating shaft 159. Compounded with the end of this shaft is a stud eccentric 160 which fits into the slotted arm of lever 161 keyed fast to the shaft 153 which is free to oscillate with the lever 152 and doffing knife 151.

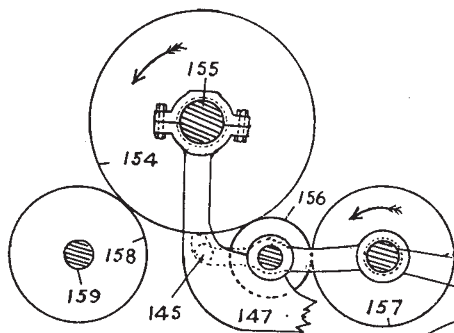
The card roller is driven at about seven revolutions per minute by a train of wheels from the cam shaft.

The pulleys and main shaft make about 180 revolutions, the segment comb and cam shafts 50 revolutions, and the brush 315 revolutions per minute.

The surface speed of the brush is $4\frac{1}{2}$ times that of the comb segment and 50 times that of the card roller. The doffing knife oscillates about 300 times per minute.

The brush penetrates the pins of the segment about one-sixth of an inch but simply grazes the pins of the card roller to which it should not be set too close or the noil will be rolled into "neps."

Fig. 218.



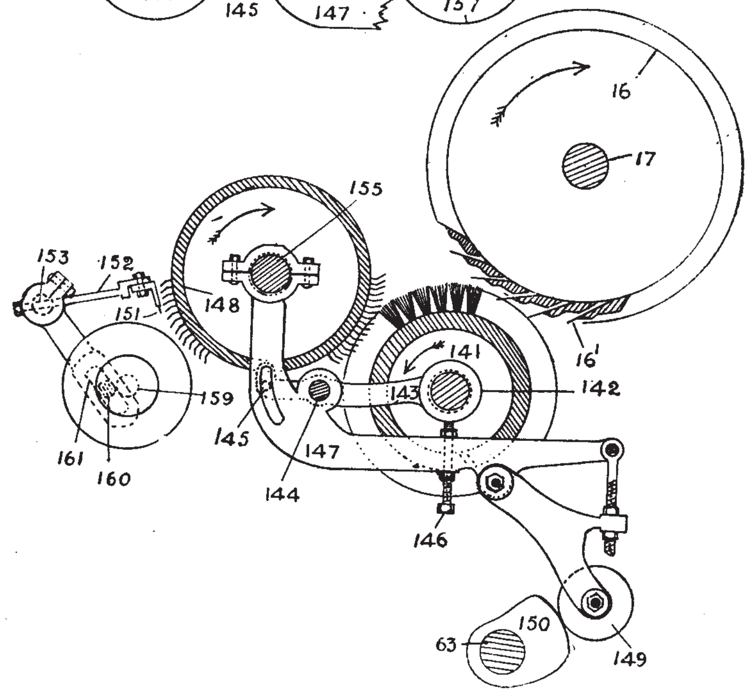


Fig. 217.

TABLE IX.

Details of segment and fixed combs for different materials

Flax Tows.

Row	Pins per inch	Size of Wire	Total length in inches	Projection in inches
1	5	14	·75	·36
2	7½	14	·75	·36
3	10	15	·75	·36
4	10	15	·75	·36
5	10	15	·75	·36
6	15	19	·76	·34
7	15	19	·76	·34
8	20	21	·78	·32
9	20	21	·78	·32
10	25	22	·82	·28
11	25	22	·82	·28
12	30	24	·84	·26
13	30	24	·84	·26
14	35	25	·86	·24
15	35	25	·86	·24
16	40	25	·88	·22
17	40	25	·88	·22
18	45	26	·90	·20
19	45	26	·90	·20
20	50	26	·90	·20
Fixed Comb.	50	21/27	—	·32

Boty. Wools.

Medium Quality.

Row	Pins per inch	Size of Wire	Total length in inches	Projection in inches
1	20	18	·86	·20
2	25	20	·86	·20
3	30	22	·92	·19
4	35	23	·92	·19
5	40	25	·96	·18
6	45	26	·96	·18
7	50	27	·96	·17
8	55	28	1·00	·17
9	62	29	1·10	·16
10	63	29	1·10	·16
Fixed Comb.	55	27	—	·25

Wool.

Row	Pins per inch	Size of Wire	Total length in inches	Projection in inches	
1A	10	19	·84	·28	All Wools.
2A	12½	19	·84	·28	
3A	15	19	·84	·28	
4A	20	21	·84	·28	
5A	25	22	·84	·28	
6A	30	24	·88	·24	
7A	30	24	·88	·24	
8A	35	24	·88	·24	
9A	35	24	·88	·24	
10A	40	26	·92	·20	Long Wools.
11A	40	26	·92	·20	
12A	40	26	·92	·20	
13A	46	27	·96	·16	
14A	46	27	·96	·16	
15A	46	27	1·03	·16	
16A	55	27	1·03	·16	
17A	55	27	1·03	·16	
18A	55	27	1·03	·16	
Fixed Comb.	55	27	—	·32	
10B	40	26	·92	·20	Medium Crossbred.
11B	40	26	·92	·20	
12B	48	27	·92	·20	
13B	48	27	·92	·20	
14B	55	27	·96	·16	
15B	65	28	1·03	·16	
16B	65	28	1·03	·16	
17B	65	28	1·03	·16	
18B	65	28	1·03	·16	
Fixed Comb.	55	27	—	·32	
10C	40	26	·92	·20	Fine Botanies.
11C	48	27	·92	·20	
12C	55	27	·96	·20	
13C	65	28	·96	·20	
14C	70	29	·96	·16	
15C	70	29	1·03	·16	
16C	70	29	1·03	·16	
17C	75	30	1·03	·16	
18C	75	30	1·03	·16	
Fixed Comb.	60	28	—	·32	

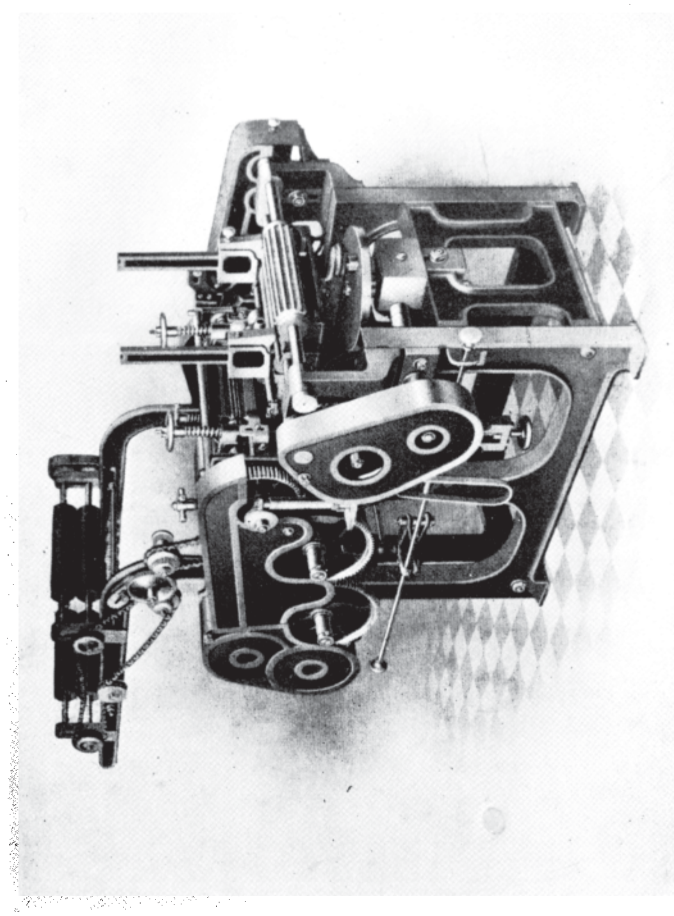


Fig. 219.
Single Head Balling Finishing Gill Box

CHAPTER XXXIV.

FINISHING GILL BOXES.

WHEN the combed wool leaves the Noble, Lister, or Holden machine, the sliver consists of distinct sections of long and short fibres, excepting the very shortest which were extracted as noil in the process of combing.

In order to thoroughly mix these long and short fibres, to ensure an even yarn throughout the entire length, the combed slivers are usually passed through two, sometimes three, gill boxes dominated "finishers."

In the first of these boxes the material is usually delivered into sliver cans, and from the second it is received in the form of a ball which constitutes the *finished* top.

Since the object of worsted spinning is to produce a yarn of uniform weight for a given unit of length, characterised by uniformity of material, which, incidentally, is the basis of worsted spinning, it is consequently essential after the combing operation to immediately and uniformly blend the long and short fibres and regulate the weight for a given length of material in order that the correct counts of yarn may be subsequently produced.

Whenever mixture yarns are required it is usual to blend the different qualities or colours in the requisite proportions in the finishing gill boxes.

Mechanism of Finishing Gills.

Fig. 219 shows a perspective view of a single balling head finisher, as made by Prince Smith & Son.

Fig. 220 is a line diagram in plan of same—right-hand drive.

Fig. 221 is a side elevation showing the wheel gearing to the front rollers.

Fig. 222 is a similar view of the gearing to the back rollers.

Fig. 223 is a line diagram, in plan, of a similar machine for fine wools—left-hand drive. The details have been taken from the same firm's double head machine, only one head being shown, however, as it includes all the motions. A indicates the machine pulley on the lower back driven shaft B, suitably carried at the back of, and between, the gables D of the machine. A pinion E, 40 teeth, drives the wheel F, 70 teeth, on the upper back shaft H. The pinion G, 24 teeth, drives, through the adjustable stud wheel I, 70 teeth, stud pinion J, 15 teeth, and the single intermediate wheel K, the large spur wheel L, 70 teeth, keyed fast to the feed roller shaft M, 3in. diameter. The bevel wheels N, 27 teeth, on the back shaft H drive the bevels O, 18 teeth, keyed fast to the shafts of the bottom screws P, the fallers for which are indicated at Q. The upper screws receive their motion from the spur wheels R keyed fast to the lower screws P. Pitch of screws—½ inch.

A spur pinion S, 36 teeth, on the back shaft H, communicates motion through two intermediate spur wheels, to the spur pinion T, 60 teeth, keyed fast to the front roller shaft U, 2½in. diameter.

Rotary motion is communicated to the balling rollers

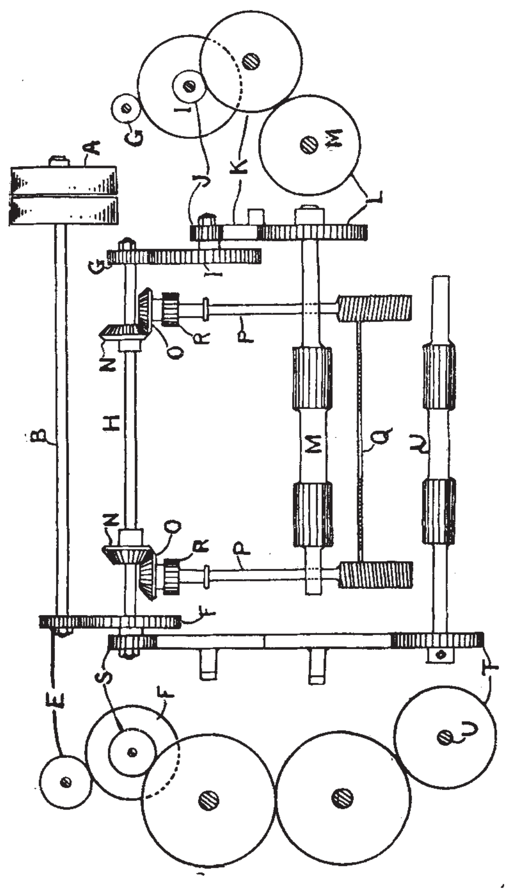


Fig. 221. Fig 220. Fig 222.

x through the spur pinion v on shaft u, and spur wheel w on one of the roller shafts x.

An oscillatory movement is imparted to the delivery funnel Z, and a lateral reciprocating motion to the spindle carrying the sliver ball by which means the *cross* winding of the sliver is effected. The position of the "conditioning" roller is indicated at C.

The solution of the drafts for the single head machine is as follows :—

1. Draft between back rollers and fallers or "lead" of fallers.

$$\frac{\text{More}}{\text{Less}} = \frac{\text{Pitch of screw} \times \text{I} \times \text{L} \times \text{N}}{\text{Cir}^{\text{ce.}} \text{ of bk. roller} \times \text{G} \times \text{J} \times \text{O}}$$

$$= \frac{1}{2} \times \frac{7}{3 \times 22} \times \frac{70}{24} \times \frac{70}{15} \times \frac{27}{18} = 1 \cdot 08$$

2. Draft between fallers and front rollers.

$$\frac{\text{More}}{\text{Less}} = \frac{\text{Cir}^{\text{ce.}} \text{ of front rollers} \times \text{S} \times \text{O}}{\text{Pitch of screw} \times \text{T} \times \text{N}}$$

$$= \frac{5}{2} \times \frac{22}{7} \times \frac{2}{1} \times \frac{36}{60} \times \frac{18}{27} = 6 \cdot 29$$

3. Total Draft in box.

$$\frac{\text{More}}{\text{Less}} = \frac{\text{Dia. of front rollers} \times \text{I} \times \text{L} \times \text{S}}{\text{Dia. of back rollers} \times \text{G} \times \text{J} \times \text{T}}$$

$$= \frac{5}{2 \times 3} \times \frac{70}{24} \times \frac{70}{15} \times \frac{36}{60} = 6 \cdot 80$$

The drafts, sizes of wheels and rollers for the double head can gill box and second finisher are as follows :—Wheel G, 26 teeth ; I, 70 teeth ; J, 15 teeth ; L, 70 teeth ; dia. of feed roller M, 2½in. Draft wheel S, 30 teeth ; T, 60 teeth ; dia. of front roller U, 2ins. Bevel wheel N, 20 teeth, and O, 20 teeth. Pitch of double-threaded screw, ⅜ in.

The solution of the drafts for same is as follows :—

1. Draft between back rollers and fallers.

$$\frac{\text{More}}{\text{Less}}=\frac{\text{Pitch of screw}\times \text{I}\times \text{L}\times \text{N}}{\text{Cir}^{\text{ce.}}\text{ of bk. rollers}\times \text{G}\times \text{J}\times \text{O}}$$

$$=\frac{3\times 2}{8}\times\frac{2\times 7}{5\times 22}\times\frac{70}{26}\times\frac{70}{15}\times\frac{20}{20}=1{\cdot}20$$

2. Draft between fallers and front rollers.

$$\frac{\text{More}}{\text{Less}}=\frac{\text{Cir}^{\text{ce.}}\text{ of front rollers}\times \text{S}\times \text{O}}{\text{Pitch of screw}\times 2\times \text{T}\times \text{N}}$$

$$=\frac{2\times 22}{7}\times\frac{8}{3\times 2}\times\frac{30}{60}\times\frac{20}{20}=4{\cdot}19$$

3. Total draft in box.

$$\frac{\text{More}}{\text{Less}}=\frac{\text{Dia. of front rollers}\times \text{I}\times \text{L}\times \text{S}}{\text{Dia. of bk. rollers}\times \text{G}\times \text{J}\times \text{T}}$$

$$=\frac{2\times 2}{5}\times\frac{70}{26}\times\frac{70}{15}\times\frac{30}{60}=5{\cdot}03$$

The lead of the fallers is determined in practice according to the kind of material to be worked—no absolute figures can be given. If the wool is loose and "fluffy," more lead should be given to the fallers, thus neutralising any tendency of the sliver to ride on the pins. If the sliver be of a solid character less draft will be required.

Influence of fluted rollers on draft calculation. In the foregoing examples no account has been taken of the fluted rollers. The following practical observations may, however, be noted. Assume, for example, that the back rollers are 3in. in diameter ; the flutes $\frac{3}{16}$in. deep, and no leathers are used. Then—

1. If the load is light and the flutes intersect to the full extent, add twice the depth of the flute to the diameter of the roller :—

$$3 + (\tfrac{3}{16} \times 2) = 3\tfrac{3}{8} \text{ in.}$$

2. If the load is heavier and the flutes intersect to half their depth, add the depth of the flute to the diameter of the roller :—

$$3 + \tfrac{3}{16} = 3\tfrac{3}{16} \text{ in.}$$

3. In all other cases add to the diameter of the roller, twice the amount of intersection.

TABLE X.

PARTICULARS OF FINISHING GILLS.

	Long coarse wool	Long & finer wool	Medium Wool	Fine Botany. Single box	Fine Botany. Double box
Pitch of Screws	$\frac{5}{8}''$	$\frac{5}{8}''$	$\frac{7}{16}'' \times 2$	$\frac{3}{8}'' \times 2$	$\frac{3}{8}'' \times 2''$
Faller—Set-over* ...	$12\frac{1}{4}''$	$12\frac{1}{4}''$	$12''$	$10''$	† $10''$-$12''$
,, Width	$\frac{17}{32}''$	$\frac{1}{2}''$	$\frac{3}{8}''$	$\frac{11}{32}''$	$\frac{11}{32}''$
,, Depth—	$\frac{9}{16}''$	$\frac{5}{8}''$	$\frac{9}{16}''$	—	—
Total length of pins ...	$1\frac{3}{16}''$	$1\frac{1}{8}''$	$1\frac{1}{16}''$	$1''$	$1''$
No. of Pins per in. (2 rows)	8	10	‖ 14	14	20
Size of Wire	14	15	‖ 17	17	21

‖ Or 12 pins per inch of 16s wire, and 16 pins per inch of 18s wire, for first and second boxes respectively.
† Or $4\frac{1}{2}$in. twice.
* Fallers all bored through.

DEFECTS OF ORDINARY GILLS.

The faller "stocks" are usually studded with *two* rows of pins, the front being slightly shorter than the back row. At the end of the top screw, where the forward movement of the faller is arrested, and where it drops to the lower screw, *both rows* of pins are simultaneously withdrawn from the sliver. Only those fibres already seized by the drawing-off rollers are drawn forward, whereas those not seized lag behind, and a thin

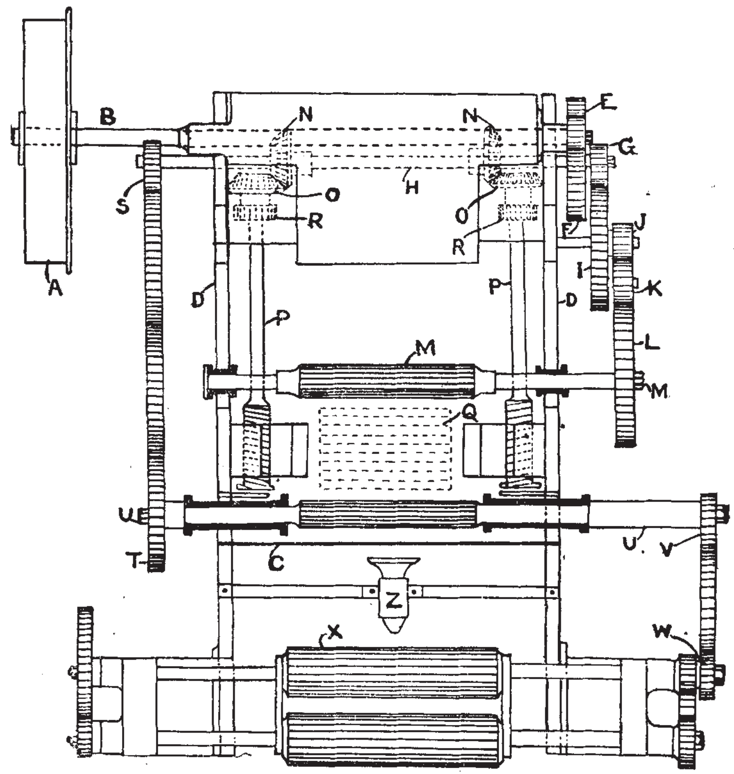


Fig. 223.

spot is produced in the sliver, followed by a correspondingly thick spot immediately the next faller is brought forward.

Perfect drawing-off can only be accomplished when the fibres are guided by the gills, at a uniform height, right up to the drawing-off rollers—a desideratum which is virtually impossible of attainment with the ordinary gills containing two rows of pins of the same, or approximately the same, height.

Since there were many practical objections to the employment of "*single*" gills, Offerman, Leipsic, introduced, in 1905, an arrangement consisting of double rows of gills of two distinct heights, combined with intersecting gills (see Fig. 228), and necessitating a withdrawal of the same in *two* stages—first the shorter pins only, and second the longer pins—by which means a more uniform drawing is effected.

A modification of this principle is employed by Prince Smith & Son in a machine denominated the O.P.S. Gill Box.

The O.P.S. Finishing Gill Box.

The O.P.S. (Offerman Prince Smith) Gill Boxes are used both before and after combing, and are especially suitable for very short wools, and mixing coloured or other slivers. In this type of machine the fallers contain two rows of pins. The first row is composed of short, *round* pins, and the second row of longer, *flat* pins. The flat pins compensate for any reduction in relative strength due to the increased length, and so offer a resistance to the pressure of the fibres, equal to that of the front row. The difference in the length of the two rows of pins is approximately equal to the thickness of the sliver.

The distance separating the two rows of pins is equal to *half* the distance between the centres of the gills.

The withdrawal of each row of pins is effected at the same distance from the nip of the drawing rollers. When the short pins are withdrawn, the longer pins still project slightly above the sliver, where they remain until pushed forward to the point of withdrawal of the short pins.

Additional points of importance are :—There are two back or feed rollers. The saddles on which the fallers are supported are *inclined* so as to enable the gills to more readily " pin " the fibre. There is no draft between the back rollers and the fallers, all the draft being obtained by the front rollers, which are spirally fluted and of comparatively small diameter. The range of sizes is 18, 20, 22, 25, 27 and 30 mms., (25·47 mms. are equivalent to one inch.)

The last thread of the top screw is an expanding one. An extra train of wheels is employed to depress the faller to the first step, after which an ordinary screw cam completes the depression to the lower screw. A special conductor conveys the faller from the top to the bottom screw.

Offerman originally employed a supplementary cam to produce the first operation.

In order to keep the drawing leather clear of the pins a supplementary roller is introduced, behind which the leather is made to pass.

An oscillating movement is given to the funnel, applied to each head.

Each machine consists of several heads, each of which is provided with an independent stop motion, in case a faller locks or a pin is broken.

The slivers from the several heads may be combined in delivery for mixing different qualities or colours of wool.

All the essential principles and features of this mechanism are illustrated by the following diagrams :—Figs. 224, 225 and 226 are transverse sections through a series of gills in three positions, viz., when the end faller is respectively in its highest, middle and lowest position. Fig. 227 shows a transverse section from the feed rollers to the balling head.

Fig. 228 shows Offerman's arrangement, with *intersecting* gills, a method common on the Continent, and Fig. 229 shows a front view of the same in relation to the cam transferring mechanism.

The same numerals occurring in the different diagrams refer to corresponding details.

1, 1 are the fallers, studded with short round pins 2, and long flat pins 3. The fallers are supported by, and free to slide over the surface of the saddle 4 and its duplicate. 4^1 is the step or intermediate stage for the fallers. 5 and 6 indicate the positions of the two pairs of fluted feed rollers, through the nips of which the sliver 7 is fed and immediately pinned by the gill as it rises from the lower saddle 4^2 to the upper saddle 4.

The drawing rollers 8 are spirally fluted, and the upper one is constantly cleaned by frictional contact with a brush 9. A leather 10 passes between the nip

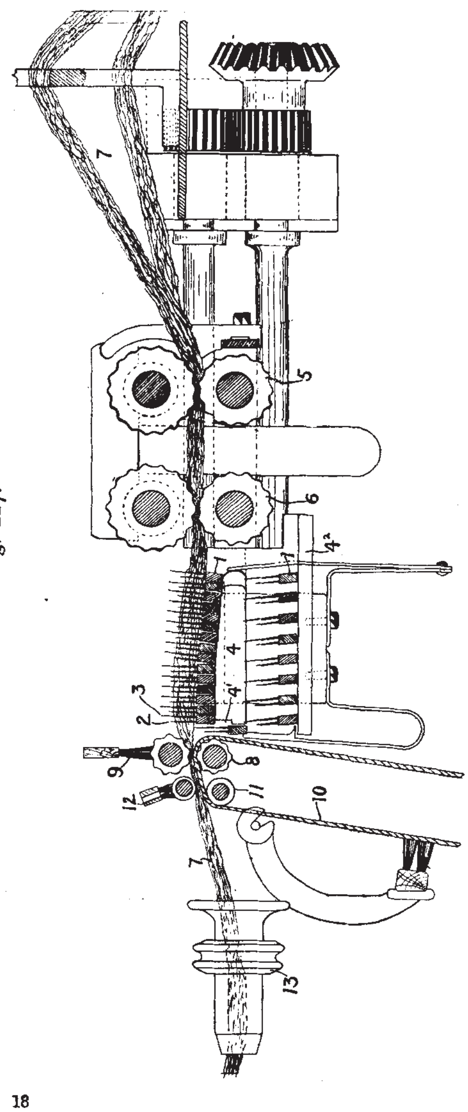


Fig. 227.

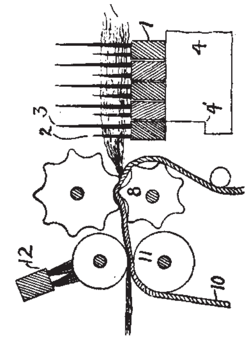


Fig. 224.

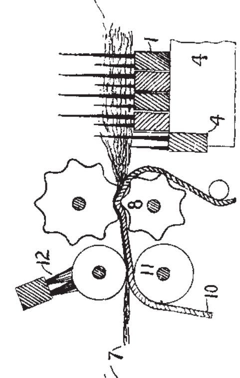


Fig. 225.

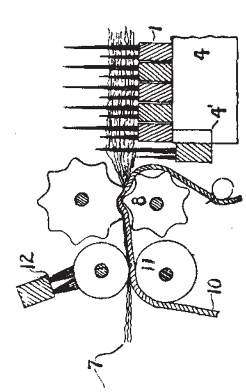


Fig. 226

18

of these rollers and two smooth supplementary and leading rollers 11. The upper of these rollers is also cleaned continuously through frictional contact with the fixed brush 12. The sliver is then led forward through a rotating funnel 13 to the balling head. In some of the newer types of machine the deliveries from each head are combined and formed into one single sliver.

In Figs. 228 and 229 of the intersecting gill type the ends of the double threaded screws are provided with the usual two cam levers 14 for the ordinary fallers, and 14^1 for the stocks of the intersecting gills. Supplementary cams 15 and 15^1 are provided to move the gill stocks to the intermediate stages.

Measuring and Knocking Motion.

For the purpose of producing evenness of sliver, by reducing, as much as possible, the relative number of thick and thin places, a large number of doublings are put up behind the first finishing box with which is combined the measuring and knocking-off motion.

The fixed length of material is then weighed and the result recorded. At the second or finishing box the several weights of sliver in the cans are grouped and made into sets of equal total weight according to the number of doublings required behind the second finisher or balling machine in order to produce a still more regular or uniform length of sliver. A measuring motion is also attached to the baller or last finishing box.

There are two types of measuring and knocking-off motions applied to gill boxes, drawing, roving and spinning frames.

First—The three-wheel or candlestick knocker-off, Vol. I, Fig. 50, page 194—generally used with gill boxes.

Second—The knocker-off combined with a train of wheels, as usually applied to drawing frames (see Vol. III).

They each receive their initial motion from a worm compounded with the front roller, and work in conjunction with it by stopping the machine after it has made a definite number of revolutions which is determined by the size of the change wheel employed, other

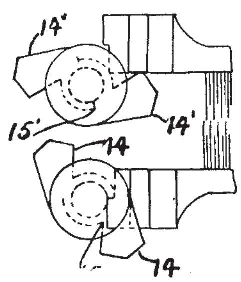


Fig. 229.

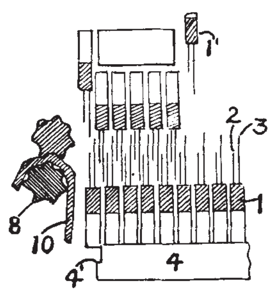


Fig. 228.

things being constant; *e.g.*, The diameter of the front roller of the gill box is 2in. The change wheel on the upright stud contains 40 teeth and is driven by a single worm on the front roller. The wheel at the bottom of this same stud contains 29 teeth and drives the adjoining wheel, which is known as the " knocker-off " wheel, with 39 teeth. On the 29 and 39 wheels there are small projections which only meet when the small wheel has turned 39 times and the large wheel 29 times. When the projections meet the 39 wheel moves laterally and by means of the lever in which it is fixed, pushes the spring-handle out of the notch which is connected with the belt fork, and so stops the machine.

The length of sliver is determined as follows:—When the front roller has revolved once, the worm on it turns the change wheel one tooth, therefore the front roller must turn 40 times to one revolution of the change wheel, and as the stud on which the change wheel is fixed must turn 39 times before it knocks off, the length of the sliver will be

$$\frac{2 \times 22}{7} \times \frac{40 \times 39}{1} \times \frac{1}{36} = 272 \text{ yards.}$$

The cans are then weighed (400 drams per 40 yards is a suitable weight for most sorts). The variation in the weight of the slivers is regulated in the subsequent boxes so that a thread of uniform weight for a given length is produced.

TABLE XI.

Average weight, doublings and drafts in finishing gill boxes.

	40 and 44s Prepared Long Wool.		Carded 50s Medium Crossbred.		Merinos 60s Short Wool.	
Slivers ...	1st box	2nd box	1st box	2nd box	1st box	2nd box
Wt. per 10 yds	$2\frac{3}{4}$ ozs.	11 ozs.	$1\frac{3}{4}$ oz.	7 ozs.	15 drs.	4 ozs.
Ends up ...	28	5	24	5	20	5
Draft ...	7	$7\frac{1}{2}$	$5\frac{5}{8}$	6	$4\frac{3}{4}$	5
Finished Wt.	11 ozs.	$7\frac{1}{3}$	7	6	4	4

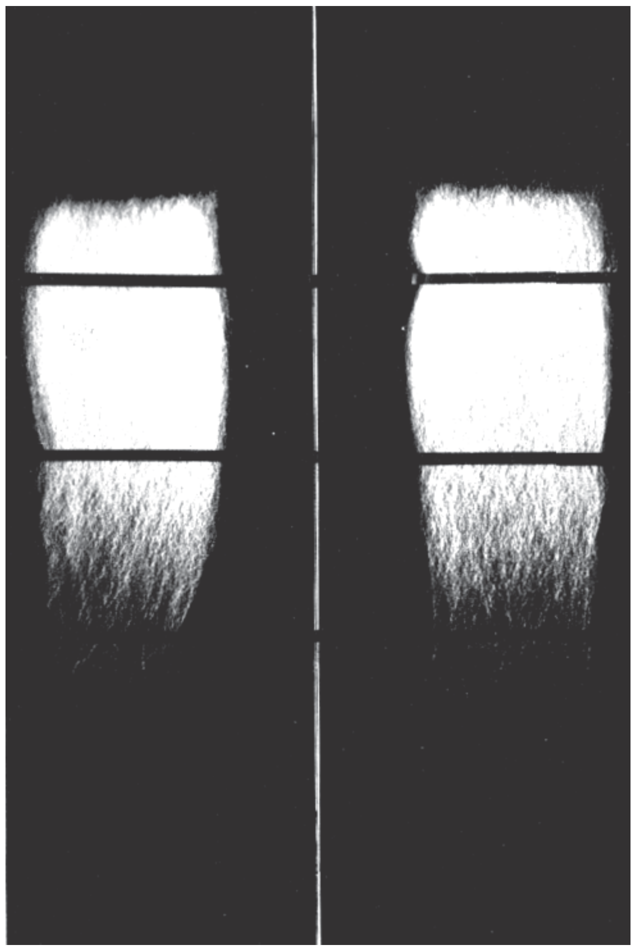


Fig. 231. Fig. 230.

OBJECT AND METHOD OF CONDITIONING.

Owing to the considerable amount of heat necessarily employed during the wool combing process, the natural amount of moisture which wool will absorb and retain is all practically evaporated. Water has therefore to be artificially added so as to bring the material back to its normal or standard *condition* and re-impart to it, its natural cohesiveness and elasticity—essential requisites for subsequent and successful manipulation.

The operation is conveniently and mechanically performed during the passage of the sliver through the finishing gill boxes.

A small trough and roller are placed between the drawing rollers and the delivery or calender rollers. The trough is supplied with water which is kept at a uniform height. The roller slowly revolves in the trough in contact with the water and the sliver is drawn across and in contact with the upper periphery of the roller, thus facilitating the natural affinity of the wool to absorb the requisite amount of moisture.

The speed of the roller modifies the mechanical supply of water to the sliver—the greater the speed, the greater the supply. The speed should therefore be adjusted so as to impart the standard allowance of moisture.

Experience has taught that it is necessary to adopt a standard allowance as well as a recognised method of testing, so that the nature of transactions may be ascertained.

The standard allowance and regain per cent. are as follows :—

Tops combed with oil for moisture, 2oz. 9drs. per lb., or a regain of 19 per cent.

Tops combed without oil for moisture, 2oz. 7½drs. per lb., or a regain of 18¾ per cent.

Noils for moisture, 1oz. 15½drs., or a regain of 14 per cent.

Under these circumstances it is necessary that the spinner should be able to ascertain for himself in what condition the tops are which he buys, especially seeing that the apparatus required for making safe and reliable tests is simple and inexpensive.

The subject and method of testing for condition, with problems re-same, are dealt with in "Calculations in Yarns and Fabrics" (Bradbury), and need not be repeated here (See also Vol. I, page 60).

Tops combed in oil. No definite and agreed standard is yet fixed which will satisfy all the varying qualities of wool and the conflicting interests of top makers and spinners.

The following approximate allowances are meanwhile favoured :—

1. Tops combed in oil, 3½ per cent. of gross fatty matters.
2. Tops combed dry, 0·634 per cent. ,, ,,

The following is a simple method of testing for same :—

EXAMPLE :—Given 1 lb. of wool.

First. Test for moisture in the usual way and note the absolute dry weight.

Second. Take the dry sample and scour with soft (olive) soap ; allow the wool to steep until thoroughly saturated, afterwards scour two or three times in a solution of soap and hot water (temperature as in wool washing); next rinse in clean water, squeeze and thoroughly dry the same. The difference in weight is denominated the commercial scour "gross loss." (See also Vol. I, p. 210).

Quality. Generally speaking quality is loosely expressed as the number to which the material will spin. It is, however, a compound of many factors, including length, fineness, waviness, softness and colour of fibre. (See also pages 17 and 18, and chapter VI, Vol. I).

The ideal top is composed of fibres of equal length—as nearly as possible.

A spinner who prepares his own tops necessarily knows their composition, but when tops are bought in the open market or from a top maker it is essential to be able to judge their quality, a faculty which is only acquired by long practice. "Touch" is so finely developed in many top makers, spinners and manufacturers through continual practice that they can distinguish the several qualities and properties of wool by simply handling it.

A mechanical analysis of two samples for uniformity of length is illustrated as follows :—

Fig. 230 is from a 60^s Botany top, and it will be observed that the several fibres are relatively uniform.

Fig. 231 is from a top supposed to be exactly like the standard sample (Fig. 230), but it conclusively shows that the fibres are not only very irregular in length, but that there is also a large proportion of short fibres which incidentally proves that the two tops were not prepared from exactly the same blend.

CHAPTER XXXV.

MATERIAL AND PRODUCTIVE COSTS.

THE correct or even approximate cost of producing any kind of yarn can only be determined by carefully noting and recording all the data associated with the manipulation of the raw material into yarn as set forth in the following pages under their respective heads and divisions.

It should however be noted that no two firms would arrive at exactly the same result for the same quality and count of yarn, the difference being chiefly due to local conditions and type and value of machinery which may materially affect the turn off.

Consequently the following, though based on actual facts and practice, can only be taken as suggestive and representative.

A.—Raw Material Costs.

The cost of producing worsted yarns depends upon the cost of the raw materials, the yield of clean wool, the amount paid for carriage, sorting (if any), scouring and drying, preparing or burring when necessary, carding, combing, drawing, spinning and twisting, and wages paid to miscellaneous workpeople whose labour cannot be located to any particular process. Allowance must also be made for the amount of waste, including shrinkage, the cost of plant and depreciation, power consumed, engineers' and firemen's wages compared with the actual turn off for any given period—say one week—and for some specific quality and number of yarn. While there is not available space here to deal with every phase and detail, the following particulars, problems and solutions will no doubt be found useful to many.

The yield of clean wool from the natural or greasy state varies from 33% to 70%, the yield being usually less in the fine sorts such as merinoes or botanys. Scoured or half-washed wool will yield from 70% to 80%.

The average cost of sorting English and domestic wools is about $\frac{1}{4}$d., while merinoes vary from $\frac{1}{16}$ to $\frac{1}{8}$ of a penny.

The cost of washing greasy wool generally adds about $\frac{1}{2}$d. to the cost of the clean wool, and $\frac{1}{4}$d. per lb. if the wool has been previously scoured.

EXAMPLE 1.—If 1,920 lbs. of Sydney greasy wool cost 9d. per lb. in the grease, and if the loss in scouring be 40% on the greasy weight, and $\frac{1}{2}$d. per lb. be added to the cost of the clean wool for wages, machinery and materials used, and $\frac{1}{6}$d. per lb. for carriage, find the average cost per lb. of the clean wool.

Then 1,920 lbs. of greasy less 40% loss in washing, etc.

$$=\frac{1,920}{1}\times\frac{60}{100}=1,152 \text{ lbs. of clean wool.}$$

	s.	d.
Also 1,920 lbs. greasy wool @ 9d. per lb.=	1,440	0
1,920 lbs. ,, carriage @ $\frac{1}{6}$d. per lb.=	26	8
Total cost =	1,466	8

$$\text{And } \frac{\overset{\text{s.}}{1,466}\ \overset{\text{d.}}{8}}{1,152 \text{ lbs. clean wool.}} = 1/3\tfrac{1}{4}\text{d. per lb.}$$

$1/3\frac{1}{4}+\frac{1}{2}$d. for cost of washing, etc.$=1/3\frac{3}{4}$d. per lb.

EXAMPLE 2.—A "lot" of wool costs 10d. per lb. If the lot is classed into two sorts and yields 65% of the lower quality, leaving 35% of the higher quality, which latter is estimated to be worth 2d. per lb. more than the former, what is the value of each sort.

Let x=price per lb. of lower quality.
Then $x+2$ = ,, ,, higher ,,

$$\therefore 65x + 35(x+2) = 10 \times 100 \text{ pence}$$
$$\therefore 65x + 35x + 70 = 1000 \text{ pence}$$
$$\therefore 100x = 1000 - 70 = 930.$$

$\therefore x = \frac{930}{100} = 9{\cdot}3$ pence, the price per lb. of the lower.
and $(9{\cdot}3+2) = 11{\cdot}3$,, ,, ,, better.

Proof	65 lbs. @ 9·3 =	604·5 pence.
	35 lbs. @ 11·3 =	395·5 ,,
	100 lbs. cost	1,000 pence.

$$\therefore \text{Price per lb.} = \frac{1,000}{100} = 10 \text{ pence.}$$

NOTE.—If it should be required to make two, three, or more sorts which are necessarily of different values, a moment's reflection will demonstrate that when the average cost price is known the product of this and the total weight is equal to the sum of the products of the respective proportionate weights and prices.

EXAMPLE 3.—What would be the price of each sort if the average cost price of a "lot" of clean wool be 1/- per lb., and respective weights are 30, 24, 20, 16 and 10 lbs. per cent., and if their values are respectively estimated at 1, 2, 2, and 3 pence above the lowest price ?

Let x = price of lowest grade, in pence.
Then $(x+1)$ = price of second grade, in pence.
also $(x+2)$, $(x+2)$, and $(x+3)$=prices of third, fourth, and fifth grades respectively.

$$\therefore 30x+24(x+1)+20(x+2)+16(x+2)+10(x+3)=12\times 100$$
$$\therefore 30x+24x+24+20x+40+16x+32+10x+30=1200$$
$$\therefore 30x+24x+20x+16x+10x+126=1200$$
$$\therefore 100x=1200-126=1074.$$
$$\text{and } x=\frac{1074}{100}=10\cdot 74\text{d. per lb., the price of the lowest.}$$

Consequently the respective prices are 10·74, 11·74, 12·74, 12·74, and 13·74 pence per lb.

B.—Cost of Preparing or Carding.

When the wool has been thoroughly dried it is then usually prepared for the combing by passing the material through a series of about six gill boxes called ' preparers '; the turn off per week of 48 hours is about 2,880 to 3,840 lbs., or 60 to 80 lbs. per hour, for each set of machines. The amount of waste during this process is small ; the operation adds from $\frac{1}{4}$d. to $\frac{3}{8}$d. per lb. to the cost. If the fibre is too short for the gilling process it is prepared for the combing by a process of carding which usually adds from $\frac{1}{2}$d. to 1d. per lb. Consequently it is generally better to prepare the wool, if the length of the fibre will permit, on the gill boxes in preference to the carding, since it is more economical both as regards cost of production and subsequent "tearing" in combing.

C.—COST OF COMBED TOP.

The greasy or scoured wool is frequently bought by the topmaker or spinner, and after being sorted it is sent to a commission wool comber who washes, dries, prepares or cards and combs the fibres and forms the wool into tops; these, together with the noil and waste, are returned to the top maker or spinner.

In some cases the spinner puts the material through these respective processes on his own machinery. Whatever may be the merits of either system it is necessary to determine the cost of the combed top, or, knowing the current market value of the top, to ascertain the price at which the raw wool must be purchased in order to leave a reasonable margin of profit.

To calculate the cost per lb. of the combed top, add to the cost of the raw wool, which includes carriage and sorting, the amount paid for combing, which is always charged on the combed or finished top and which amount varies as per price list supplied on page 292. From the total cost deduct the amount received for the noil and divide the remainder by the percentage of combed top.

EXAMPLE 4.—A spinner buys 2,657lbs. of 80^{S} quality washed merino fleeces at 26d. per lb. (1914). The combing costs $2\frac{1}{2}$d. per lb. of top. The market value of the noils is 17d. per lb., and of the combed top 2/9 per lb. The yield of top is 2,120lbs.; noils 240lbs., and the balance is waste or sinkage. Ascertain the gain or loss on the combed top, the percentage top, noil and waste, also the tear.

Answer.

	£	s.	d.		£	s.	d.
Wool 2,657lbs. at 2/2 =	287	16	10	Top 2,120lbs. at 2/9 =	291	10	0
Combing 2,120lbs. at 2½d. =	22	1	8	Noils 240lbs. at 1/5 =	17	0	0
	£309	18	6		308	10	0
				Loss...	1	8	6
					£309	18	6

Comber's result.—Wool, 2,657lbs.

Top ...	...2,120lbs. =	79·79 per cent.
Noil ...	... 240lbs. =	9·03 ,,
Shoddy	... 6lbs. =	·22 ,,
Burrs	... 21lbs. =	·79 ,,
Evaporation	270lbs. =	10·17 ,,
	2,657lbs. =	100·00

Tear, nearly 9 top to 1 noil.

EXAMPLE 5.—A top maker sells to a spinner 135 packs of crossbred tops at 15⅛d. per lb. (1913). He buys 195½ packs of wool to cover this sale, which, when sorted and delivered to the comber costs 10d. per lb. He pays 1¼d. per lb. of top for combing and sells the noils for 8d. per lb. The wool comber delivers to the top maker 32,297lbs. of combed top and 2,827lbs. of noils. Ascertain the percentage of top, noil and waste or sinkage, also the tear. What is the top maker's gain or loss on the transaction ?

Answer.

	lbs.		£	s.	d.		lbs.		£	s.	d.
Wool 195½ packs × 240 =	46,920	at 10d. =	1,955	0	0	Tops ...	32,297	at 15⅛d. =	2,035	7	8
Combing	32,297	,, 1¼d. =	168	4	3	Noils ...	2,827	,, 8d. =	94	4	8
			2,123	4	3				£2,129	12	4
		Gain...	6	8	1						
			£2,129	12	4						

$$\text{Tops} = \frac{32{,}297 \times 100}{46{,}920} = 68{\cdot}84 \text{ per cent.}$$

$$\text{Noil} = \frac{32{,}297}{2{,}827} = 6{\cdot}02 \text{ per cent.}$$

$$\text{Sinkage} = {\cdot}14 \text{ per cent.}$$

$$100{\cdot}00$$

$$\text{Tear} = \frac{32{,}297}{2{,}827} = 11{\cdot}42 \text{ top to 1 noil.}$$

EXAMPLE 6.—8,000lbs. of greasy wool costs 12d. per lb. (1913), yields 60 per cent. of clean wool, and tears 7 to 1. The noil sells at 10d. and combing costs 2d. per lb. Ascertain the cost per lb. of the combed top.

Answer.

By equational method :—

The combed top $= \frac{7}{8}$ of 60 per cent. yield $= \frac{60 \times 7}{8} = 52{\cdot}5$ per cent.

And noil $= \frac{1}{8}$,, ,, ,, $= \frac{60 \times 1}{8} = 7{\cdot}5$,,

$$\text{Also } \frac{\left(\begin{smallmatrix}\text{Price per lb.}\\ \text{of raw wool}\end{smallmatrix}\right) + \left(\begin{smallmatrix}\text{Yield \% of top} \times \text{cost}\\ \text{per lb. for combing}\end{smallmatrix}\right) - \left(\begin{smallmatrix}\text{Yield \% of noil}\\ \times \text{ value per lb.}\end{smallmatrix}\right)}{\text{Yield per cent. of combed top}} = \begin{matrix}\text{Cost per lb.}\\ \text{of}\\ \text{combed top.}\end{matrix}$$

$$\text{Thus}\left(12 + \frac{52{\cdot}5 \times 2}{100} - \frac{7{\cdot}5 \times 10}{100}\right) \times \frac{100}{52{\cdot}5}$$

$$= \frac{1200 + 105 - 75}{100} \times \frac{100}{52{\cdot}5} = 23{\cdot}43\text{d. per lb.}$$

EXAMPLE 7.—Assume the market value of 60^s Botany top is 27·5d. (1914), combing 2½d., and noil value 17d. per lb. The wool tears 8·5 to 1 and the sinkage is estimated at 50 per cent. At what price must the greasy wool be purchased to produce the above top, irrespective of the top maker's charges and profits?

Answer.

Then Value of combed top	= 27·5d. per lb.
Combing charges ...	= 2·5d. ,,
Net value of clean wool top and noil	= 25d. ,,
Proportional value of clean wool constituting top	$= \frac{25 \times 8 \cdot 5}{9 \cdot 5} = 22 \cdot 37$d.
Plus value of noil	$= \frac{17 \times 1}{9 \cdot 5} = 1 \cdot 80$d.
Net value of clean wool	= 24·17d.
Value of greasy wool including freightage and sorting	$= \frac{24 \cdot 17 \times 50}{100} = 12 \cdot 09$d.

EXAMPLE 8.—Assume the top maker's value of greasy wool is 12d. (1914), combing charges 2½d. per lb., and the value of the noil 16·5d. The top tears 9 to 1 and the sinkage is 50 per cent. Ascertain the cost of the finished top.

Answer.

1. Net amount of combed top $= \frac{100}{1} \times \frac{50}{100} \times \frac{9}{10} = 45$lbs.

2. ,, noil $= \frac{100}{1} \times \frac{50}{100} \times \frac{1}{10} = 5$lbs.

3. Cost of combing 45lbs. at $2\frac{1}{2}$d.	=	112·5d.
4. Value of noil, 5lbs. at 16·5d.	=	82·5d.
5. Noil value "underpays" combing		30d.
6. Plus cost of 100lbs. greasy wool at 12d.	=	1200d.
7. Net total cost of 45lbs. combed top	=	1230d.

8. Cost per lb. of finished top $= \frac{1230}{45} = 27·3$d.

EXAMPLE 9.—A worsted spinner buys 24,000lbs. of Lincoln wether fleeces at $7\frac{1}{4}$d. per lb. (1922 prices). If cartage, sorting, and warehouse charges at $\frac{3}{8}$d. per lb. amount to £37 10s. 0d., ascertain the gain or loss when the following sorting results are known :—wether britch 535lbs. at $6\frac{3}{4}$d.; wether brown 23,350lbs. at $7\frac{3}{4}$d.; shorts 27lbs. at 6d.; toppings 52lbs. at 1d.; pickings 41lbs. of no value; grey and kempy fibres 7lbs. at 5d.; "moiety" 8lbs. at 4d.

SORTING RESULTS.

	£	s.	d.
Lincoln wethers, fleeces 24,000lbs. at $7\frac{1}{4}$d. =	725	0	0
Cartage, sorting and Warehouse charges at $\frac{3}{8}$d. =	37	10	0
Balance over =	7	14	6
	£770	4	6

	£	s.	d.
Wether brown, 23,350lbs. at $7\frac{3}{4}$d. =	754	0	2
Wether britch, 535 lbs. at $6\frac{3}{4}$d. =	15	0	11
Shorts, 27lbs. at 6d. =	0	13	6
Toppings, 52lbs. at 1d.	0	4	4
Pickings =	0	0	0
Grey and Kempy, 7lbs. at 5d. ...	0	2	11
"Moiety" 8lbs. at 4d.	0	2	8
	£770	4	6

EXAMPLE 10.—Given 23,350lbs. of wether brown matchings worth 7¾d. per lb. (1922); the combed top yields 18,167 lbs. and the noil 1,300 lbs., the market values of which are 12⅝d. and 6d. respectively, and the combing costs are 3d. per lb. Find the yield per cent. of top, noil and sinkage; also the "tear" of top to noil, and gain or loss for the results and values given (condition 2 ozs. 3 drams per lb. and 3% oil).

COMBING RESULTS.

	£	s.	d.		£	s.	d.
Wether brown matchings, 23,350lbs. at 7¾d. =	754	0	2	Top, 18,167 lbs. at 12⅝d. =	955	13	2
Combing top, 18,167lbs. at 3d. =	227	1	9	Noil, 1,300lbs. at 6d. =	32	10	0
Gain in value =	7	1	3				
	£988	3	2		£988	3	2

$$\text{Yield of top} = \frac{18{,}167}{23{,}350} \times \frac{100}{1} = 77{\cdot}80\%$$

$$\text{,, noil} = \frac{1{,}300}{23{,}350} \times \frac{100}{1} = 5{\cdot}56\%$$

$$\text{Sinkage} = \frac{3{,}883 \times 100}{23{,}350} = 16{\cdot}64\%$$

Tearing 13·95 top to 1 noil.

D.—SPINNER'S MARGIN.

EXAMPLE 11.—A worsted spinner receives 18,167 lbs. of combed top—wether brown matchings as in example 10—together with instructions to draw, spin and twist into $2/28^{S}$ worsted yarn, the market value of which is

1/9 per lb. If the cost of the combed top is $12\frac{5}{8}$d. per lb., the total loss in weight from top to spun and twisted yarn is 10%, inclusive of 5% laps worth 12d. per lb. and $1\frac{1}{2}$% waste at 11d. per lb. Ascertain the maximum margin per lb. left to cover cost of drawing, spinning and twisting (for convenience referred to as "spinning margin"), including overhead charges and profits.

Solutions.

		£	s.	d.
I. Cost of combed top, 18,167 lbs. @ $12\frac{5}{8}$d.	=	955	13	2
Less (a) value of laps $\frac{18167}{1} \times \frac{5}{100}$				
$=908{\cdot}35$ lbs. @ 12d. = £45 8 4				
(b) value of waste $= \frac{18,167}{1} \times \frac{1\frac{1}{2}}{100}$				
$=272{\cdot}5$ lbs. @ 11d. = £12 9 10		57	18	2
Net material costs	=	£897	15	0

		£	s.	d.
II. Total market value of yarn				
$= \frac{18,167}{1} \times \frac{90}{100} = 16,350{\cdot}3$ lbs. @ 21d.	=	1,430	13	0
Less net Material costs		897	15	0
Total spinning margin	=	£532	18	0

III. Maximum spinning margin per lb.

$$= \frac{\text{£}532 \text{ 18s. 0d. (total margin)}}{16,350{\cdot}3 \quad \text{(weight)}} = 7{\cdot}8\text{d.}$$

From the above three examples it is seen that a "lot" of Lincoln wethers costing $7\frac{1}{4}$d. per lb. is increased in commercial value to 21d. per lb. when sorted, washed, prepared and spun into 2/28s worsted yarn.

Index.

Backwashing machines, 276.
  Necessity and principle of, 273.
  Boldy & Son, 288.
  Howard & Musgrave's, 286.
  Drying by Steam—indirect, 277.
  Drying by Steam—direct contact, 282.
  Drying by hot air, 283.
Balling machine—Punch box, 305.

Can and Coiler, 419.
Can and Coiler Problems, 424, 428.
Cleaning the comb circles, 324, 428, 431.
Combing appliances—Dabbing blades, 381.
Conditioning, 533.
Cooper's Noble Comb, 456.
  Mechanism and Operation, 458.
  Rotary disc mechanism, 466.
Cost of combed top, 540.
Cost of Preparing or Carding, 539.
Costs, Raw materials, 536.

Dabbing Mechanisms, 362.
Donisthorpe, G. E., 304.
Draft in finishing gill boxes, 522, 532.
Draft, influence of fluted rollers, 523.
Draft in Noble Comb, and examples, 412.
Drawing off mechanism, 391.

Funnels, 416.

Gilling—after Carding, 273.
Gilling—after backwashing, 282.
Gilling in the Nip comb, 469.
Gill boxes, finishing, 519.
Gill boxes, finishing, draft, 522.
Gill boxes, finishing, set over details, 524.
Gill boxes, defects, 524.
Gill boxes, O.P.S., 526.
Greenwood & Farrar's noil brush, 429.

Holden Comb, 484.
Heilmann Comb, 494.

Knocking off and measuring motions, 530.

Lister comb, 469.

Nip comb, 469.
  Gill box, 469-474.
  Nip arrangement, 470-477.
  Carrier comb, 471-477.
  Comb circle, 471.
  Drawing-off rollers, 472.
  Details of mechanism, 474.
  Driving details, 477-478.
  Gearing and Speed details, 481.
  Set over particulars, 483.

Noil increasing factors, 293.
Noble comb, 302.
James Noble, 303.
Balling or punch machine, 305.
General description and action of the, 313.
Principal details of the, 316.
The modern, 325.
Prince Smith's, 325.
Cooper's three or four circle, 456.
Taylor & Wadsworth's, 340.
Driving the circles and drawing-off rollers, 334.
Alternative form of detachment of pillars and shafts, 337.
Pillars arranged outside the small circles in the, 340.
Sliver funnels, 416.
Can and Coiler, 419.
Modern method of driving, 424.
Cleaning the comb circles, 428.
Noil brush details, 429.
Stop motions for combing machines, 432.
Set over and theory of pinning, 439.
Set over particulars, 447.
Set over tables II. to VII., 450-455.
Feeding the, 345.
Ball creel, 345.
Feed or conductor boxes, 348.
Inclined plane, 348.
Feed knife, 350.
Cleaver knives and comb cover, 352.
Automatic feeds, 352.
Flax Syndicate, 356.
Taylor & Wordsworth's, 359.
Goodhall & Co., 353.
Dabbing mechanisms, 362.
Brushes and operations, 362.
Relation of motion to comb circles, 364.
Types, 369.
Single eccentric, 396.
Crank pin eccentric, 371.
The balanced dabber, 374.
Dabbing blades, 378.
Flax Syndicate's, 380.
Combing appliances, 381.
Escapement apparatus for dabber blades, 384.
Auxiliary feed to dabber blades, 386.
Rotary brush—Wilson's, 387.
Rotating discs—Cooper's, 456.
Drawing-off mechanisms, 391.
Drawing-off rollers, leathers, etc., 391.
Weighting the drawing-off rollers, 393.
Weighting by a single spring, 396.
Double springs to drawing-off rollers, 398.
Ball bearings applied to the drawing-off rollers, 400.
Non-leather drawing-off rollers, 405.
Traverse motion for drawing-off leathers, 408.
"Twisted" flutes on drawing-off rollers, 411.

O.P.S. Gill boxes, 526.

Prince Smith's Alsacienne Comb, 495.

Quality, 535.

Stop motions for combing machines, 432.
Set over and theory of pinning, 439.
Set over particulars, 447.
Set over tables II. to VII., 450-455.
Square motion comb, 484.
Feeding and filling heads, 484.
Square motion, 485.
Drawing-off, 487.
Noil, "Robbings" and "Backings," 487, 488.
Chief details of mechanism, 488.

Schlumberger's comb, 494.
  Principles and process, 495.
  Feeding, combing, and drawing-off details, 498.
  Feeding, 500, 509.
  Combing the fringe, 502.
  Fixed comb, 503.
  Drawing-off rollers, 498, 504, 512.
  Nipper mechanism, 506.
  Striker blade—details, 508.
  Carrier rollers, 512.
  Noil mechanism, 515.
  Speed details, 516.
  Details of pinning comb, 518.
Sorting results, 544.

Tops—Examples on cost of combing, 540.
  Combed in oil, 534.

Wool combing—Necessity and object, 289.
  Prices for and cost of, 292.
  Hand combing—a factor in worsted, 296.
  By machinery, 298.
  Principle of machine combing, 298.
  Types of combing machines, 301.

Wire Gauge—Imperial standard, 449.

F. KING & SONS, LTD., PRINTERS, HALIFAX, YORKS.

Demy 8vo. 356 illustrations

Jacquard Mechanism & Harness Mounting

By F. BRADBURY.

CONTENTS.

PART I.

Chap.		Pages.
	THE EVOLUTION OF FIGURE AND JACQUARD WEAVING.	17 66
i.	Origin and growth of pattern desig	17–25
ii.	Fundamental principles of weavi ...	26–32
iii.	Hand loom weaving—Treadle s ...	32–44
iv.	The draw loom	45–53
v.	British efforts to supplement	54–60
vi.	French efforts to supersede ...	61–66
	MODER	67–258
vii.	The single lift Jacq ...	67–83
viii.	Double lift Jacqua	84–116
ix.	Cross border Jac	117–130
x.	Twilling Jacqu	131–159
xi.	Compound dr	160–171
xii.	Pressure an sm	172–190
xiii.	Gauze or	191–209
xiv.	The gau	210–222
xv.	The Sw	223–244
xvi.	Inde nes	245–258
	I.	
	G.	259–315
xvii.	ounting	259–268
xviii.	mounting...	269–302
xix.	... ...	303–315
	RT IV.	
	G, REPEATING AND LACING.	316–347
	ard stamping	316–323
xx	... ...	324–329
xxii.	g machines	330–347

OUT OF PRINT

The Yorkshire O

"... Mr. Fred Bra ury has dealt specifically with a branch of the weaving industry which has been too long neglected. . . . . It is especially welcome on the score of its thoroughness in treatment."

12/6 net.

F. KING & SONS Ltd., Publishers, HALIFAX, Yorks.

Worsted Preparing & Spinning—Vol. 1.

By BRADBURY & BUCKLEY.

CONTENTS.

PART I.

RAW MATERIAL, VARIETIES AND PROPERTIES.

Chap.	Subject.	Page.
i.	Varieties of sheep and sources of supply ..	3
ii.	Influence of climate and pasture	17
iii.	Impurities in wool	26
iv.	Influence of chemical re-agents	35
v.	Physical structure of the wool fibre	42
vi.	Physical Properties of the wool fibre and influence of structure	53

PART II.

CLASSIFICATION, WASHING AND DRYING.

vii.	Classification of wool	54
viii.	Wool sorting	91
ix.	Wool scouring and washing	98
x.	Wool washing machinery and processes ..	108
xi.	Wool Drying	141
xii.	Worsted and woollen yarns—a comparison	158

PART III.

WORSTED PREPARING.

xiii.	Gilling	162
xiv.	Drafting in gill boxes	169
xv.	Double or two-screw gill boxes	185
xvi.	Oiling Wool	198

PART IV.

WORSTED CARDING.

xvii.	Opening processes and removal of loose and vegetable impurities	207
xviii.	Object and process of worsted carding ..	220
xix.	Card clothing	233
xx.	Setting, speed, functions and grinding of the various rollers	245

6/6 net.

F. KING & SONS, Ltd., Publishers, HALIFAX.

Worsted Preparing & Spinning--Vol. 3.

By F. BRADBURY.

CONTENTS.

	PAGES.
CHAPTER XXXVI.	
Worsted Drawing	549–584
CHAPTER XXXVII.	
Fundamental Principles of Drawing and Spinning ...	585–603
CHAPTER XXXVIII.	
Drawing Operations and Reduction Calculations ...	604–626
CHAPTER XXXIX.	
Calculations on the Production of Drafts and Twists	627–646
CHAPTER XL.	
Relative Productive Capacity of the Drawing Boxes	647–656
CHAPTER XLI.	
Differential Bobbin Winding or " Cone Drawing ...	657–681
CHAPTER XLII.	
The Differential Mechanisms	682–710
CHAPTER XLIII.	
French Drawing	711–728
CHAPTER XLIV.	
Worsted Spinning	729–762
CHAPTER XLV.	
Lifter Mechanism, Spinning and Twisting	763–789
CHAPTER XLVI.	
Worsted Yarn Calculations	790–797
CHAPTER XLVII.	
Automatic Doffers	798–829
CHAPTER XLVIII.	
Worsted Mule Spinning...	830–838
CHAPTER XLIX.	
Twisting	839–849
CHAPTER L.	
Warping and Supplementary Processes	850–869

7/6 net.

F. KING & SONS LTD., Publishers, HALIFAX.