# Cotton Spinning and Weaving

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# COTTON SPINNING

AND

# WEAVING.

A PRACTICAL AND THEORETICAL TREATISE.

BY

HERBERT EDWARD WALMSLEY.

SECOND EDITION.—Enlarged and Revised.

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## PREFACE TO THE FIRST EDITION.

In compiling this Work, the Author's endeavour has been to put before the Student, in as simple, practical, and interesting a form as possible, an epitome of the art of Cotton Spinning, coupled with a few hints and remarks, which it is hoped may be useful to those aspiring to the important and responsible position of managing the various branches of this great industry.

H. E. W.

March, 1883.

# PREFACE TO THE SECOND EDITION.

The present edition has been completely revised and re-written, and with the many important additions forms practically a new book upon both Cotton Spinning and Weaving. The success of "Cotton Spinning" has induced the author to treat the entire subject,—from the raw cotton to the woven cloth,—as fully and as exhaustively as possible, in fact, to keep pace with these advancing times. The explanations, details, and all the calculations for the different machines are given under their respective heads, and chapters have been added upon the Ring Frame, the Electric Stop Motion, &c. With regard to all the most recent improvements in the art of Spinning and Weaving, and in the construction of textile machinery, he has spared no pains in endeavouring to keep his book well abreast of the times.

The diagrams will, it is hoped, be found to usefully illustrate the text. Short notices on Management, Cotton, Yarn, Cloth, Workpeople and Production, Wages, Strikes, &c., &c., have been added, and, lastly, on the all-important questions of Technical Education and Foreign Competition. To these the reader's attention is particularly drawn.

The writer's best thanks are due to the eminent firms whose machinery is alluded to, for their courteous assistance in the compilation of this work; but more especially is the author indebted to the publisher, —Mr. Abel Heywood, Junr.,—for his extreme pains and kind and invaluable help and advice during the printing and publishing of this volume.

H. E. W.

Serpuchoff, near Moscow,
June, 1885.

# INTRODUCTION.

In the management of a cotton spinning mill it will be admitted that the practical man who has from quite a lad been brought up to the business, and had a thorough insight into the working and management of such an establishment, possesses great advantages over those who have not been so favourably situated. No person, unless he devote his whole energy to the business in all its minutest detail, need ever hope to become a successful manager, and the only way to become a really first-class man in a cotton mill, is to commence at the bottom of the tree, and gradually work your way up. Go into the mill as a lad, and begin by sweeping the floors and picking waste, &c.; spend a certain time in the mixing and scutching rooms, mixing, weighing and feeding; then go to grinding and stripping and oiling, and also work at the spinning machinery, doffing, piecing and spinning. Make yourself useful in every department, and learn thoroughly how to tackle and work each machine in the mill. Spend a certain time in the mechanic's shop, at the bench and the lathe, and devote yourself to the fitting and adjusting of the machinery. Mechanics and the steam engine should form a special study. By degrees you will become a judge of cotton and yarn, after which, close application to duty, coupled with tact, will ensure success. Unless the manager have his business at his finger ends he will have to leave much of the management of the different departments to the overlookers, and they holding minor positions, naturally feel minor responsibility, and much mismanagement is the result, entailing loss and annoyance to the proprietors, and serious reflections on the manager. The manager who knows his business can not only give directions to those who are under him, but discern whether they are qualified for the situations they occupy, and when they fail in their duty. It is therefore necessary to impress upon the reader the fact, that if he wishes to become a successful manager, and eventually a prosperous cotton spinner, the only way to attain the desired end is to devote himself with his whole energy to the one object of becoming complete master of the entire business in all and every branch, even to the minutest detail. Cotton spinning mills are very expensive concerns, requiring a large amount of capital to be invested in them for manufacturing purposes; and they must be very skilfully managed to ensure success. It is well known that the proprietors of the present day are most particular in the choice of those to whom they confide the management of their establishments. Considering the great risk and amount of interest at stake, this is not to be wondered at—it is only right and natural; but the knowledge of it should serve as an incentive to all who wish to take a leading part in the management of cotton mills. Formerly, interest and influence went a long way towards obtaining the head posts, but now it is pure merit that is looked for in deciding upon an overlooker or manager. The whole mill may be fitted up with the best machinery, with all latest improvements, &c., and everything may be arranged in the most judicious manner, but unless it is well managed, and the mode of government is good, nothing will prevent a general collapse. It is a great mistake to suppose that any man, who has not been brought up in a mill, can, in a comparatively short space of time, acquire sufficient knowledge and tact to enable him to take charge of a spinning mill. It is a matter of perfect impossibility for such to compete with the practical man, who has been brought up in the mill from childhood, and has had every opportunity of learning the business thoroughly, both practically and theoretically.

The man that is wanted now-a-days is he that can produce a superior quality of yarn, and turn off a large quantity in proportion to the extent of the machinery; the man that can work cheaply and economically, keep the machinery in good working order, and manage the "hands" and the entire concern with credit to himself, and to the satisfaction of his employers.

## TABLE OF CONTENTS.

# A FEW REMARKS AND HINTS ON THE MANAGEMENT OF SPINNING MILLS.

As great care and attention are required in the management of Spinning Mills, if they are to be successfully and profitably worked, more especially as competition in this branch of business has now become so keen, it is absolutely necessary, and of the very first importance, that the charge of these establishments should be entrusted to none but men of proved ability and first-class character. The manager should be thoroughly acquainted, both practically and theoretically, with all the machinery, and the most approved manner of working it. He should likewise be able to tackle and work each machine himself; besides which he should have a thorough knowledge of both Cotton and Yarn, and be familiar with the different calculations required in making changes or in starting a new mill. In a word, the manager should be acquainted perfectly with all and every detail of the whole business, and to produce a good yarn, he should have every department of the mill arranged and worked upon the newest and latest principles. All unnecessary expenses, whether by alterations in the plan of the gearing, or arrangement of the machinery, should be avoided, unless such alterations would improve the productive capabilities of the establishment, or are absolutely necessary to suit local requirements. When once a mill has been filled with machinery, and its arrangements are completed, it is far better to let it remain so, unless the advantages that might accrue from alterations are very material. It is important for the manager to know at all times, the effect arising from any change in the qualities of the cotton, the manner of preparing it, or any other alteration he may have occasion to make in any department of the process.

A thorough and perfect system is of the very greatest importance. The manager should always have a mutual feeling and good understanding with the workpeople, and avoid as far as possible being too severe, but at the same time uphold his legitimate and proper authority. He should not on any account allow the hands to be needlessly harassed or unnecessarily interfered with, so long as they continue to attend to their work in a proper manner. He should show no favouritism, but treat them as far as is possible all alike, and according to their merits.

Unless in extreme cases, fines should be avoided, as fining the "hands" is a most vicious practice, which leads to nothing but unpleasantness and ill-feeling. The operatives as a rule are very unwilling to submit to fines, and it is far better to turn them away altogether than to resort to this mode of treatment. Nothing, however, but a little tact, and knowledge of them and their ways is necessary to secure harmony and good-will all round, for the workpeople as a rule, have a very fine sense of what is right and just.

In conclusion, the manager can never have too much general knowledge regarding the varieties and improvements introduced into every branch of the business.

## COTTON.

Cotton is generally distinguished by its colour, and the length, strength, and fineness of its fibre; besides which its softness, equality of staple, and freedom from impurities must likewise be taken into consideration. Cotton fibres vary from 1-500th to 1-7,200th part of an inch in diameter, and in a natural state contain from 300 to 500 twists per inch. In length, the staple or fibres range from ½ inch to 2 inches, according to the variety of wool to which they belong. In the trade the many different varieties of cotton wool are known by the names of the countries or districts where they have been grown. Our largest supply of cotton comes from North America, India, Egypt, and the Brazils; in the order named, and in all these countries the cotton plant is cultivated to a great extent. The most valuable cotton is that known as "Sea Island," it is of a very superior quality, with a staple or fibre from 1½ inches to over 2 inches long. This class of cotton is principally used for the production of the finest fabrics in the fine spinning and weaving mills of Manchester and Bolton. Egyptian cotton ranks in price and quality next to Sea Island, and is also a very superior wool of a yellowish colour, with a long and strong staple, but not nearly so fine and silky as Sea Island. It is used for the production of medium and fine Nos.

The Brazilian varieties also stand high in the market, and rank next to Egyptian.

"Uplands" or New Orleans is a fine, soft white cotton. It is in great demand for 30-32's twist, and is well adapted for making calicoes, velvets, and fustians.

The British India or Surat cottons are of a lower quality altogether, but are very extensively cultivated; the demand for this class of cotton being for the lower qualities of yarn and cloth.

In judging cotton the usual way is to take up a small quantity of the wool and press it gently in the hand and between the fingers, so as to know whether it is soft and silky or harsh and woolly, and watching how far the fibres are elastic or become entangled. Then with the fore finger and thumb of each hand, draw the cotton out until you get a clear staple, and until the fibres arrange themselves parallel to each other, so that you may know their average length and regularity. During this process the regularity, length, strength, fineness, and smoothness of the material must be carefully noted. If the fibres are short and weak, the cotton is of a poor quality and not worth much, as the spinning qualities of cotton depend upon the length, strength, fineness, and elasticity of its fibres. Experience has proved that it is a great mistake to use an inferior or low quality of cotton, neither the quality nor quantity of the yarn are so good, and there is a much greater loss in working. Inferior cotton also causes the yarn to weigh light and wrap irregularly, entailing harder work and less wages on the operatives, and as a result much trouble and upsetting of the whole arrangments of the mill.

## FRAUDULENT COTTON PACKING.

The adulteration of cotton, from the United States, with sand, water, and other fraudulent foreign substances, is now carried on to such a serious extent, that it has become absolutely necessary to take special precautions in purchasing the raw material. The following remarks on "Mixing different kinds of Cotton;" "Damp Cotton;" and "Dust and Sand in Cotton," may therefore be of value:—

## MIXING DIFFERENT KINDS OF COTTON.

American cotton in the same bale is often of different staple or fibre. Where the colour of the cotton is uniform, want of proper sorting, or overginning, will probably account for cotton of different staple in the same bale; but when the cotton is found in layers of different sorts, as is often the case, the general opinion is that it is the result of fraudulent admixture of different kinds of cotton, and does not arise from careless sorting. The even grading of cotton is very important, and there is room for improvement in this respect, in much of the cotton received from America. A better grading of cotton would be secured, if the plan of careful inspection by first purchasers were enforced.

## DAMP COTTON.

Very serious complaints are heard on all hands of unnatural damp in American cotton; and there can be no doubt whatever that the packers infuse steam, and even throw large quantities of water into the cotton during the process of packing, with the object of augmenting its weight.

All American cotton is now packed with the addition of water, more or less. No other cotton imported into England loses weight like American cotton does. When an excessive quantity of water has been used, the centre of the bale is frequently found to be in layers of caked cotton, very wet, and often highly dis-coloured. In some instances whole bales have the feel of having been steamed to a considerable extent before packing; and it is a very common thing for this cotton to lose fully 10% in the process of drying.

## DUST AND SAND IN COTTON.

Complaints as to the adulteration of American cotton by the addition of dust and sand are not only more general than the complaints in regard to the mixing and damping of cotton, but they are likewise of a far more serious character. Whether the adulteration consists of a percentage of sand, or of an equal percentage of damp, the actual loss is the same in each instance. The adulteration is flagrant and extensive. Thousands of tons of white and red sand are purchased every year, at the price of cotton, and some concerns have been carried on at a loss, in consequence of this grievous adulteration of the raw material. In some instances, the sand is evidently thrown into the cotton during the process of packing, in shovelfuls; in many cases, sand in larger quantities, varying from 20lbs. to 80lbs., has been found in the middle of bales of cotton, and even as much as 100lbs. of sand has been found in one bale. The sand is evidently wet when the bales are pressed, for in many instances the cotton about the sand is discoloured and caked. Very rarely is a sandy lot of cotton alike, as regards the amount of adulteration. Some bales are almost wholly free from sand, some contain more or less, while other bales are full of it. In most cases the sand is so evenly distributed through the bale, as to give to the cotton a deep red colour, while in other instances, the sand is so very fine and white as to be hardly perceptible at the first glance, and it has the appearance, upon examination, of having been blown into the cotton. In a case of this kind, the purchaser is able to assess from samples, with tolerable certainty, the proportion of sand in the cotton he is buying; but in many instances the sand varies so considerably, even in the same bale, as to render it impossible by means of samples, to determine the amount of adulteration with any degree of accuracy.

In ordinary American the loss is very heavy, little less in low middling, while middling and upwards show considerable loss from sand and dust.

The following are the chief varieties of cotton known in the trade, viz :—

Sea Island.—The finest cotton known, fine silky cotton, of a creamy tinge, with a long, strong, and glossy staple.

Egyptian.—A very superior cotton, yellowish colour, with a long and strong staple, but not so fine and silky as Sea Island, and very dirty, no description of cotton loses less after passing through the operation of carding.

Pernam, Maranham, and Maceio Cottons are of a superior quality, and are fine rich cream-coloured cottons; they rank with Egyptian, but are not so fine.

New Orleans.—A superior clean cotton, soft, glossy, and silky, and of a very fair staple, but not so long as Pernam.

Savannah, Mobile, and Texas are fair coloured short stapled cottons, and are good for weft; they are all three irregular, both as regards staple, cleanliness, and quality.

West Indian Cotton.—This wool is various in its qualities, but in general is a strong coarse article, irregular in staple, &c.

East Indian Cottons are of a very low quality, and of very short fibre.

Hingenghaut.—Strong fine fibre, free from leaf, and does not contain much other dirt but seeds.

Oomra is a very dry leafy cotton.

Broach.—Soft silky fibre of a glossy appearance; good for weft.

Dhollerah—A very dirty cotton of a longish staple; when cleaned this cotton is very white as if bleached.

Dharwhar.—Dull, dark brown neppy cotton.

BUCHARIAN.—A very harsh woolly cotton, short and weak fibre, and completely full of seeds and shell.

PERSIAN.—Similar to Bucharian, but longer and stronger in staple, and with not near so much seed and shell.

## YARN.

The commercial qualities of cotton yarn are elasticity, strength, regularity, counts, and colour. All twist yarns should feel round and sharp in the fingers, and should be extremely elastic; weft yarns soft and pliable. A little age improves all descriptions of cotton yarn. Yarn (cotton) is a ready absorbant of moisture, and is greatly improved thereby. The yarn should be regularly wrapped and tested every day, and the best way to test it is to take so many cops from each mule, or so many bobbins from each throstle, independently of examining the yarn in the hank; this is far the best, in fact the only means of ascertaining the true strength, regularity, and counts of the yarn; it is likewise a great and very necessary check, for unless there be a systematic wrapping and watching of the yarn day by day it is certain to get wrong, and when once this is the case, it is a difficult matter to get it right again.

There should also be regular and independent tests of the yarn—as to its quality, &c.—at the warping (beam) frame; when a certain number of cops out of the whole trial, should be wrapped and weighed (each cop separately), so as to get at its regularity or irregularity. It will thus be seen if the yarn comes within the range of Nos. usually allowed for variation. The average counts and average test will also thus be got at.

The weight of waste in winding, and the percentage of soft cops, will also be made clear; besides which the time it takes on the beaming frame to fill a beam will likewise come out. This after all is the best test of the yarn, and although severe, it is nevertheless necessary, for if the yarn will beam well it is sure to weave well.

In the packing of the yarn, the cops should be carefully handled, nor should they be too hard pressed in the skips or barrels. It is a great fault with many packers to press or stamp the cops down to such an extent that it becomes perfectly impossible to skewer them, thus causing much waste. It is also important in packing in skips that the "bottoms" of the cops be placed next the skip ends or sides, for when the cop "noses" are so placed they get turned up, and knocked altogether out of place and shape, likewise causing much unnecessary waste, which is indeed a very serious item in a weaving mill.

## ON MIXING COTTON.

The first thing to be done with the cotton is to sort and examine every bale previous to mixing; the thorough and careful examination of every bale that is opened cannot be too searching. Any bales that are not up to sample should be put aside for further examination and consideration as to what should be done with them. Falsely packed bales, or bales saturated with water, or full of sand should be rejected. The mixings must be made according to the Nos. and quality of the yarn required, the price at which it is to be sold, and according to the machinery with which it has to be made. It is advisable to make the mixings as big as possible, as there is such great variety in the different bales, and unless they are thoroughly well mixed together it is quite impossible to make a nice yarn of uniform quality.

To make up a stack or bing of cotton is a matter of the very first importance, and should never under any circumstances be left to careless hands, or to those who are ignorant as to the serious results of bad mixing. When making up the bing or bunker, the bales that are to be mixed should be brought forward one by one, opened, pulled into small pieces, and spread out equally over the whole surface of the bing, beginning at the bottom, and so on alternately, layer above layer, and should be trampled down exactly in the same manner as building a hay stack. When the cotton is required it should be pulled from one end of the mixing, in a regular cut as it were, from top to bottom. Long and strong stapled cotton is better suited for twist; short and soft for weft; but whether mixing for twist or weft the cotton should be as nearly equal in length of staple as possible, for when short and long cottons are mixed together, the long staple being a heavier body, tends to throw out the short, and the yarn is sure to be unequal and uneven, &c. The saying that "there is a deal of spinning done in the mixing room" should be a sufficient proof of the importance of good mixing.

Every new lot of cotton should be tried to see what percentage of loss it contains. A certain quantity is taken from the middle of each bale until say 100lbs. is got together; it is then put through the Opener and Scutcher. The insides of these machines are thoroughly well swept out, and the cotton is then put through them, after which it is again taken and weighed; and the machines are once more swept out, and all the droppings, dust, sand, seeds, &c., that have come out of it are collected and weighed; the dust by itself, and the sand, seeds, &c., by themselves. These weights are entered in the loss book opposite the mark of the cotton, so that at any time it may be seen what the first loss is in the different kinds of cotton.

It is necessary to have the cottons used regularly entered into a book denominated the Mixture Book.

## THE DIFFERENT MACHINES, THEIR DESCRIPTION AND USE.

### OPENING AND CLEANING MACHINES.

Machines for opening, cleaning, scutching, and forming cotton into laps, to be fed up to the carding engines, have undergone very little change in design during the last few years; but changes have been made to economise labour by shortening operations, such as the use of single instead of double machines, and a better disposition and arrangement of the machines in the mills.

## THE OPENER.

This is the first machine the cotton passes through, and as its name implies, it is used to open up the cotton that is clagged together in hard lumps, so that it may be easily and equally spread upon the travelling lattice at the scutcher. The opener also cleans, or knocks out of the cotton the heavy dirt, such as sand, seeds, &c. As this machine is considered destructive to the cotton, it is passed through as quickly as possible. There are several descriptions of openers; the principal of which are Crighton's Opener, the Porcupine Opener, the Compound or Combined Opener and Lap Machine. Any one, or all of these machines are so simple in their construction and details, and their mode of working is so well known that no elaborate explanation of them is necessary.

Plate 4 represents Crighton's Opener. This machine is now very generally in use, in fact, it has almost become universal, and it may be said to be almost indispensable in a cotton mill; especially where the cotton used is of a dirty nature. Its capabilities of thoroughly well opening up, and knocking the heavy dirt out of the cotton are not equalled by any other opener. It is now made with a patent feed motion, which is a great improvement on the old system of feeding. The cotton is drawn into the machine, or delivered from the feed rollers of this apparatus, in a regular and uniform manner, so that the machine has a better chance than formerly of doing its work well and thoroughly. The cotton is far better opened and cleaned, and the staple or fibre is not damaged or "curled" as was formerly the case. The delivery is so regulated that the cotton is not damaged by being kept too long in the machine. Upon reference to the plate, this machine, and its mode of working will be easily understood.

The Porcupine Opener is a first-class machine for opening clean American cotton, and is specially adapted for soft cottons; its action upon the cotton is less severe than the Crighton opener, and the fibres are therefore less liable to be broken or damaged. The cotton is fed upon a travelling lattice, and after passing through the machine, and having been subjected to the action of the porcupine cylinder, it is delivered ready for the breaker scutcher in an undamaged state and beautifully opened. This machine altogether does its work well and efficiently. Its construction and the construction and working of the scutcher are on one and the same principle; the only difference being that in place of the beater in the scutcher, this opener is supplied with a porcupine cylinder. These machines are made with one or more cylinders. The speed of the porcupine must depend upon circumstances, such as the cleanliness of the cotton, and when the teeth get broken out or much worn the cylinder should be re-covered.

## THE BREAKER SCUTCHER.

The cotton from the opener is next weighed, previous to being put through this machine, after which it is spread upon the travelling lattice into a given length, breadth, and thickness, and this is called a feed; these continually follow each other, so that a continuous web of cotton passes through the machine, and is rolled on to a roller until it be of sufficient size, when the machine knocks off, and the cotton, which is now called a breaker scutcher lap, is taken and put on to the finisher scutcher. The breaker scutcher further opens up the cotton, and likewise knocks out the sand, seeds, and heavy dirt; to allow of which being got thoroughly well rid of, the bars or knives at the back of the beater should be set pretty well open and at a nice angle. The dust box should be let down and cleaned or cleared of all dust, fly, &c., about every two hours. The weighing and feeding at this machine should be well and accurately done, and the tenters should be carefully watched to see that they do their duty properly, otherwise they get very careless, and it is then impossible to keep the laps regular. It is very essential to have good drafts in the scutching.

## THE FINISHER SCUTCHER.

The laps from the breaker scutcher (say 3 or 4, according to local circumstances) are now put on to the travelling lattice at the finisher scutcher; the cotton is again broken up at this machine, and likewise passes through in a continuous web, and once more rolls itself upon an iron roller into what is called a finished scutcher lap, or breaker card lap. The finisher scutcher likewise beats out what sand, seeds, or dead cotton still remain in the cotton, or may have escaped the action of the breaker scutcher beater. This machine also helps to disentangle the fibres, and spreads them out, so that when the cotton enters the card, it is so separated, that the card teeth can take hold of the fibres separately. The beater blades must be set to the feed rollers, according to the staple of the cotton; the bars at the back of the beater may be set closer than in the breaker scutcher, as there is less dirt here to be got rid of. Under any circumstances the setting of the bars must depend upon the cleanliness or otherwise of the cotton. The dust box should also be let down and cleared of all fly, &c., about every two hours; and the flues, as in the breaker scutcher, regularly and thoroughly swept.

There is generally a patent feed motion attached to these machines to regulate the weight of the laps; the great necessity of keeping the laps regular and as near one weight as possible cannot be too earnestly impressed upon the reader, for upon this point depends the regularity of the yarn. The doubling also tends very greatly towards regularity; but it should be borne in mind that Egyptian, or long and strong stapled cotton, is only injured by too much doubling at the scutcher, and does not require the same amount as American, or short and weak cotton.

Scutchers have undergone considerable modification within the last few years, and the general practice now is to scutch cotton less than was formerly the case.

Plate 5 represents a single beater scutcher machine, with Lord's Patent Feeder. This sketch is simply to show the action of the beater, and the mode of setting the bars at the right angle. Everything else about this machine is so simple, that no further explanation is considered necessary.

## THE CARDING ENGINE.

For low numbers the Roller and Clearer Engine is generally preferred; but for medium and fine counts the Self-Stripping Revolving Flat Card is much more extensively used. What is known as the Double Engine is likewise very extensively in use, especially in the Oldham district, for medium and coarse Nos. Some spinners prefer for medium counts two sets of cards, *i.e.*, for the breakers, rollers and clearers, and for the finishers, revolving flats; cards are also working in some districts, which consist of part rollers and clearers, and part flats. In many instances the Combing Machine is now taking the place of the Finisher Carding Engine, and this machine is indespensable when a clear, strong, and uniform thread is required, as it completely separates the long fibres from the short ones, which the Carding Engine does only partially. Cotton that is to be combed is opened, cleaned, and carded on the Breaker Card, and the sliver is delivered into cans. A number of these are put up behind a Drawing Frame and their slivers passed through it to be drawn, straightened, and laid parallel. By drawing the slivers once or twice through the drawing frame the loops and kinks are to a great extent taken out, and less waste is made. About 14 cans of the sliver, thus made on the drawing frame, are doubled and united at the lap machine so as to form a lap $7\frac{1}{2}$ inches wide, which is then passed through the combing machine.

The carding engine is the most important machine in a cotton mill, for it is, as it were, the back bone of good spinning. Steel instead of iron wire is now generally used for card teeth. Its advantages over iron are many; it can be drawn finer, thereby giving a greater number of points in a given space, and being hardened and tempered, it carries a finer point; the hard points keep their sharpness for a longer period, less grinding is therefore required, it is less liable to be knocked down, and altogether wear and tear is considerably reduced. It will thus be seen that steel wire is far better adapted for doing its work in a satisfactory manner than iron wire.

The wire should be kept clean, the points sharp, and set as close as possible to each other without touching. In cards, whether worked with rollers and clearers, rollers and part flats, or all flats, the wires should be set as near as possible all through the card, but not touch each other. The first three or four flats should be set rather more on the heel or back of the card for the purpose of detaining heavy dirt.

The carded cotton should be quite clear and free from all dirt, motes, and dead cotton; this can only be attained by having a thorough system kept up of grinding, stripping, and setting. The most approved system is light and quick carding, so that the engine is not overloaded, and the wire not surcharged. The card has then a better chance of doing its work, and the fibres will not be weakened by being kept too long in the card.

The less cotton is carded the better, so that the dirt is taken out, and the fibres laid straight, after which the cotton by being continued in the cards is only weakened. The great object of the carding is to draw out the fibres from each other; to straighten, clear, and lay them side by side; to separate the long staples from the short, and form them into a thread, commonly called an end or sliver. As the laps run out they should be neatly pieced up to one another, and the cans should not be allowed to get choked up, or be too hard pressed.

Good carding is essentially necessary, as it forms the base of good cotton spinning, and as it is utterly impossible to make anything like a nice yarn, unless the grinding, stripping, and setting be thoroughly well attended to, regularly and systematically, the very greatest care and attention should be devoted to this most important department. The necessary number of times to strip each day, or the necessary number of times to grind each week, must of course depend upon circumstances, such as the quality of the cotton used, and the hours worked. The following may be taken as a guide, when spinning 32's twist out of Orleans, or 36's weft out of Savannah, and working say 60 hours per week:—

Cylinders and Doffers to be stripped every two hours, and ground every day. Clearers to be ground once a fortnight, Rollers once a week. Rollers and Clearers to be set once a fortnight. The Flats to be ground and set once a fortnight, and their speed, and the strips they make to be regulated according to the quality of cotton being put through the Card. Doffers and takers-in to be set regularly every week. The wire should retain in working a dark clear surface.

It is the card master's especial duty to look after the above; but the manager should have an independent and regular system of going through the cards himself.

Plate 7 represents a sketch of a breaker engine, rollers and clearers; and is simply to give an idea of how the card works, and the way the fillet is put on, which the points of the wire indicate. The speed of cylinder, doffer, taker-in, and rollers and clearers are also given. The cotton passes through the card in the order shown by the Nos. 1 to 18.

Plate 8 represents a finisher engine with self-stripping revolving flats. This machine is now made with great perfection of accuracy, and supersedes to a large extent that class of labour in the cotton mill which is the most difficult to control. The arrows indicate the direction in which the flats travel.

Plates 9 and 10 are illustrations of Dronsfield's Patent Grinding Frame, with dust fan and cover; to grind two rollers and two clearers at the same time. Grinding roller 12in. dia.; driving pulleys 9in. dia.; speed 300 revolutions per minute. This machine is fitted with Dronsfield's patent motion for setting the card rollers in the centre. Its advantages are—its great simplicity, perfect solidity in working, and non-liability to get out of order, ensuring the greatest accuracy in the setting and grinding of the card rollers. The hand wheel used for setting the card rollers is shown in the centre of the machine, above the fan; this wheel actuates a worm gearing with a segment wheel on the cross shaft; cranks are formed at each end of this shaft with blocks fitted on the crank pins, and also fitted to slide in the slots formed at the bottom of the card roller steps. These steps are fitted to slide or turn on a ring which is formed on the brackets bolted on the frame ends of the machine, and also on the central studs which hold the brackets and card roller steps together, the said brackets also carrying the bottom portion of the cover, so that by turning the hand wheel the card roller steps at each end are moved simultaneously towards or from the grinding roller, ensuring the most perfect accuracy in the setting of the card rollers, which cannot be obtained when they are set at each end by separate adjustment.

The emery roller, card roller, and fan are all actuated by the driving shaft of the machine, so that a single strap only is required to drive the machine from the line shafting.

Fig. 1 Plate 11 represents Dronsfield's improved Light Grinding Roller for grinding the cylinders and doffers of carding engines, and is designed with the object of obtaining a perfectly true emery roller in a more portable form than that of the ordinary rollers. The cylindrical portion of this roller is formed of tin plates stiffened by numerous metal discs, fitted with cast iron ends and steel shafts, producing a strong, rigid, and substantial roller, weighing only about one half as much as the ordinary roller. This is a great advantage, as they are more easily carried from one cylinder to another, and fixed in their places for grinding, the shafts also are not so liable to be strained. A traversing motion is fitted on the roller shaft adapted to fit any width of grinding step; the bracket E carries a worm F, gearing with a worm wheel. The boss of the worm wheel is formed as an eccentric, which acts upon the arm G, fixed to the clipping piece, which can be adjusted to the step H; the step thus forms a fulcrum on which the eccentric on the worm wheel acts to move the roller to and fro.

Fig. 2 Plate 11 represents this roller with patent grooved covering, the object of which is to obtain a grinding surface more regular in its form, more uniform in character, and better adapted to penetrate between the card teeth, so as to produce better points than the ordinary roller. In the ordinary covering the grinding is principally effected by the large grains of emery with which the outer surface of the roller is covered. These grains are irregular in form, some being adapted to penetrate between the points of the cards, and others, not being so adapted, and as the grains which do not penetrate, only act on the extreme tips of the card teeth, they have a tendency to produce hooked points. The disposition of the grains upon the surface of the roller is irregular, so that there is no continuous penetration, and the effect produced by the grains which are best adapted to produce a point upon the card is neutralised by the action of the other grains. As the grinding is effected by a comparatively small number of grains of emery, the grains which are brought most into use are liable to become detached, and the efficiency of the roller is thereby impaired.

In the grooved covering a finer emery is employed, and the coating of emery is moulded into sharp angular ridges which extend around the roller. These ridges are of perfectly regular formation, and the grains of emery composing the ridges are compactly cemented together, so that there is less tendency for the grains to become detached, and the loss of a few grains does not impair the efficiency of the roller to any great extent. When in use these ridges penetrate thoroughly between the points of the card teeth, and being of regular formation, and of a perfectly true circular form, their action upon the cards is more regular than in the case of the ordinary covering.

Fig. 1 Plate 12 represents the traversing emery wheel grinder (Horsfall's), with the ordinary covering on the emery wheel.

Fig. 2 Plate 12 represents the traversing emery wheel grinder (Horsfall's), with the patent grooved covering on the emery wheel.

These grinders are most accurately made, and are fitted with an improved die or fork for traversing the emery wheel, so that they are much more durable, and do not wear away against the slot in the tube.

Plate 13 represents an improved form of grinding roller for cards. The difference between this roller and the ordinary construction of long rollers for grinding is that the former is spaced at intervals by having a spiral groove, nearly two inches wide, formed in the emery covering. It is found that this very simple expedient throws the dirt and hard substances out of the card with greater facility, neps and small lumps of cotton, which sometimes roll about between the roller and card being easily removed. The spiral groove also, as will be seen by a little study of its action on the wire, is a kind of additional traverse motion, which in conjunction with the ordinary traverse has the tendency to produce a sharper point on the wire. This it will accomplish in less time than is required by a plain roller. Another result of the use of the groove is that it keeps the card wire cool and of the right temperature, by reason of the current of air generated, which becomes specially desirable for the tempered steel wire cards now coming so largely into use.

## Dronsfield's Patent Elastic Covering for Emery Rollers.

The improvement consists in first covering the rollers with a foundation of india-rubber, one quarter of an inch in thickness, and fastening on the emery with an elastic cement, so as to secure the elasticity through the emery covering, the rollers thus covered present a slightly yielding surface to the cards, touching them more gently, which is found to be an advantage over the dead, unyielding surface presented by the ordinary covering. The rubber is a permanent covering, and does not require to be renewed when the rollers have to be re-covered with emery.

If the filleting becomes dry and hard it will be necessary before using it to keep it in a damp place until it becomes sufficiently pliable to bend easily, and when the covering of the roller is completed the roller should be kept in a warm place until the covering is sufficiently firm. This elastic covering for emery rollers cannot be too highly recommended.

## Re-Covering Rollers with Emery.

It is of the utmost importance that emery rollers should be covered perfectly true, and with a good sharp and even grinding surface. In re-covering a roller first paste well all over its surface with cement (boiled oil and white lead), then put on the cloth or thick coarse calico, in a similiar manner to clothing an ordinary card roller. Let this dry thoroughly and get perfectly hard, and then glue well all over its surface, and drop on the first coat of emery, after which keep the roller slowly turning for an hour or so. The next day glue again well all over this coat, and drop on the second coat of emery in the same manner as the first, and keep the roller again turning slowly for an honr. After a reasonable time put the "cutter" to and varnish, when having put the roller by for a time, it will be ready for use.

Plate 14 is an illustration of Dronsfield's patent card mounting machine, for mounting card fillets on the cylinders, doffers, &c., of carding engines, a portion of which is represented by the cylinder F, and the framing on which it is mounted. The card is passed, teeth upwards, through an open trough D, for the purpose of guiding it on to the cone drum, which has three divisions, A, B, C; A being $6\frac{1}{2}$in., B 7in., and C, $7\frac{1}{2}$in. in diameter. The card first passes over division A, then over a curved plate E, which is shaped so as to pass it on to B, and then to C, which delivers it to the cylinder F. The object of varying the diameter of the drum divisions is to obtain an increasing tension on the card fillet, and it will be seen that the second division of the drum being greater in diameter than the first, it will require a greater length of card to cover its surface, and so will draw the card over A more rapidly than the revolution of A itself. A, offering some resistence, stretches the card, and this process being repeated over the third division C, a very strong tension is obtained; and so gently is this done, step by step, that the most delicate card cannot possibly be injured. The tension is all put on the back of the card, and is increased or diminished by altering the position of the weight on the lever G, which presses on the card passing through the trough D. The drum, which revolves freely as the card passes over it, is covered with leather, so as to hold the card firmly; it is mounted on a carriage H, which is fitted to slide on the bed K, across which it is moved by means of the screw L, driven by the chain pulley O, and also when required by the handle M. The cylinder F is turned by means of the double purchase jack U, which also actuates the chain pulley, giving motion to L by a change wheel, the size of which is governed by the width of the card fillet required to be wound on the cylinder. For example: if the card is 1in. wide the change wheel will have 32 teeth, that is one tooth for each 1·32nd of an inch, and therefore $1\frac{1}{2}$ inches of card will require 48 teeth, and 2 inches 64 teeth on the change wheel. This arrangement of wheels will cause the sliding carriage to move along the bed a distance equal to the width of the card while the cylinder is making one revolution, and thus the card is wound on the cylinder with mechanical accuracy, and with an unvarying tension throughout. One man only is required to turn the handle R, which actuates the whole machine.

When required, the bed K can be used as a rest for turning up wood rollers and cylinders. The drum must then be removed, and the slide rest X, carrying a turning tool, substituted.

The prevalent method of mounting fillets on cylinders is very unsatisfactory unless done with very great care. It is as follows:—The fillet is taken from a can, passed round a man's body, afterwards under and over two bars placed on the engine framing, thence on to the cylinder or doffer, as the case may be. Another man slowly turns the cylinder (or doffer), and the card nailer himself guides the fillet on to the cylinder (or doffer), and here and there drives in a tack to secure it. Fillets as a rule are put on very tightly, the tension is applied by the man around whose body the fillet passes, leaning backwards from the engine, and as a matter of course, the tension is greatly increased by the friction between the fillet and the bars mentioned. The tension put on can only be regulated by the merest guess work, and as a result the clothing is laid on irregularly, too tight in some places and too slack in others. Very often the stress put on is in excess of the strength of the fillet, which consequently gets broken. Besides this varying tension, the fillet in this plan of mounting, has furthermore to undergo some rough handling, and its teeth get damaged in consequence.

## THE DRAWING FRAME.

The sliver from the carding engine is next taken to the drawing frames, where a number of ends, say six or eight, are put up together, and then doubled and drawn through the rollers, in order to equalise the sliver, and to straighten and lay the fibres parallel and in a longitudinal direction. Upon a proper arrangement of the drawing and doubling the particular quality of the yarn in a great measure depends. By passing the cotton between two pairs of rollers, and making the front ones revolve faster than the back ones, it may be drawn to any extent required; therefore the effect produced by the relative motion of the rollers is called the draft. When there is a sufficiency of doubling at the most suitable departments of the process, and when the fibres are well straightened and drawn, the yarn will be more level and even, as well as stronger and smoother. The drawing sliver should be delivered from the front roller as clear and level as a board, and the drafts should be nicely and equally arranged. Short and weak cotton requires less doubling and drawing than that which is long and strong; weft requires less doubling than twist.

The rollers and flats should be kept clean, and the leather rollers should be well and accurately covered and kept in good working condition. The saddles and weights should be accurate, and both front and back stop motions should be in perfect working order. The sliver is generally passed through three heads of drawing, and in changing, the change ought to be made between the first and second rollers, as the greatest amount of elongation takes place here.

Figs. 1 and 2, Plate 15, shows the gearing for connecting the four lines of bottom rollers, the whole being at the driving end of the frame. By this arrangement each roller starts simultaneously, thus securing a more equal drawing of the sliver, and also doing away with cut places when the frame is started after a broken sliver has been pieced. The front and back rollers are connected by a crown wheel arrangement; and the second and third rollers are connected with the back roller by separate and distinct carriers, either of which may be altered without affecting the speed of the other roller. The wheels and pinions are of much larger diameter than formerly, by which means a finer variation in the weight of the sliver is secured. When the draft is altered no difference is made in the intermediate drafts, and the operation of changing is altogether simpler than in the old plan with the connection at both ends. The bottom rollers are case-hardened, and are therefore better able to resist the severe strain put upon them.

On referring to Figs. 3 and 4, Plate 15, it will be seen that the gearing has a much stronger and better support than formerly, thus producing a better quality of work, through the drawing operations being made smoother and easier. The front stop motions are most sensitive and quick in action, thereby preventing much waste, and producing far better work. The back stop motions likewise act with great precision when an end or sliver breaks, stopping the frame before the broken end reaches the back roller, and thus enabling the tenter to piece the end, before it has disappeared between the rollers (as shown at B in Plate 16). The arrangement which causes the front and back stop motions to stop the frame, is called the knocking-off motion, and is shown at Plate 16. It is very simple and easy in its action, and needs very slight force to make it act; it acts rapidly, and is not liable to derangement. The eccentric C gives the reciprocating motion, to the inclined rod D. The slot E at the upper end of this rod is oblique to the length of the rod; the projecting snug at the middle of the rod is for liberating the bar F out of a notch, at the proper moment. A lever fastened on the oscillating shaft G carries a stud, which fits into the oblique slot E in the rod D; the weighted lever H also fixed on the shaft G keeps the stud pressed against the outer end of the slot, so that the shaft G is rocked by the reciprocating movement of the rod D.

The knocking-off action may be illustrated by the back stop motion, Plate 16. The sliver in passing over the spoon or tumbler B is seen broken, and the spoon being liberated, the weighted lower end drops, and comes in contact with an arm projecting from the back of the shaft G, thereby arresting the rocking of the shaft. The stud E thus comes to a standstill, and the rod D continuing its reciprocating motion, the oblique slot causes the upper end of the rod to rise upon the stud, and so brings the projecting snug against the bar F, which now being lifted and liberated from its notch, shifts the driving strap from the fast to the loose pulley, and so stops the frame.

The front stop motion is also seen at Plate 16. At J is a funnel-shaped guide through which the drawn sliver passes on its way from the front roller to the calendar rollers, K. The sliver of course enters at the large end of the funnel, and passes out at the small end. The guide J is carried on the front end of a lever: and the back end I being the heavier, it naturally tends to tilt the guide upwards. The reciprocating rod L is connected with an arm on the oscillating shaft G, and has a notch in its front end. The heavy tail I of the guide lever, when liberated by the breaking of the sliver, drops into this notch, thus arresting the motion of the rod L, and therefore of the shaft G and stud E. This brings the stop motion D F into action, and immediately stops the machine.

A can stop motion is now in use for stopping the machine when the front or receiving can is full. This apparatus consists of a false bottom N, to the coiler wheel M, Plate 16. The plate N forming the false bottom is weighted by a ring above, which is varied in weight to suit the hank sliver. The finer the sliver, the finer the ring, and *vice versa.* Fine drawings will not admit of being pressed in the cans so tightly as coarse drawings. When the can is filled sufficiently to lift up the loose plate N close to the coiler-wheel M, the vertical stop S is raised in front of the end of a reciprocating bar P, connected with the oscillating shaft G, and the machine is stopped as before described. It is of great advantage to put the same length of sliver into each can, so that all will run out at the same time, when put up to the second or third heads, or at the slubbing frame. The tenters then know which cans require replacing without looking into more than one. When the quantities in the cans vary, they have continually to look after them, or the frames will stop very often. Another great advantage of the can stop motion is that it prevents the cans from being choked up, thus the sliver is not damaged, nor are the coiler tops broken as in the old system. The work of the tenter is more systematic, and a greater weight is got through the drawing frame, with at the same time a slower speed of the front roller.

## SLUBBING, INTERMEDIATE, AND ROVING FRAMES.

These three machines, which intervene between the drawing and spinning, are for the purpose of reducing the drawing sliver into the form of a thread or rove of the required fineness, preparatory to its being spun into yarn. To make good rovings is a most important object in cotton spinning; they ought to be uniformly level and even, and should be equally twisted all through. The slubber is the first machine where the fibres, in their progress from cotton to yarn, receive any twist. The only twist required is just sufficient to enable the roving to draw off nicely, and to give it the necessary strength. The amount of twist must obviously depend upon circumstances. The drafts should be set out nicely and uniformly, not too much in one frame or too little in another, a single draft should in no case exceed one in six. The rollers, as in the drawing frame, must be set according to the staple of the cotton. To ensure good spinning it is most essential to have good roving—level, even, and equally twisted all through. Loose bossed top rollers are now almost universally used in the drawing, slubbing, intermediate, and roving frames.

To ensure a clear yarn, the rollers should be in good condition, and kept clean and well oiled. To produce clear yarn the flats and flyers should be continually picked and cleared of all flat dirt and fluss. The machines should be thoroughly well cleaned every Saturday, and the differential box opened, cleaned, and oiled. The iron rollers should be taken out and scoured regularly, stands cleaned, and inlaid with pure tallow. All the driving wheels and boards around them, gearing, shafts, &c., should likewise be regularly cleaned, and new tallow laid on the necks of the shafts, &c.

These machines are now made with better and surer winding apparatus than formerly, with stronger spindles, steel flyers, and single pressers, case-hardened rollers, stopping and lock motions, &c. As to whether the bobbin or the flyer should lead, there is now only one opinion, and that is in favor of the bobbin leading. With the bobbin leading, the work of the differential motion is increased, so that it is absolutely necessary to have a better control over this apparatus. To meet this requirement the cone drums are made of larger diameter than heretofore, besides which they are driven much more rapidly, and are placed further apart, thus giving a longer strap, and therefore more uniform winding, with less strain on the strap. As the spindles are driven by tooth and pinion, through a range of wheels direct from the frame shaft, they must start at one and the same time with the shaft, and a little before the bobbins; the differential apparatus is the medium through which the bobbins receive their motion, and not being positive, on account of the cone drum strap, cannot take up the backlash so quickly.

With the flyer leading there is a tendency to stretch the roving. When the bobbin leads the ends slightly slacken, but are at once taken up when the bobbins have got fairly into motion. Through the increased speed of the spindles, and the almost universal use of single pressed flyers, it has become necessary to strengthen the spindles, so that they may be better able to stand the extra work, and better withstand the extra wear and tear. Long collars have become very general, and the spindles are thus better able to stand the strain of the comparatively unbalanced single pressed flyers. It is proved by experience that better work can be produced from the single than from double-pressed flyers; more especially when making a fine hank roving. Where true excellence alone is required, or for a very fine hank roving, flyers without pressers, for soft bobbins, are used; but the perfection of modern flyers, and the necessity of keeping down the cost of production, have led to the introduction of pressed bobbins up to as fine as a 24 hank roving. The pressed bobbins contain more than double the quantity of roving, and there is much less creeling required in the after processes. The best flyers are now made of solid steel, are much lighter, and will stand a finer polish. They are also free from cracks inside their hollow leg. Any roughness inside the legs catches the fibres of the cotton, makes bad work, and causes the ends to be continually breaking.

Machines, of course, have long been made to stop when the right amount of roving has been wound on the bobbins, and they are fitted with a lock-motion, as shown at Plate 17, by which, after stopping, the tenter cannot set the frame on again, until she has doffed, until the empty bobbins have taken the place of the full ones, and until all is made ready for a fresh start. Before this motion was applied the tenters frequently set the frame on again after it had been stopped in the ordinary way, by holding the strap on the fast pulley, until the bobbins were filled to the full extent allowed by the flyers, without breaking the ends. This of course made very bad work, the roving became ragged and stretched, and the flyer legs were much strained and thrown out of balance.

This lock motion, Plate 17, is controlled by the rack of the cone motion. C C are the top and bottom cones for driving the "jack-in-the-box;" the strap A is moved along them by the forks FF, which are fastened to one end of the rack D, sliding in a grooved rail E. At the other end of the rack is an adjustable bracket B. Gearing into the rack D is a pinion on the vertical shaft G, at the top of which is a cord pulley. The weight H suspended from the cord tends to turn the shaft G and its pinion, and so to make the rack travel towards the cones. At the bottom of the shaft G is the ratchet wheel J, controlled by the "box of tricks." This apparatus allows the ratchet to turn on its axis, through one tooth, at each rise and each fall of the bobbin lifting rail. Each rise and each fall of this rail corresponds with one layer of roving wound on the bobbin. The strap A thus gradually traverses from one end of the cones to the other, by means of the motion of the shaft G, communicated to the rack D. The ordinary setting on rod M M slides endwise in the frame, and is connected with the strap-guider of the fast and loose driving pulleys; N N are the ordinary handles used by the tenter for starting and stopping the frame; and K is an arm fixed upon the setting-on rod M. The slide bar I L, sliding in fixed brackets, has two notches in it, I and L, and carries a projecting lug P, to which is hooked one end of a coiled spring (shown broken), its other end being hooked to the fixed bracket T on the frame; the spring therefore tends to pull the slide bar I L towards T, into the position shown by the dotted lines. Catches ready to fall into the notches I and L are carried upon arms turning loose on a centre-pin, from which is also suspended the lever R. On this lever is a stud S which is suitably placed for acting on the tail ends of the catches, and shown holding the left hand catch clear above the slide bar I. The parts are shown as they stand, just before the lock motion comes into action. The right hand catch is resting in the notch L of the slide bar, thus preventing the spring from moving it. When the bobbins are full the bracket B will have pushed the lever R far enough aside, as shown by the dotted lines, to lift the catch out of the notch L; thus releasing the slide bar, and allowing the spring to pull it towards the right hand, and with it the setting-on rod M, by means of the arm K, and so to shift the driving belt from the fast to the loose pulley, and stop the frame. The tilting of the lever R, as shown in dotted lines, removes the stud S from contact with the tail end of the left hand catch, and allows this catch to fall into the notch I of the slide bar, thereby locking the slide bar in the position indicated by the dotted lines. The left hand catch and the upper part of the lever R are enclosed within a box, so that they cannot be tampered with; an inside view of the cover of this box is shown above it in the drawing. It is therefore impossible to set the frame on again until the catch has been disengaged from the notch I, by winding the rack D back again, ready to commence for a fresh set of bobbins.

The production per spindle of these machines is greater than formerly, and a far better quality of work is turned off, besides which a tenter can watch more spindles with more ease and at the same cost. The machines work with far less breakage, and it is a very common thing for a set of bobbins to be filled without a single end breaking.

It is now generally admitted that a fair and moderate speed of spindles is most economical, and produces the best quality of work with a minimum of waste. The high speed of spindles attained some little while back, with its attendant waste, and inferior work, has gradually given way to more moderate rates of speed. The trite but true saying that work spoiled in the card room cannot be mended in the spinning is a good guide to go by.

Explanation of the Sun and Planet, or Differential Motion:—This motion works on the frame shaft, the twist half being made fast, while the other half that drives the bobbins is loose; on each half is fixed a wheel of 36 teeth, and instead of coming into contact with each other, there is a centre bevil wheel of 120 teeth fitted loosely on the shaft, and working right between the twist and bobbin halves. These two halves of the differential motion are set opposite to one another, and close up to the sides of the centre wheel. Between the spokes of this centre wheel are two other mitre wheels, therefore, when the two halves are set close up to the centre wheel on each side, the four mitre wheels are all brought into contact with each other, and as the half that is made fast to the frame shaft revolves with the shaft, motion is transmitted to the half that drives the bobbins, by means of the wheels that are fitted between the spokes of the centre bevil wheel of 120 teeth. Now, if the centre wheel remains stationary or moves round with the twist half, it is evident the bobbin half must be carried round at the same speed. On the other hand, if the twist half stands still, and the centre wheel revolves, the mitres between the spokes of the centre wheel revolve round the wheel of the twist half, at the same time moving the bobbin half in the same direction as the centre wheel, at the rate of two revolutions for every revolution of the centre wheel, so that the variable speed of the bobbin half is entirely effected by the motion of the centre wheel. Unless the centre wheel stands still, or revolves at the same rate as the twist half, the motion of the bobbin half cannot be the same as the twist half. If the centre wheel rovolves in the same direction as the twist half, the bobbin half will lose two revolutions on the twist half for every revolution of the centre wheel, but if the centre wheel revolves in the opposite direction, it will gain in the same proportion, therefore, the taking-up of the bobbin is regulated by the motion of the centre wheel, and this motion is regulated by means of the cone.

One tooth of the rack wheel is shifted every time the bobbin rail goes up and down, and at every shift the cone drum strap is moved further on to the thick part of the cone; consequently the speed of the bottom cone decreases more and more, as the strap is worked or moves up the cone, and being connected with the centre wheel by a range of other wheels, it drives the centre wheel either faster or slower, and with it the bobbins.

THE RACK WHEEL should be set with the button to ½ tooth, otherwise the "ends" at one change will be slack, and the other change will be tight.

In left-handed speeds the bobbin leads. In right-handed speeds the flyer leads. For moving the rack (for cone strap) more or less, change the wheel on top of upright.

For moving the "hanger bar" quicker or slower, and thus altering taper of bobbin, change the wheel on the bottom of the upright. To make taper of bobbin longer or shorter, change the taper wheel.

TAKING-UP.—Always have the drum straps beginning level with the ends of the drums, and also have the frame beginning the first "row" on the bobbin, exactly the proper tightness. This is done by the wheel on the end of the cone drum, or the wheel on the top of the upright. Regulate the remaining "rows" on the bobbin by rack wheel.

To make the Bobbins an exact Taper.—Run the lifting rail to the exact centre of the bobbin; move the hanger bar backwards and forwards, to see that the reversing screws do not dip; if they do, move the hanger bar bracket higher or lower, as the case may require.

Flyer leading: to make bobbin lead. Alter the wheel that works under the drum-end wheel to work above, thus causing the revolving plate wheel to run the reverse way. At the same time be careful to change the bent lever for a straight one, so as to counteract the reversing bevils, as they also are driven by the drum-end wheel.

In changing hank roving, if you cannot alter the lift enough by the lift pinion, change the wheel on the bottom of the upright. To lift quicker use a larger wheel.

If the twist wheel is too large to gear, then change the top shaft wheel.

The differential motion consists of the following wheels, viz.:—a mitre wheel of about 7in. diameter, fastened on the frame shaft, working into two other mitre wheels of the same size, carried by the central bevil wheel of 120 teeth. The two mitres gear into another mitre wheel fastened on the end of the socket, which runs loose on the frame shaft, and conveys the motion to the bobbin shaft by a spur wheel, made fast on the other end of the socket, driving through two carrier wheels, one placed on the joint pin of the dog-leg lever, and the other placed so as to gear into the joint pin wheel, and the wheel on the end of the bobbin shaft. The bevil wheels of 60 teeth on the bobbin shaft gear into the bobbin wheels of 21 teeth, which would make the same revolutions per minute as the spindles, if the centre bevil wheel remained stationary, while the other part of the machine is in motion, consequently no winding-on whatever could take place; but if the central bevil wheel be allowed to move in the same direction as the frame shaft, then one revolution of the central bevil wheel will have the effect of slowing the motion of the socket two revolutions. How much must the central bevil wheel be allowed to move to give the bobbins the correct number of revolutions, that they ought to go slower than the spindles for the proper taking up of the roving as it is delivered by the front roller, without straining the rove? If the top cone be 526,655 inches diameter, and makes 265 revolutions per minute, how many revolutions per minute will the bobbin cone make at 323,345 inches diameter? The answer is 432, and this is the speed requisite for the first layer on the bare tubes of 11,875 inches diameter.

Details of Plate 20.

1. Driving cone.
2. Driven cone.
3. Back bearing for cone rack.
4. Cone rack.
5 & 6. Bearing and rack for hanger bar.
7 & 8. Back shaft and rack wheel.
9. Hanger bar bracket.
10. Hanger bar.
11 and 20. Reversing motion levers.
12. Reversing wheels.
13. Wheel driving cannon (lifting wheel).
14. Frame driving shaft.

## The Cones.

The two cones are formed on the same parabolic curve of mathematical correctness, but the reverse of one another; the driving cone is hollow in its length, the driven bulges outwards in its curved line. Without this curvature it would be impossible to get correct or accurate winding except at the commencement and finish of the bobbin, in fact, the curvature is essential to make compensation for having an equally divided rack. If the cones were a straight taper, the winding would be too keen when the strap arrives at the middle of the cones, and would therefore cause the roving to be stretched.

## THE COMMON FLY THROSTLE.

The yarn produced from this machine, from its strength and smoothness, is extremely well adapted for warps. In the throstle frame the spindles on both sides are driven by cotton bands from the tin roller, extending from end to end of the machine. On the one end of the tin roller are the fast and loose driving pulleys, and from the tin roller shaft motion is conveyed to the iron rollers by a range of wheels and pinions. The roving in passing through the three sets of rollers undergoes a draft of from say 5 to 8 inches—according to circumstances; it is now twisted by the flyer and wound on to the bobbin. The thread itself is of sufficient strength to bear the drag of the bobbin, and the velocity of the bobbin is retarded by friction, which can be increased or decreased to any degree that may be required, by means of washers of cloth, and being thus retarded, the thread, by the motion of the flyer, drags the bobbin round after it with a velocity equal to the difference between the speed of the flyer and the length delivered by the front rollers. The flyer is fixed on the spindle, and the flyer legs, which are solid, are twisted at their lower extremities, somewhat like a cork-screw. The thread is put through the guide wire, which keeps it steady, and conducts the yarn to the bobbin. The flyer in revolving rapidly communicates twist to the yarn. The bobbins rest on the bobbin rail, and are retarded by washers from revolving with the same velocity as the flyers, the thread is therefore wound on to the bobbin as fast as delivered by the front roller, whilst the lifter or traverse rail ascending and descending by a regular alternate motion, fills the bobbin equally from end to end. This alternate motion of the traverse rail is accomplished by means of a heart, and is called the heart motion; it is extremely simple, and can be understood at a glance. The highest range of counts spun on the common throstle is 34's and 36's, and very few of the latter. The yarn produced is stronger than that produced by the mule; but a throstle spindle cannot produce the same weight in proportion as a mule spindle.

When spinning from 40's to 50's on the common throstle, most spinners have their own special weight of bobbin, which they find from actual experience suits their particular description of yarn, and it is rarely found that two spinners use bobbins exactly alike, although spinning the same counts. The quality of cotton, strength of yarn, the twist and description of drag cloth—cotton listing is used by some spinners—have all to be considered, in determining the pattern of bobbin to be used. It is also usual when spinning these Nos. on the common throstle, to comb as well as card the cotton, and put it through an extra drawing frame and second intermediate. The heat of the room should be about 75 degrees Fahrenheit, if it gets below this, the rollers begin to lick, causing more breakage and waste.

Any one of the six bobbins in Plate 21 may be used when spinning from 40's to 50's out of long stapled cotton; but of course the diameter of the spindle blade should be borne in mind when ordering bobbins, on account of the size of the hole in the bobbin, and because a larger spindle exerts more force on the bobbin, and consequently the bottom flange of the bobbin must be slightly larger to counterbalance the effect.

No. 1 represents an ordinary throstle bobbin (2in. lift, spindle $\frac{5}{16}$in. dia.) for 32's/34's American twist. By reducing the drag from $1\frac{11}{16}$in. dish to $1\frac{1}{2}$in. or $1\frac{3}{8}$in., making the top head $\frac{1}{16}$in. thinner, and keeping the barrel of the same diameter, it is possible to spin 40's/45's on this bobbin.

No. 2 represents a bobbin used by some spinners for 40's to 50's, and can be recommended for a trial.

No. 3 represents a bobbin which can be highly recommended for fine counts. It will be found to answer very well for average 45's.

No. 4 represents a very suitable bobbin; it will be observed that the drag is even wider than the ordinary bobbin (No. 1) for 32's; it has also a metal bush in the bottom, which further increases its drag power; the top head being smaller reduces its weight a trifle, and causes less vibration in working.

No. 5 represents a bobbin used for spinning 40's to 50's twist from long stapled cotton. The bore is for over $\frac{11}{32}$in. diameter of spindle, consequently it necessitates the drag being wider, as the spindle exerts more force than will be produced by a $\frac{5}{16}$in. spindle.

No. 6 represents a bobbin which is greatly in use for fine spinning. The bushes being so short, the spindles will have very slight power over the bobbins, therefore the drag will be stronger.

N.B.—When spinning these fine Nos. on the throstle, in consequence of the fineness of the yarn, a light bobbin is required, with a very small drag; the larger and heavier the bobbin used the smaller diameter of drag is necessary.

### The Common Fly Throstle, with Ashworth's Long Collar applied.

| Counts. | | Lift. | | Speed of Spindle. |
|---|---|---|---|---|
| 14's to 20's | ...... | $3\frac{1}{4}$-in. | ...... | 5,500 to 6,000 |
| 16's to 24's | ...... | 3-in. | ...... | 5,800 to 6,200 |
| 20's to 30's | ...... | $2\frac{3}{4}$-in. | ...... | 6,000 to 6,300 |
| 26's to 36's | ...... | $2\frac{1}{2}$-in. | ...... | 6,000 to 6,800 |

The speed of the spindle must depend upon the quality of the cotton used, and the amount of twist required in the yarn. If the counts range from 12's to 34's, and average 24's, the lift should be say $2\frac{3}{4}$in.; it is better to adopt a long lift for coarse Nos., and thus save time in doffing.

The spindle wharves are 1in. diameter, and with $\frac{1}{8}$th inch diameter, the tin roller—9in. diameter—should make about 730 revolutions per minute to give 5,900 revolutions to the spindles.

The bobbins fit loosely on the cast iron shells, so as to allow for the swelling that might take place in the wood, from dampness, &c. The bobbins should be rubbed well inside the barrel with clean melted tallow, so that they may drag the shells. The collars should be well oiled, and between the collar and shell should also be well oiled before starting. When spinning from 14's to 20's a round washer cloth of 2in. diameter is required; but when spinning from, say 20's to 36's, no drag cloth is necessary. If a stronger drag is required for coarse Nos., such as 10's or 12's, a continuous drag cloth, as used in the ordinary throstle, will be necessary, and the holes must be made a little larger than the shell, so as not to bind the shell.

In setting the collars, they should be set at half lift. The fly wheel, 22in. diameter, is indispensable to the successful working, in order that the frame may be stopped gradually, as the bobbins have a tendency to over run the spindles when the frame is stopped suddenly, owing to the lightness of the drag. The following are the advantages of Ashworth's improved patent long collar, over the ordinary short collar, when spinning counts up to 32's twist:—

1. The yarn is superior in quality.

2. Can spin with less twist in.

3. Production of yarn some 25% over ordinary throstles.

4. The waste, which is a most important item, is less than on other principles.

5. Nearly double the quantity of yarn put on a bobbin than ordinary throstle bobbins.

6. The bobbins holding nearly double the quantity of yarn, fewer piecings and winder's knots, also a saving in the winding and doffing.

7. The saving in the bobbins is very considerable—a most important and expensive item—and the wear and tear of the frames is less than on the ordinary throstles.

N.B.—42 hanks of 20's and 32 hanks of 32's per spindle are being got off per week of 56½ hours.

## THE SELF-ACTING MULE.

### (Platt's.)

In this machine the fine roving from the roving frame is drawn and spun into yarn of the required fineness. The rollers are set according to the length of the staple, and the amount of twist put into the yarn is regulated and determined by circumstances, such as the length and strength of the staple, whether twist or weft, counts, and according to order. In the mule the yarn is built on the bare spindle in the form of a "cop," and in such a manner as to throw little or no stress upon it, therefore this machine is used for spinning fine Nos. The yarn is also dragged, the amount of drag required is greater or more in long than short stapled cotton. The carriage recedes from the rollers as fast as the reduced rovings are delivered, the spindles at the same time revolve rapidly, and communicate the twist to the yarn. The distance which the spindles recede from the rollers is called the stretch, and when the spindles recede faster from the rollers than the yarn is given out, it is called the gaining of the carriage. When spinning fine Nos., the rollers stop, after delivering a certain length of yarn, but the carriage continues to recede, and the spindles go on revolving; and even when the stretching is completed the spindles continue still to revolve until the right amount of twist has been put in the yarn. As little twist as possible is put into the yarn before the jacking commences, only just sufficient to keep the fibres united, therefore a great amount has to be put in after the rollers have stopped. This naturally tightens the yarn, and unless the tension is reduced, the yarn is liable to break before the required amount of twist has been put in. In former times it was customary to cause the carriage to move inwards a little, in order to ease the tension of the yarn; this had the desired effect; but it shortened the stretch, and the carriage was difficult to regulate. Now, however, instead of moving the carriage, the rollers are made to revolve, and to deliver a small quantity of roving, at a rate which can be varied at will, whilst the extra twist is being put into the yarn, and the result is very satisfactory. It is also customary when spinning out of long stapled cotton, to cause the rollers to deliver from three to four inches of roving during the run in of the carriage, whilst the spun yarn is being wound on the spindles, and it is found that both the spinning and the yarn are greatly improved thereby.

In the self-acting mule there are two fallers, one the under or counter faller, with the wire beneath the yarn, and some $2\frac{1}{2}$ inches below the spindle points; the other with the front or winding faller about $1\frac{1}{4}$ inches above the spindle points.

The back shaft causes the carriage to recede from the rollers, and when the receding carriage has reached its final or outermost position, that is, at the end of the stretch, and when the right amount of twist has been put into the yarn, the driving strap is shifted from the fast to the loose pulley, and the reversal of the tin roller causes the spindles to turn in an opposite direction, thus uncoiling the spiral of yarn that is coiled upon the bare spindles, above the top of the cop. The backing off now takes place, the counter faller rises, and at the same time the winding faller is brought down, and the wires of the two come in contact with the yarn, and acting against each other, regulate its tension and prevent it from slacking or snarling. During the return or run in of the carriage the yarn is wound upon the cop in the peculiar form given by the shaper.

The governor motion regulates the position of the quadrant nut, causing it to work up the screw of the quadrant. This screw is now made taper, and the entire motion is very reliable and accurate. The rail regulates from the shoulder to the nose of the cop, and the plates regulate from the shoulder to the bottom of the cop. The copping rail rests at each end on the front and back copping plates. In Plate 22, the loose front incline, 4 is jointed to the copping rail at 6; its other end rests on the additional front copping plate 5, which is fastened to the ordinary front copping plate 2. The front and back copping plates, 2 and 3, are attached by the rod, 13, and through the revolutions of the shaper screw the plates recede, causing the rail to fall. The lower the rail goes the higher the faller rises; and whatever bevil the copping rail may have, will be the length of the chase given to the faller.

### The Backing-off Motion.

The operation of this motion is regulated automatically to suit the position of the cops at every successive stage during their formation, from winding the first stretch of yarn on the bare spindles, at the commencement of the cop, to the winding on of the last stretch, when the cop is completed. The copping apparatus is the controlling agent for regulating this motion, and is made with a separate loose front incline, and governed by the additional front copping plate. With the copping rail in one solid piece—as was formerly the case—only two points were capable of being adjusted to the exact positions required; but with the loose incline all the positions are regulated; the advantage of the latter over the former, is the very important one of being able to regulate the precise position of the faller wire when the faller is locked. In the hand mule, when the spinner had depressed the faller to the proper position for winding, and uncoiled the exact or right amount of yarn from the bare spindles, he arrested the operation of backing-off and commenced the winding on. This accuracy could not be attained with the copping rail in one solid piece, for the amount of inclination was determined by the conditions required to commence the cop on the bare spindles. At the commencement it was necessary to make the chase of the cop as short as possible, so as to prevent waste in the after processes. When the copping rail was set to its proper place at the commencement of the cop, the position of the faller wire was determined, and set at the position to suit the requirements of the operation; but immediately upon the winding part of the copping rail becoming more inclined, to enable it to wind a longer chase, then the front incline assumed a less inclined position, thereby leaving the faller wire, at the time of the faller locking, in a worse and worse position at each successive stretch or draw, until the chase has attained its greatest or maximum length, and had begun to be gradually shortened again. With the moveable front incline its position can be so nicely and accurately regulated that the operation is an exact counterpart of the hand spinner's work, and by the use of the automatic apparatus for tightening the backing-off chain, in conjunction with the loose incline on the copping rail, the amount of yarn uncoiled from the spindles is regulated to suit the position of the faller wire at the termination of the backing-off. When once set this apparatus needs no further attention.

## Platt's Backing-off Chain Tightening Motion.

When the carriage is coming out the winding faller is generally about $1\frac{1}{4}$ inches above the spindle points; this is also the position of the parts immediately before the operation of backing off the spiral of yarn that is coiled upon the bare spindles, above the top of the cop. The reversal of the tin roller causes it to uncoil this yarn from the spindles, and also brings into action the parts which pull the faller wire down. It is evident the spindles begin to move before the faller wire is brought into action, as the tin roller must make some little movement before the backing off click can take hold of the ratchet wheel. In addition to this the spindles continue to uncoil the yarn during the time the faller wire is moving from its position above the spindle points, until it touches the yarn. It will therefore be seen that a certain length of yarn will be uncoiled from the spindles before the faller wire can overtake the yarn. The spindles thus have a considerable start, and at the completion of a set of cops this loss of motion or behind-handedness of the faller wire produces very bad results. In the case of a cop with its nose only $\frac{3}{4}$ of an inch from the spindle points, the loss is nearly one half the entire motion of the faller wire, which moves as far before it touches the yarn as it does after, so that it becomes necessary to have the backing off chain tight in order that it may act on the faller as quickly as possible; and the backing off snail is made as large as possible, and of the proper form, so that the faller wire may act on the yarn at the earliest moment. At the commencement of a set of cops the conditions are very much more favourable; for although the space actually passed through by the faller wire, before it touches the yarn, remains constant, it bears at the commencement a very much smaller proportion to the entire distance passed through by the wire before the faller locks, than it does at the completion of the set of cops; consequently the back-off chain has to be slack at the beginning of a set of cops, otherwise the speed of the faller wire would force the yarn down the spindles faster than it would uncoil, and would thereby break the thread. Hence the back-off chain having been adjusted to the proper length for backing off nicely at the commencement of the set of cops, it is desirable gradually to tighten or shorten it as the cop increases in length; until at the completion of the cop the chain is almost tight. By this means the backing off can be adjusted all through the set, so that it corresponds at every stage with the exact requirements of the case; the nose of the cop is preserved in a properly firm condition, and neither too much nor too little yarn is uncoiled. Next to winding the yarn properly on the cop, this is the most essential condition in making a good cop.

In Plate 22, the backing off finger (7) has fastened to it one end of the backing off chain (8), and the other end of this chain is fastened to the backing off snail (9). The backing off tightening chain (10) has one end fastened to the snail (9), and the other end to the bell crank lever (11). The tail end of this lever is seen resting on the short incline (12). This incline is fastened to the copping plate connecting rod (13), and moves upon a plate fastened to the floor, and as the rod moves backwards during the formation of the cop, the incline goes with it, thus bringing the higher part of the incline (12) under the tail of the lever (11), causing it to turn in the direction shown by the arrow, and so pulling the chain (10), which, acting on the snail (9), takes up the slack of the backing off chain (8).

The incline (12) is made so that it can be varied to suit the particular requirements of various kinds of mules. The absolute amount of tightening depends upon the setting of the incline, or upon the difference of level between its two extremities; and the rate of tightening at different parts of the incline depends upon the form of the outline. By varying the form of the incline the action on the chain can be varied to suit any circumstances. When once set the apparatus needs no further attention. At the commencement of a new set of cops the copping plates are wound forward again to their original or proper places, the incline goes with them, and the backing off chain is restored to its normal slackness.

Where this apparatus is at work, it is found that very much fewer noses, or points of cops, are halched or entangled.

## Platt's Automatic Nosing Motion

(See Plate 23.)

Is a great improvement on Roberts' old winding apparatus. The only variation in the action of Roberts' quadrant was caused by the nut that worked up the screw of the quadrant arm, as it moved through the governor motion further outwards, from the centre of the quadrant, to suit the increasing diameter of the cop, until it had reached its full diameter. If the spindles had been of equal thickness where the cop is wound on to them, the winding on would have remained, in each and every stage, equally good; but this is not so, the spindles are taper, and as cops are now made much longer than formerly, it has become necessary to have a longer and stronger spindle, and consequently an increase in the amount of taper, the points of the spindles being always of the same diameter. As the cop bottom increases in diameter, the quadrant nut works up the screw of the quadrant arm, thus decreasing the speed of the spindles, as they wind on the larger diameter of the cop; but imparting the full terminal speed to them, when the winding reaches the nose of the cop. In Roberts' quadrant there was very little, if any, variation between the final speed, and the commencement on the bare spindles. Now, the winding part of a cotton mule spindle tapers from $\frac{1}{3}$ to 1-16th of an inch in diameter; and as it is most necessary in making a good cop to wind the nose, at each successive stage, equally close and firm, the winding ought to be gradually modified, so that the terminal velocity of the spindles may be increased in the same ratio as their diameter decreases. This object is attained by Platt's automatic nosing motion, in conjunction with the scroll on the end of the winding-on drum; the velocity of the winding increases, in the same ratio as the diameter of the scroll from which the winding-chain is uncoiled decreases.

Plate 23 shows the automatic nosing motion in conjunction with the winding apparatus. One end of the winding-chain (6), instead of being simply attached as it formerly was to the quadrant nut, is wound upon the boss of the ratchet wheel (1), the other end is fastened to the scroll end of the winding-on drum (7), which scroll increases the speed of the spindles, when the faller rises to the small end of the nose. At the other end of the winding-on drum is a twitch-nicked pulley, in which runs a band, fast at both ends; this band winds the chain on to the drum.

On the shaft of the ratchet wheel (1) the scroll (8) is fixed, and the other chain (3), coiling on to it, passes under and over the pulleys (2 and 4), and then under the swing pulley (9), its other end is attached to the bracket (11), which works on the shaper screw (20) of the copping motion.

The quadrant nut working up the screw in the quadrant arm as the cop bottom increases in diameter, the slack in the chain (3) is soon taken up, after which, the further the nut works up the screw, the further the chain (3) draws the bottom of the lever (13) inwards. As the carriage returns the bracket (17) comes into contact with the arm (16), and shoves the lever (13) out again; this action pulls an amount of chain (3) off the scroll (8), thereby turning it round, and winding on the ratchet wheel (1) a length of winding chain (6), which would otherwise remain coiled on the winding-on drum (7). In consequence of the ratchet wheel in the quadrant nut thus taking up from time to time a length of winding chain about equal to the increasing distance of the nut from the quadrant centre, the length of chain left coiled on the winding-drum at the end of each inward run of the carriage will remain nearly the same, until the cop has attained its full diameter, the quadrant-nut having then reached the farthest extremity of its travel along the quadrant-arm. The nut (12) on the shaper screw will now come in contact with the sliding-bracket (11), and will draw it inwards, together with the chain (3) and lever (13); in so doing it must draw a further length of chain (3) from the scroll (8), thus winding more of the winding-chain (6) on the ratchet-wheel (1), and therefore cause the winding-chain (6) to unwind from the scroll end of the winding-on drum. As this movement is repeated at each successive stretch, more and more of the scroll part of the winding-on drum is brought into action, until at the completion of a set of cops, as much of the scroll has been utilised as the circumstances of the case require.

**A** represents the position of the nut, &c., at the commencement of the cop.

**B** when the cop-bottom is completed.

**C** at the finish of the cop.

Plate 24, Figs. 1 and 2, shows that the cam shaft receives its motion from the backing-off wheel.

Plate 25 shows the taking–in motion. No. 1 is the end of the lever that works in the cone; No. 2, the lever that works the drawing–out catch box; No. 3, the swivel joint connecting scroll and taking–in lever with lever 2; No. 4, the bowl and set-screw for regulating the lever for back shaft catch-box; No. 5, the taking-in lever; No. 6, the taking-in contact; No. 7, the taking-in cone; No. 8, the winding-on scroll; No. 9, the scroll bevil; No. 10, the drawing-in scroll; No. 11, the scroll shaft; No. 12, the connecting rod from taking-in lever, to rod for holding-out catch; No. 13, the footsteps for upright for taking-in friction; No. 14, the upright of do.; No. 15, bevil on do. for do.; No. 16, the spiral spring.

### Roller Delivery Motion.

On the back shaft there is a clutch-box, one part of which works loose on the back shaft. On the outside of this loose part is a wheel of 18 teeth, working into a carrier of 57 teeth, which drives a wheel of 53 teeth on the front spindle; on the inside of this loose part are eight clicks. On the other part of clutch-box (inside), which is keyed on to the back shaft, there is a click-wheel. When the carriage is going out, these clicks are out of gear, and therefore do nothing, but when the carriage returns to the roller-beam (back shaft running in opposite direction) the clicks are thrown in gear, and give motion (roller delivery motion) to the rollers. This motion is generally used when spinning long-stapled cotton, and the roller delivers from three to four inches.

### The Snarl Motion.

On the front spindle is a catch-box, inside one-half of this catch-box (which works loose on spindle) is a "disc" with two recesses; the "disc" is fast on front spindle. On other half of the catch-box (also loose on the spindle) there are two nugs which work in the recesses of the disc. When the catch-box goes in gear, it works the half that is loose, and causes the rollers to revolve. For the "snarl motion" the recess is made much larger, and the nugs having so much more play, prevent the rollers from starting until just after the carriage has started.

### The Jacking Motion

Continues the outward run of the carriage, after the rollers have ceased to revolve, in order that any thick places occurring in the yarn may be made uniform with the rest; its effect being that wherever there is a thin place in the thread, the greater portion of the twist runs into that part first, and thereby renders it more difficult to be elongated than the thicker parts, which are thus drawn down. The amount of jacking introduced varies from four to five inches, according to the staple of the cotton; the longest admitting of the greatest amount of jacking. The "sun and planet" is the best system, as the stoppage of the rollers is more gradual by this motion than by any other.

### The Winding Motion.

An improvement in the winding motion has been effected by a change in the manner of engaging the click with the click-wheel on the shaft of the tin roller

(6), Fig. 1, Plate 26. Formerly the movement of the carriage (3) at the commencement of its inward run by means of the winding chain (2) drum (4), and spur wheel and pinion, caused the loose click-plate, carrying the click–catch, to turn on the shaft, and by means of the click-spring to make the click-catch engage the teeth of the click-wheel. But as the carriage moved inwards a little further on some occasions than on others, before the check–catch could engage the teeth (owing to the teeth not being always in the same relative position to the click), this caused the winding to commence in some runs later than in others. This was very objectionable, because the yarn would be very liable to form into "snarls" when the winding commenced later than it should have done.

To remedy this defect, the click (5) Fig. 2, can now be engaged before the carriage (3) actually begins its inward run, by a very simple contrivance; consequently the same amount of motion is imparted to the spindles in each inward run, after the cop has attained its full thickness, except what is gained by the acceleration due to the nosing motion. In the old arrangement the click was engaged by the click moving round the click-spring, which at the moment was stationary. In the new arrangement, the spring is put in motion, whilst the click is stationary, one arrangement being thus the converse of the other. For this purpose the pivot round which the click-spring rotates, instead of being as hitherto a portion of a fixed bracket, is now the centre boss of a lever (7), which swings loosely on the shaft of the tin roller (6), through a small arc. This lever is actuated at the proper time by a finger fixed on the connecting-rod (8), which lifts the "holding-out catch" (1). This rod receives its motion from the "taking-in lever," as it puts the taking-in friction into gear; and by means of the lever and spring puts the click into gear with the click-wheel; this stops the click, and on the carriage moving inwards the winding-on commences. By this means the winding is more uniform in its action, the yarn is subjected to less strain, and it is kept freer from snarls.

The "middle drawing-out apparatus," which greatly increases the steadiness of the mule carriage, consists of an extra "drawing-out scroll" on the back-shaft, opposite the middle of each half of the carriage; from each of these scrolls a band is connected with the carriage, in the same manner as at the middle of the head-stock, and at the out ends of the mule, except that the bands are here passed under the carriage. Another improvement in the back-shaft, is the connection between it and the shaft of the taking-in scroll. Formerly the carriage was pulled in from the head-stock only, that is to say, from the middle of its length only, and the ends of the mule were kept something like parallel with the middle part by means of squaring bands. By connecting the back-shaft, when the mule is going in, with the taking-in scroll shaft, by means of extra scrolls and bands, the back shaft receives a motion exactly similar to that imparted to the middle of the carriage. It is converted into a taking-in, as well as a drawing-out shaft, and the motion of the carriage is kept steady by six bands, instead of two as formerly.

The "cam-shaft" is one of the most important features of the self-acting mule. In its best form it is worked by a friction box, which permits of the quickest velocity of rotation, and at the same time, whilst it is sufficiently positive or unyielding for the work it has to perform, is not liable to break the rigidly connected parts in case of derangement. For medium counts it is now almost universally used with two changes, the other changes in the action of the mule being effected without its intervention. Thus the two former systems are combined—namely, that in which all the changes were made by the cam-shaft, and that in which no cam-shaft was used. The great desiderata are reliability and rapidity; and those have been attained to a remarkable extent, yielding a regularity of production unknown in former times.

The general parts of the mule are made much stronger than formerly. Rim shafts now revolve at as high a speed as 650 revolutions per minute, driven by $4\frac{1}{4}$ and $4\frac{1}{2}$ inch straps. The rim-pulley being 15-in. dia.; or, 3·92 feet circumference, this gives 2,550 feet per minute as the speed of the strap.

The backing-off, taking-in, and cam-friction clutches have been enlarged to give them greater controlling power. The rods, levers, &c., have been strengthened, to enable them to distribute properly the greatly increased power represented by the increased breadth and speed of the driving belt.

The spindles are now made capable of revolving up to 9,000 revolutions per minute, with cops on them 20 to 25% heavier than those formerly made.

Mules now work much more steadily and quietly—and are far less subject to stoppages from breakdowns, and are far better able to stand the strain of the extra work. Whereas, in former times, 24 hanks per spindle per week of 60 hours, spinning 32's twist, was considered good, the present production of a modern mill, working 56½ hours per week, is from 28 to 30 hanks per spindle, same counts. The quality of the yarn spun is fully 10% better as to strength.

The number of workpeople required for a pair of mules containing, say, 2,000 spindles, is the same as before. The cops are made so much larger, that fewer doffings are required for the same length of yarn; but, taking the increased production into consideration, the actual amount of doffing labour is about the same.

The head-stock being much improved in its automatic movements, the "minder" can devote his attention more to piecing ends, and looking after the younger pieces. Altogether the self acting mule may be described as one of the cleverest and most wonderful pieces of mechanism in existence. Messrs. Platt Bros. & Co. have succeeded in producing a head-stock renowned all over the world for its marvellous accuracy and perfection.

### THE RABBETH RING THROSTLE.

(See Plate 27.)

(HOWARD AND BULLOUGH'S.)

For some years past the impression has been strengthening that in one branch of cotton spinning, and that a most important one, the Americans had surpassed us in this country. We with our strong conservative tendencies adhered to the old fly throstle. Its speed is slow, its power is excessive, it is wasteful in oil and flannel, and its production is small. But it was thoroughly established, thoroughly understood by our work-people, and perfected to the fullest extent that its principle admitted of. The Americans clung to the ring throstle. Its speed was high, it required little power to drive it, its production was great. But it, up till a very few years ago, was not so thoroughly developed and matured as the fly throstle was. Hence, in actual results, it did not show much advantage over the fly throstle. But its principle had in it abundant promise of advantage, if it were successfully developed and fully matured. During the last few years the Americans have thoroughly succeeded in doing this. So complete has been the victory of the ring throstle, that it did not stop at beating the fly throstle, and it is now successfully competing with the mule, and in some instances it has actually beaten the mule itself out of the field for twist. The Sawyer spindle marked a great advance on all past ring frames. The margin between what existed and what was desirable, was much narrowed by the Sawyer ring spindle. That margin has again been very much narrowed by the Rabbeth ring frame, which scarcely leaves any room for opponents of the principle to hang their objections on. Its peculiarities are, first, the Tubular Bolster, which ensures perfect and safe lubrication, at the least cost in oil. The tube being filled with oil, and the spindle itself being put in the tube, the bearing parts are actually submerged in oil, and therefore lubrication is guaranteed. It is not as in the common spindle, that neglect of oiling, once or twice every day, would be serious; it is not even as in the sawyer, where the oil is put in at the bottom of the bolster, and if all is in perfect order, and clean, the spindle itself will cause it to rise to the top of the bolster. It is not dependent on constant daily vigilance, and the greatest care to secure safe lubrication; but this object is perfectly secured with less than ordinary care and attention. Indeed, it is so well secured, that only by wilful neglect can lubrication fail. This is an all important quality—an indispensable quality—to the continuous and successful running of these ring spindles, at speeds ranging from 7,000 to 9,000 revolutions per minute. The tubular bolster being filled with oil, at the foot of the spindle, and the upper bearing of the spindle in the bolster are completely submerged in oil, and it is not left to chance whether the oil finds its way to the right place or not. This tubular bolster holds an ample supply of oil for months, and therefore no damage will result if months elapse without oiling being done. But the oil must be kept clean, and must be protected from all dirt or fibres most effectually. If this is done, there is no reason why such an ample supply of oil as the bolster contains should not last an indefinite time. And indeed practice on a large scale proves that one gallon of oil is sufficient for 1,000 spindles running a whole year. The protection of this oil in the bolster from contamination is complete. This is effected by the cast iron shell or sleeve which comes over the bolster and completely encompasses it. The ample supply of oil therefore remains pure, and instead of requiring attention to avoid serious injury at these high speeds, twice a day, once in six weeks or two months is quite often enough. The whole weight of the moving parts, spindle, sleeve, and wharve, is only $3\frac{3}{4}$ ounces. The next important feature of this spindle is the cup at the bottom of the sleeve. It is obvious that the cup must constrain the bobbin to its true position for working, and that it must check any tendency in the bobbin to "warp" or "fly," and thereby to get out of balance. This advantage is considerable, for no spindle will run well unless the bobbins are kept balanced. The cup also aids in driving the bobbin, and although that aid is scarcely required, as experience proves, yet its tendency is in the right direction, if it only makes sure doubly sure. If such spindles as the sawyer drive the bobbin safely, with only the bearing at the top of the spindle, then the bearing at the top of the spindle, with the friction of the cup as well, is still more safe. But these advantages, however important, are only incidental. Its primary object is to facilitate "doffing," or the operation of changing the full bobbins for empty ones. *It dispenses with the necessity of tying the thread round each empty bobbin at the commencement of a new set.* It is in fact a doffing motion, or rather as there is no motion about it, it may be more correctly described as a contrivance which dispenses with the necessity of all so-called doffing motions. It effects the object such as doffing motions aim at and accomplish more or less imperfectly by round about means. In removing the full bobbin the thread between the bobbin and the traveller will coil itself in a coarse spiral round the sleeve of the spindle. The empty bobbin being placed in position over the sleeve with its lower end in the cup, it will be found that the thread has been pressed downwards into the cup, and that it is pinched between the said cup and the bottom of the bobbin. It is thus held as fast as though it were tied round the empty bobbin, although no extra time whatever has been taken in so fastening it. The act of taking off the full bobbin and placing the empty one on in its place, fastens the thread as though it were tied, quite unconsciously to the operator. The bottom of the bobbin being within the cup, and the thread from the traveller being over the top of the latter, it follows that in starting the machine, the threads must at once be wound on the proper part of the empty bobbins. The cup guides the thread on the lower part of the bobbin, and prevents it being wound on too low. Thus this simple cup, which is really a part of the spindle, fulfils every one of the functions which elaborate doffing apparatus imperfectly accomplishes, and over and above this, it steadies the bobbin, and prevents it warping and losing its balance. The tubular bolster, the sleeve, and the cup are the great features of this latest American development of the ring throstle. The removable phosphor bronze brush at the top of the tubular bolster can be taken out if worn, and new ones spring in almost with the fingers alone. The patented adjustable wire holder for holding spindle in bolster whilst doffing dispenses with the need of a special tool for turning each wire separately, and it also dispenses with the objectionable sliding bar. This is a very valuable improvement.

### Howard and Bullough's Patent Automatic Spindle Holder.

Figs. 1 and 2, Plate 28, are sketches of this great improvement. Its advantages over the old sliding bar are obvious. There is no difficulty with the pins F coming loose, as they are not screwed into a thin bar, but into a solid casting as shown, which gives ample thread hold. Any spindle can be stopped, taken out, and oiled, or otherwise attended to without interfering with the rest. In the case of the sliding bar it is necessary to stop the whole number of spindles in order to attend to one.

The hinged piece A gravitates to the position shown in Fig. 1 when the spindle is in working position. The greater the force applied to lift the spindle up, the more firmly it is held down, because the pin F, to which the force is applied, is on the opposite side of the hinge or fulcrum C to the part D, which rests on the solid collar E. Any force applied to lift the spindle up, only causes the part D to press so much harder on the unyielding E.

The moment, however, the part D is lifted in position shown in Fig. 2, by the tip of the finger, the spindle can be lifted up or out; and to replace the spindle it is only necessary to drop it carelessly in the point B. The piece A is thrown in the position of Fig. 2 by the weight of the spindle; and when the wharve has passed, the heavier side D descends and brings the pin F back in its holding position as shown in Fig. 1.

These machines are constructed with very great care, the finish and adjustment of the parts to each other being all that can be desired. Each spindle is tested at a considerably higher speed than it is ever likely to work in actual use. All the rings for the frames are made upon special machinery, each ring being carefully hardened to the highest degree possible. The fluted bottom rollers are made from the best material. The various parts of the machine are finished as well as possible; and in the fitting together, the parts are accurately adjusted so as to give the best results in operation.

The general verdict appears to be that a stronger and more even yarn, from the same roving, and with the same twist, can be obtained on this machine, than on the mule. The production is some considerable per cent. more; and the loss from waste is not so great. In place of the skilled labour of men, with which there is often so much difficulty, the cheap and unskilled labour of children suffices, each of whom can tend from 400 to 600 spindles, according to the counts and quality of yarn in process.

The speed recommended for economical spinning is 7,000 revolutions per minute for $1\frac{1}{2}$in. rings with 5in. lift of spindle, and 6,500 revolutions for $1\frac{5}{8}$in. rings with 5in. lift, and the same speed for $1\frac{3}{4}$in. rings, 6in. lift; the tin rollers (either 9in. or 10in. diameter) making, according to their diameters and the diameters of the spindle, wharves ($\frac{3}{4}$in. for 5in. lift, and $\frac{7}{8}$in. for 6in. lift) from 662 to 720 revolutions per minute.

As regards the out-turn of yarn the table data given below are from actual practice, and vary more or less, according to circumstances, and the kind of material spun. If these figures are compared for different counts with the production of a mule on the same counts, it will be seen that in the lower numbers the production of the ring frame is considerably greater than that of the mule, but as we proceed to the higher numbers, say up to about 80's, the mule becomes more and more equal to the ring frame, and finally its superior.

On the point of power per spindle the ring frame spinning 30's beats the fly-throstle by two-fifths, or 40%, requiring only three-fifths of the power, but compared with the mule, the latter has the advantage by one-sixth, or about 16%, requiring per spindle five-sixths of the power necessary to drive the ring spindle. But for the average counts of yarn the superiority still remains with the ring frame, as requiring less power than the mule for the same weight of yarn turned off, the advantage becoming more marked the lower the counts, *i.e.*, with 16's (see table below) for the ring frame, an extra production of 43%. The limit of production of the mule in coarse counts is determined by the number of draws per minute the carriage can run at, and as this number is limited, it controls the speed of spindles. In spinning low counts with comparatively little twist, the spindle speed would be, roughly, about 4,500, whereas the ring frame, on the same counts and twist, runs continuously at about 7,000 per minute.

With respect to attendance for piecing, it of course varies to some extent with the quality of the roving, but one hand (as before stated) to 600 spindles may be taken as an average.

TABLE.

| Coun's of yarn spun. | Speed of Spindle per minute. | Speed of front Roller per minute. | Diam. of front Roller | Twist. | Diam. of Ring. | Production per Spindle per week of 56½ hours. | |
|---|---|---|---|---|---|---|---|
| | | | | | | In lbs. & oz. | In Hanks. |
| 4's | 6020 | 230 | 1 inch | 8·3 | 1¾ | 16·5 lbs. | 66 hanks |
| 10's | 6020 | 158 | 1 ,, | 12·12 | 1¾ | 5·25 ,, | 52·5 ,, |
| 16's | 6700 | 131 | 1 ,, | 16·25 | 1¾ | 2·68 ,, | 43 ,, |
| 22's | 7450 | 134 | 1 ,, | 17·69 | 1¾ | 29·09 ,, | 40 ,, |
| 26's | 7100 | 114 | 1 ,, | 19·86 | 1½ | 23·25 ,, | 37·75 ,, |
| 30's | 6850 | 107 | 1⅝ ,, | 21·73 | 1½ | 17·25 ,, | 32·34 ,, |
| 34's | 6800 | 90 | 1 ,, | 24·05 | 1½ | 14 ,, | 29·75 ,, |
| 40's | 6800 | 84 | 1 ,, | 25·76 | 1½ | 10·94 ,, | 27·37 ,, |

## THE ELECTRIC STOP MOTION.

### (HOWARD AND BULLOUGH'S PATENT.)

This very important and useful invention overcomes one of the most serious difficulties incident to the intermediate roving frame, and is also of great value as applied to the card and drawing frame. It is without doubt one of the most successful inventions of modern times.

This stop motion is of very great delicacy, and is almost entirely without any moving parts liable to derangement. The fact that cotton, when in a comparatively dry state, is a non-conductor of electricity, is the leading principle of the method which has been taken advantage of and adopted for the electric-stop-motion, for the carding engine, drawing frame, and intermediate or roving frame. The perfect adaptability of electricity for stopping purposes may be best seen and understood by an examination of the drawing frame, for here no less than four conditions can occur in which the work may be spoiled, when in each case it becomes necessary to stop the machine. Firstly a sliver may break on its way from the cans to the drawing rollers—this also includes a can getting empty; second, the cotton may lap or accumulate on the drawing rollers; third, the slivers may break in passing from the drawing rollers to the calendar rollers; and fourth, when the front cans get filled with the drawn sliver. Before considering the application of each of these cases in the order given, we will in general terms describe the principle of the "electric stop motion." The electric current is supplied by a magneto-electric machine, which is driven by a small band or belt an inch broad. The power absorbed by this machine is about as much as will drive a small sewing machine. In the early history of the invention the ordinary electric batteries were used, and found to be unreliable. With the electro-magnetic machine the current is available so long as the engine is running. One pole is connected by means of a rod or wire to the machine framing, and the other pole to the electro-magnet, in as simple a manner as the ordinary wires conduct electricity to electric bells in a house; the magneto machine acts exactly as a battery to the ordinary electric bells; and instead of ringing a bell when contact is made, the electro-magnet at the machine attracts an armature of soft iron, which drops into a ratchet wheel, causing the strap to shift from the fast to the loose pulley, and thus stop the machine; electrical contact is made in each case of stoppage by the various simple contrivances which are attached to the machine.

### Carding Engine.

The following is a description of the application of this system to a carding engine. The stop-motion acts automatically when attached to a carding engine, by either the breaking of a sliver, or when the can becomes full. The breaking of the sliver causes the two small calendar rollers inside the coiler to touch each other, producing electrical contact, and the machine stops. When the can becomes full, in an equally simple manner, the table wheel in the coiler becomes gently raised until it makes electrical contact, and then stops the machine. The stopping of a carding engine, however, is disadvantageous on many grounds—it is generally preferred to incur a little waste rather than experience this evil. The current, therefore, in this case, instead of being the means of stopping the machine, is made to ring a bell as an alarm to the attendant, that something requires his prompt attention. The bell continues ringing until the evil is remedied.

## Drawing Frame. Plate 29.

The application of the invention to drawing frames will be seen on reference to plate 29. The slivers before they reach the drawing rollers are made to pass between rollers which we may describe as electric rollers, the bottom one of which is fluted, and revolves in bearings attached to the machine frame. The top rollers are made short, so as to allow of there being one for every pair of slivers which is passing through the frame, and they revolve in plates secured to a plate which is called a back-plate, which is electrically insulated from the rest of the machine. On the frame is a small electro-magnet, and the stop-motion, and strap fork. The top series of electric rollers are kept from being in contact with the bottom one by means of a non-conducting cotton sliver, and the upper and lower rollers being insulated from each other by the non-conductors, the passage of the current is not possible; but supposing the sliver to break, the rollers come into contact, the circuit is completed, and the machine is stopped instantly. When the cotton laps on the drawing rollers the stoppage is obtained as follows: these drawing rollers, both top and bottom, are in electrical contact with the machine frame, and, as is usual, are covered by the plates of the top clearers, which are placed at short distances from them, and are attached to the insulated back plate. The top clearers, therefore, are in electrical contact with one pole of the magneto-electric machine, and the drawing rollers in contact with the other. When the rollers work properly, the distance between the upper and lower rollers is of a well defined character, but should the sliver lap over either top or bottom roller, the distance between the centres increases, which raises the top roller, and so comes in contact with the projection from the top clearer, and produces electrical contact, stopping the machine as before. The calendar rollers are insulated from each other by much the same simple means. Where the sliver is properly passing through, they are separated, no current passing; if, however, the sliver breaks in one of the funnels, then the rollers, having nothing to keep them apart, cause contact to result: the circuit then being complete, the operation becomes suspended, because the machine is stopped until the ends are pieced up. The last operation in connection with this ingenious mechanism is when the front cans become full, when the required amount of sliver has accumulated in a can, the tube wheel is lifted up very slightly, completing the circuit, and stopping the machine as before.

### Intermediate Frame. Plate 30.

In this machine it is requisite for the stop motion to act in two cases which are provided for the prevention of "single;" first, when the end breaks before it reaches the rollers; and secondly, when a bobbin in the creel becomes empty. By them these causes of "single" are guarded against by the adoption of an "electric roller," round which the ends pass before they reach the drawing rollers. The breaking of an end, or the finishing of a bobbin, will cause electric connection to take place with this roller, and thus stop the machine. How the electro-magnet gets action in the intermediate frame will be understood by a reference to Plate 31. After the explanation, which has already been given, it is scarcely necessary to describe in detail anything further in connection with this machine.

Among the many valuable inventions used in the cotton manufacture, Messrs. Howard and Bullough's electric stop motion holds a leading position, and it only needs to be seen by practical minds to be appreciated.

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## MISCELLANEOUS.

### Workpeople and Production.

How does it happen, that with no physical advantages, in the shape of water, facilities for carriage, &c., Oldham and the surrounding townships are continuously and rapidly increasing the number of their mills, and underselling North and East Lancashire spinners on their own ground? The profits made in the first named districts are such as to excite surprise, when it is remembered, that at the same time, spinners in the last named districts complain of the slight margin between cotton and yarn, and the consequent impossibility of realising even bare interest on the capital invested, to say nothing of remuneration for the trouble and risk involved. That the complaints from the North and East Lancashire districts are not without truth, may be reasonably inferred from the fact that the total number of spindles in these districts is gradually decreasing, which would not presumably be the case, were the trade in a healthy condition. It is sometimes asserted that the operatives of Oldham are harder workers than their fellows of other localities, but without endorsing this as the truth, in every sense of the word, it may be assumed that it is not far wide of the mark, so far as actual results are concerned. Spindle for spindle the Oldham mills are producing more than any other in the world, and leaving out the share contributed by the employers to this result, and confining ourselves for the moment to the operatives, there can be little doubt that the reason is, as has been said, that Oldham workpeople are generally the best of their class in the whole trade, being comparatively well paid, and paid on such principles as give quite general satisfaction to both employer and employed. The local cotton trade is almost entirely free from those petty strikes at individual mills, which are the bane of employers in other towns. Should any dispute arise, properly accredited officials at once take the matter in hand, and settle it with almost mathematical precision by arbitration. The foregoing remarks refer exclusively to the spinners, or what are perhaps more commonly termed "minders," and it is quite possible that the system above referred to may have some connection with the supposed superiority of Oldham operatives spinner as compared with other districts; at all events, this, taken in conjunction with the closeness with which they watch the "spindle point," are undoubtedly the main secrets of the success of the Oldham spinning mills. Very much of course depends on the weight of yarn turned off the spindles, as there are so many standing items of expense, whether there be a large or comparatively poor production. A margin of 3d. per pound between the raw material and 32's cop twist is considered fairly remunerative, and a good return upon the capital invested may be looked for. It is well known in the trade that this state of things is fairly remunerative, for in well managed modern mills 32's cop twist can be produced for $2\frac{5}{8}$d. per lb. without loss.

## Wages.

In Oldham the system of payment is based upon the fact, that the price should be fixed in accordance with the circumstances of each individual firm, and not on a hard and fast line. Should any employer obtain an order for yarn which could be satisfactorily filled by the use of inferior cotton he puts it in, reduces his speed, and pays a slight increase in price; or, on the other hand, should he, by improving his machinery, by using a superior cotton, or by employing superior talent to keep the machinery in order, be able to increase his speed, without unreasonably taxing the workman, he is entitled to a reduction. This course stimulates an employer to use his utmost energies to increase production, as for the labour and expense thus involved, he reaps his reward in reduced cost, in contradistinction to his competitors in other districts, who are mostly tied down to a fixed list of prices, and have scarcely any incentive for improvement.

In Blackburn, Preston, Burnley, &c., a fixed price per 100lbs. is paid for yarn, which is supposed to be a certain number of hanks to the pound, and this price is entirely independent of the circumstances surrounding each particular mill.

An employer may supply the best of cotton, and spend large sums in improving his appliances for increasing production, and yet he must pay the same price for his turn off per 100lbs. as his neighbours, who may be running the most antiquated machinery, by methods which are altogether out of date.

So far the difference in the two systems applies almost exclusively to the employers, but it is quite as great when applied to the operatives.

In the early days of cotton spinning workmen were paid by the length of yarn produced, but from the manner in which it was registered, this course was open to grave abuses, and it was ultimately superseded by the weight system. It is now asserted by the operative spinners that this system is now abused by unscrupulous managers; but be that as it may, there is no doubt it forms a principal element in the fluctuations of wages from week to week. A workman spinning, say 32's, may, on an average, be fully level with his counts; and yet he may sometimes be down to 31's, and occasionally be up to 33's, which will make a difference of from 3s. to 4s. per week in his wages. The weight of the doffing skips, and the number of turns per inch in the yarn, also form subjects on which there is a continual difference of opinion between men and masters, and this leads to many strikes which take place at individual mills.

By the method of payment in Oldham none of the foregoing points have any influence in affecting the workman's wages, and as a consequence he never troubles himself about them. Altogether irrespective of thickness or hardness, he is paid by length, as registered by an untamperable indicator, and being consequently free from the petty jealousies inherent to the weight system, he devotes all his energies to making his machines turn off the best possible results.

## Strikes.

Strikes, however conducted, are a deplorably clumsy and uncivilised contrivance, and this indisputable fact cannot be too strongly impressed upon the reader. At best they are a blind, haphazard mode of deciding differences, by which both employers and employed probably, and the latter certainly, must lose more than they can possibly expect to gain. The immense loss, unspeakable misery, and bad feeling engendered by strikes are deplorable in the extreme; it therefore becomes the duty of those in authority to anticipate by every means in their power any such occurrences, and by the exercise of reason and foresight to avert such calamities. On the other hand the operatives themselves must be prepared and determined to give a fair return of labour for a fair and reasonable wage. They should also not disregard those necessary rules of discipline and subordination without which no concern can be carried on with any degree of comfort, pleasure, or profit. Strikes, where at times they appear almost inevitable, may often be avoided by the exercise of a little mutual forbearance. Any dispute that may arise should be calmly and candidly considered, by which means a strike with its attendant miseries may be averted, to the great advantage of the parties most interested, and the community at large. Great industries have been ruined by bad feeling and bad blood between employers and employed; strikes and lock-outs are a curse to all alike. On the other hand trade may be fostered and encouraged by a sound, healthy, and contented feeling between employers and employed, based upon a right understanding of mutual advantage and the inseparably connected interests of labour and capital.

## WASTE.

The waste that is made in a cotton mill is a very serious item, and upon a little reflection, it will be seen that unless very great care and attention are bestowed upon this matter, in each and every department of the mill, any carelessness or neglect on the part of the workpeople will result in heavy loss. It is therefore necessary to be both very particular and strict upon this most important point.

At the scutchers nothing should be allowed to be beaten out of the cotton, or lost, except what is absolutely necessary; such as sand, seeds, and heavy dirt; any real cotton of any staple that may be getting knocked out with the fly, &c., should at once be stopped, and the evil remedied by closing up the bars at the back of the beaters.

To prevent any extra fly being made at the carding engine, if the cotton is anything like clean, and the yarn is giving satisfaction, the cards should not be allowed to run without grids or under-covers under the cylinders, more especially if there is plenty of carding in proportion to the number of spinning spindles, and if the cards are not overloaded. The strips, of course, must be regulated to the quality of cotton used, and yarn required; but much waste in the form of strips may be avoided by a little extra care and attention to surrounding circumstances.

The cards will carry and make much less strips if they are kept sharp, and well set. The lap piecers or carriers, and can and drawing frame tenters, may prevent much soft waste by seeing that the cans do not get choked up or run over; and drawing frame roller laps may be avoided by keeping the leather rollers clean, nicely varnished, and in good working order. The rovings at the frames, throstles, and mules should be made to run off to the very end; many tenters and piecers have a bad habit of roving off and pulling to waste the last row or so of rove which remains on the bobbins or tubes, and which would otherwise draw off, and be spun into yarn. This should not be allowed.

In one word, as little waste as possible should be made at every machine, all through the process, and should not be permitted except within reasonable limits. The waste that is made, and that cannot be avoided, should not be carelessly thrown on the floors, nor should it be dirtied. The different kinds of waste should be kept separate, and the fly, strips, roller and clearer waste, and sweepings should be carefully picked.

The soft waste may be used up with advantage, and put into the weft mixing in a fair proportion. For the fly and strips a mixing may be made for say 24's twist as follows:—One-third ordinary cotton, one-third soft waste, and one-third fly and strips.

The low fly and strips, first sweepings, and clearer dirt, &c., may be worked up into low numbers, or sold.

## General Stores.

The stores, such as card clothing, strapping, roller skins, tubes, banding, &c., &c., should be of a good quality. It is much better in the long run to expend a little extra money upon these necessary articles, than to lay in, or work with a stock of second rate material. The first out-lay is rather more, but the extra expense incurred is fully recouped, as the articles, if of a fair quality, will last much longer, and do their work better than cheap and poor stuff.

The card clothing especially should be of a first-class quality, and should be got from the best makers. If it is not up to the mark the teeth or wires soon begin to break out, and then the cards require re-covering, as when the card clothing gets damaged it is impossible for it to do its work efficiently. Card clothing is a very expensive article, and becomes much more so if of an inferior make or quality.

The strapping should also be of a good quality, it will then run a reasonable time, and there will be less stopping of the various machines, through the strapping breaking, which is invariably the case when it is of a poor nature. The continued stopping of the machinery is a very serious matter, and can be avoided to a great extent by the use of good strapping, which will thus pay for itself, independently of any other consideration.

The above remarks apply to all the stores of whatever description, and may be summed up in one word, *i.e.*, reasonable and fair results if the articles be of a good quality; unsatisfactory and poor results if of an inferior quality. The manager should himself decide as to whether or not the various articles are of a sufficiently good quality, and give satisfaction in working. He should not take the mere word of anyone in the place upon this point, but should personally satisfy himself, as for obvious and well-known reasons, such word, in many instances, is not to be relied upon.

The looking after and giving out of the stores should be in the hands of a trustworthy and reliable man, upon whom nevertheless there should be an effective check. The store-room should be open an hour a day, say from 10 to 11 a.m., and each overlooker should then present himself to the store-keeeper, with his book, in which are duly written the articles he may require, and signed by the manager. A certain amount of oil each day should be carefully measured out to each department. Cards, strapping, bobbins, &c., should be made to last a reasonable and proper time; any carelessness or negligence on this head should be strictly avoided.

Altogether this department should be carried on with a system second to none in the mill.

The Roller Covering Department.—It is impossible to over-estimate the importance of this department, for in making a nice, smooth, level yarn, everything depends upon having good leather rollers. In the first place the leather itself should be of a first-class quality; any false economy on this head is sure to lead to most unfavourable results, and should therefore be strictly avoided. The skins, before being cut up, should be carefully sorted and picked, as there is such a wide difference in the quality, thickness, &c., of them. The skins should be of a soft and pliable nature, so that in being drawn on to the rollers they will give nicely,—similar to a kid glove when drawn on the hand—and present a smooth and even surface; this will tend greatly to produce a smooth and wiry yarn. Great care and attention should also be given to the piecings; as also with the piecings of the cloth, before the leathers are put on; the piecings should be so neatly made, that it is impossible from the touch, to tell where they are. If this is not attended to the yarn is sure to be cut at every revolution of the roller. The rollers should be covered as tightly as possible, and they should be neatly ended. Any little extra attention devoted to the roller covering department will be fully repaid upon examination of the yarn.

Varnish for Leather Rollers.—

6ozs. Navy Blue.
1oz. Ordinary Glue.

$\frac{1}{4}$oz. Fish Glue.
$\frac{1}{4}$oz. Gum Arabic.
With $2\frac{1}{2}$ gills of water, to simmer for one hour.

Cement for Leather Rollers.—Fish glue, or isinglass, torn into small shreds, and as much vinegar as will dissolve the isinglass. To stand all night, and then let down with vinegar to proper thickness.

Cement for Cloth.—
2lbs. White Flour.
1lb. Unmade Resin.
$\frac{1}{2}$lb. Turpentine.
To boil in one quart of water. Also for Cloth :—A thin coating of boiled-oil and white lead.

The cutting up of the skins should be closely watched, so as to prevent waste.

Oiling the Machinery.— The oiling of the machinery, well and regularly, is of the very greatest importance, for a machine which is regularly oiled will last a great deal longer, do its work better, and require less repairing than one which is neglected in this respect. Everything which moves ought to be oiled, for where there is moving there is friction, and where there is friction there is wearing, and to prevent this wearing oil is required. There can be no doubt that in the long run it is far better and more economical to use good oil; the evil consequences attending the use of poor or bad oil are great and serious. Opinions, however, differ very widely upon this subject, and with circumstances, so that it is quite impossible to lay down a hard and fast line to go by. The following therefore must simply be taken as a guide :—

No. 1. For Engine and Shafting.—Castor oil or Gallipoli.

No. 2. For Machinery.—Quarter double refined Gallipoli, quarter pure lard, half good mineral.

No. 3. For Machinery.—Sperm, Gallipoli, and mineral—mixed.

Or say for the card-room, mineral; and for the spinning rooms, mineral, sperm, and Gallipoli mixed, or used separately, according to circumstances.

The Scutchers should be continually oiled, and the "cups" always kept full.

The Card.—Clearers once a day, rollers twice a week. Cylinder, doffer and taker-in bearings should be filled with tallow.

Drawings.—Top and bottom rollers every morning. Loose boss rollers once a week. Quick motions and shafts every morning.

Speeds.—Footsteps once a fortnight. Collars once a day. Rollers once a day. Loose boss rollers once every two weeks.

Throstles.—Rollers once a day. Footsteps three times a week. Collars twice a day. Tin rollers, &c., twice a day.

Mules.—Footsteps three times a week. Bolsters twice a day. Rollers, top and bottom, twice a day. Headstock and fast motions twice a day.

It is as well to put tallow in the roller necks.

The drawing-frame rollers should be varnished about twice a week; and the slubbing frame rollers about once a week.

Fires.—The plan of erecting light iron stair-cases outside mills, which has of late been so widely adopted, has been the means of saving both life and property; by enabling workpeople to leave the premises more quickly and safely in case of fire, and making it easier for the firemen to get into the particular room with the hose pipe where the fire has broken out. The great proportion of fires that take place in spinning mills are traced to friction in the mule headstocks, and owing to the tin roller centres getting hot and sending sparks into the carriage of the mule. This dangerous friction should be avoided by the judicious use of suitable lubricants, and taking care that the working parts do not get much worn down and out of order. If fire does occur in a mule headstock, it can be prevented from spreading to the carriage by the carriage ends and adjacent portions of the carriage bottoms being shut off from the headstock with fixed sheet-iron plates. These are neat and cost little; and if such precautions were taken, the risk of large fires would be reduced to a minimum.

Steaming in Cotton Mills.—The atmosphere is capable of holding in suspension a considerable amount of moisture. This is a fact, the knowledge of which may be of considerable advantage to a millowner, for moisture is well known to be a great assistant in spinning and weaving. It is undoubtedly advisable to introduce steam into mills, not only for the benefit of the cotton, but also for the "hands," for it increases the amount of moisture contained in the air. A continuous north or north-east wind dries the air in the mill, and is as injurious to the hands as it is disadvantageous to the cotton; to enable the air to hold a certain amount of moisture it must be raised to a proper temperature. Warm air holds more moisture than cold air, but of course there is a limit. What, therefore, it is necessary to point out is the fact that the introduction of steam must be accompanied by the introduction of heat, for where the latter is deficient the steam will condense, and then there will be water instead of steam, which again will absorb heat from all surrounding objects, and thus produce the chilly feeling so injurious to health.

Speeds of Line Shafts.—The great velocity now given to the rim shafts of mules has caused the line shafts of spinning mills to be driven very much more quickly; formerly 180 to 200 revolutions per minute was considered a good speed, but with quicker rim shafts a speed of 240 to 250 revolutions is now desirable, so as to avoid the use of large drums on the line shafts, and also of large drums and small pulleys on the counter-shafts.

The difficulty of obtaining these high velocities by direct driving has led to the introduction of belt and rope driving in almost all cotton mills recently built; rope driving especially having become very general, and with most satisfactory results; a steadier motion being imparted to the machinery, with less frequent breakdowns. The adoption of belt and rope driving has been greatly influenced by the number of breakdowns where gearing was used.

Where rope or strap driving has not been introduced —these instances, however, are very few—cast-steel wheels have been generally substituted for the broken cast-iron ones.

Depreciation of Machinery.—For depreciation of the machinery in a cotton mill, there should be a proper percentage written off annually, and the percentage of depreciation ought to enter into the annual calculation, for little as it may in a profitable year affect the balance of this one year by itself, it is of very serious importance when the result of several years trading is taken into account. For the depreciation of machinery and other property the correct amount should be set aside each year. The wear and tear in the working of a mill is constant and great, and becomes a very serious item, it is therefore necessary to make the proper allowance for it. To work on year after year without giving this matter any serious thought, or to deceive oneself wilfully or through ignorance, is a very gross miscalculation, and in time is sure to be attended with disastrous consequences.

## JOTTINGS AND USEFUL HINTS.

To gain power you lose speed. To gain speed you lose power.

In a mill, it is of great advantage to have plenty of driving power, so that a regular and uniform speed may be kept up; plenty of preparation machinery, and plenty of room, so as to allow the machinery to be laid out to advantage.

Every machine in the mill should be adjusted with the greatest precision, and kept in perfect working order.

The scutchers should be pulled to pieces, and cleaned thoroughly whenever there is a chance, and the flues should be swept and emptied regularly.

The speeds and spinning machinery should be thoroughly and regularly scoured.

Scutch and card light, and make as fine a roving as possible.

If the laps are kept regular, and of one weight, little or no alteration is required in the after process; but when necessary to change, it is better to do so at the drawing.

The number of wires contained in 4 inches long (of wire) equals counts of wire.

To make the laps heavier, make the weighings heavier; or where self-regulating, speed the feed rollers.

To prepare light in the card-room, is the best method for making a superior quality of rove or yarn.

Yarn spun from coarse rovings is never so beautifully even and wiry as yarn spun from fine roving.

On account of the distance between the third and back rollers in the drawing frame, or the middle and back rollers in the speeds or mules, when set so far apart, anything but a very little draught would be injurious.

If the yarn is "cut" at every 3 inches, it is the fault of the mule or throstle rollers; the piecings must be bad, therefore the rollers require re-covering.

To produce a regular yarn on the common fly throstle, it is necessary to have good washers for the drag.

Potash and hot water is a capital thing for cleaning machinery.

The end of all government is order.

Always be on the alert to prevent faults, rather than to check them after they have occurred.

Piece-work and "bounty" stimulates the work-people to greater exertion.

Consumption and production is according to traversing of rollers, which in all cases will be found by multiplying number of revolutions of rollers by circumferences.

The total draft of any machine where there are intermediate drafts, may be found by multiplying the drafts respectively into each other, the sum of which will be total draft.

In grinding, the "wire" should if anything out-run the "emery." If the emery runs quicker than the wire, it will have to go at an immense speed to over-run the latter; the "emery" would therefore be liable to jump, and not run true, and going at such a speed, would hook the wire, cause it to get hot, take temper out of it, and altogether spoil it.

The scutcher is the best place for the thorough good mixing of cotton, when two or three kinds have to be incorporated, in the proportions of one in four, one in three; two in four, two in three; or three in four.

To prevent soft cops, see that the fallers are properly weighted, and see also that the spindle bands are tight.

Waste made at the carding engine, with and without grid or under cover:—

Example.

| Without Grid. | lbs. | oz. | |
|---|---|---|---|
| 1 Lap $34\frac{1}{2}$lbs. Egyptian... | 1 | 0 | 1st fly |
| ,, ,, .... | 0 | 11 | 2nd do. |
| ,, ,, ... | 0 | 4 | 1st strips |
| Total...... | 1 | 15 | |

| With Grid. | lbs. | oz. | |
|---|---|---|---|
| 1 Lap $34\frac{1}{2}$lbs. Egyptian... | 0 | 6 | 3rd fly |
| ,, ,, ... | 0 | 3 | sand |
| ,, ,, ... | 0 | 3 | strips |
| Total...... | 0 | 12 | |

Patent plate iron bobbin caps for slubbing, intermediate, or roving tubes:—These caps are admitted to be the best and most effective caps yet introduced. They combine lightness with great strength, cannot possibly get loose in working; run steadier than the cast-iron hoops, secure perfect protection against breakages, and are fast superseding the cast-iron hoops.

If the feed rollers in the scutcher are "licking," set the back bar close up to the bottom roller to prevent this nusiance. If "plucking," *i.e.*, coming in in lumps

—thick and thin—weight heavier, and see that the roller necks and steps are not worn.

If the scutcher-beater blades become worn round, turn the beater, so as to bring the sharp side of the blade into action on the cotton. If both sides of the blade are worn, the blades require planing up.

If the frames or speeds are all one gear, and of one date, and also working the same hank roving, be careful to have the drum-end wheels, rack, lifter, twist wheels, pinions, and wheel on bottom of upright alike in all frames.

Receipt in case Shaft runs hot.—Black antimony and best castor oil; you may if you like add a little black lead. Work it up nicely together, and lay it on the shaft, first thick, and then taper down to nothing but the oil.

How to Stone Iron Rollers.—First put the roller in the lathe, and skim it up with a file, then take a piece of pummice stone, and hold it to the flutes for a reasonable time, next get a piece of oil stone, and hold this to the flutes in the same way as the pummice. Rub well all over the roller with a bit of card filleting, and clean with hard waste and whitening.

Mason's patent long collar for slubbing, intermediate, and roving frames, is recognised in the trade to be a great improvement on the ordinary short collar. Its advantages are greater speed and steadiness, less wear and tear, and an improved production both as regards quality and quantity.

Many cotton main-driving ropes now working have stood the test of six years with the most satisfactory results. A two inch cotton rope will transmit 50 horse power, travelling 4,000 feet per minute.

SIZE FOR COP BOTTOMS.—

| | |
|---|---|
| 36lbs. | Potatoe Flour. |
| 3lbs. | Tallow. |
| 3lbs. | Soft Soap. |

To boil 35 minutes.

In a 16-in. mule spindle, when spinning medium nos., the bevil is generally 4-in. The bevil in a 15-in., 15½-in., or 16½-in. is, of course in proportion.

| | | | | |
|---|---|---|---|---|
| A 15-in. spindle should be | | | 6½-in. out of bolster. | |
| A 16-in. | do. | do. | 7½-in. | do. |
| A 16½-in. | do. | do. | 8-in. | do. |

Length and diameter of spindles.—

| | | |
|---|---|---|
| Slubbing ... ... ... | 36-in. | x ¾-in. |
| Intermediate ... ... | 32-in. | x 11/16-in. |
| Roving ... ... ... | 30-in. | x ⅝-in. |
| Mule ... ... ... ... | 16½-in. | x ¼-in. |

If it is required to spin, say 36's weft, on twist mules that have been spinning, say 32's twist, the following alterations must be made:—

1st.—Close up the back and front plates a little, to shorten the bottom and the chase of the cop.

2nd.—Lower the boot-leg, to raise the faller, thus winding higher on the spindle.

3rd.—Turn the shaper rail screw up, by so doing the rail will drop and the faller will rise.

4th.—Change the shaper wheel to take two teeth at once, for the thickness of the cop.

5th.—Alter the back-change wheel to speed the carriage.

6th.—Knock the twist arrangement out of gear.

Whether or not, to turn the spindle bands must depend upon circumstances.

| Wheels for— | 36's weft. | 20's weft. |
|---|---|---|
| Rim | 22in. | 18in. |
| Back change wheel | 48 teeth | 42 teeth |
| Crown wheel | 120 ,, | 120 ,, |
| Back roller wheel | 50 ,, | 32 ,, |
| Wheel on front spindle | 18 ,, | 18 ,, |
| Change pinion | 36 ,, | 44 ,, |
| Shaper wheel | 20 ,, | 10 ,, |
| 30yds. of roving | 60grs. | 60grs. |

Mixing $\frac{2}{3}$ Savannah, and $\frac{1}{3}$ soft waste.

Mule (to doff).—

1. Stop mule when backing off.
2. Fasten under faller down.
3. Put cops up.
4. Wind quadrant chain down to bottom.
5. Turn shaper back.
6. Wind on spindle (stripping thread).
7. Doff.
8. { For twist, turn winding chain up 5 or 6 turns. For weft, nothing—or a very little. }
9. Put mule up to rollers, and then start off again.
10. Paste after 4 or 5 stretches.

At the commencement of a set, when the spindles are bare or empty, great care must be taken to set the copping rail and winding-on chain to their proper places; for if right then, they will regulate themselves afterwards.

It is of great importance to have a thorough and regular system of oiling all the parts of every machine in the mill.

It is a good thing to black lead the "grids" in the scutcher, and the "cages" or under covers, under the cards.

It is well to have stout slubbing spindles, so that when worn, they can be turned down to intermediates; and scutcher beater blades thick, so as to plane when worn.

Trial of 100lbs. of clean, white, fair-stapled Savannah cotton, tried on single revolving flat cards: diameter of cylinder, 45in.; doffer, 22in.; 57 flats to the set; drawing 3 heads; slubbing, roving, and weft mules. Yarn spun 40's, and a good regular thread.

| | o/o |
|---|---|
| Sand | 1·650 |
| Droppings and blow fly | ·775 |
| Card fly | ·625 |
| do. strips cylinder and doffer | 1·175 |
| do. strips flats | 1·800 |
| do. soft waste | ·750 |
| Drawing soft waste | ·700 |
| Roving do | ·250 |
| 1st sweeping | ·045 |
| 2nd do. | ·337 |
| Clearer waste—bits | ·125 |
| Dead loss | 7·043 |
| Roving—delivered | 84·725 |
| | 100 o/o |

| Mules. | o/o |
|---|---|
| Soft waste | 1·125 |
| Clearer waste | ·312 |
| Sweepings | ·8 |
| Hard waste | ·212 |
| Dead loss in mule | ·675 |
| Yarn delivered | 81·6 |
| | 84·724 |

| | o/o |
|---|---|
| Laps delivered from scutchers | 92·7 |
| Roving delivered | 84·7 |
| Yarn delivered | 81·6 |
| Total loss in working | $18\frac{1}{5}$ o/o |

### To Find the Loss per cent. in Waste

Weigh 100lbs. cotton, put it through blowers and carding engine; then weigh what is left, which is the loss % in *weight*, thus:—

No. 1.

| | |
|---|---|
| Raw cotton | 100lbs. |
| Cleaned do. | 88lbs. |
| | 12lbs. loss, or 12 % |

No. 2.

Loss in money—12 %.

```
100lbs. cotton at 6d. per lb.  £2 10  0
 88lbs.    do.    cleaned       2 10  0
  £2 10  0.
    20
   ———
    50
     12
   ———
88)600(6d. 82 per lb. cleaned.
   528
    ———
     720
     704
    ———
      160
     ———
```

No. 3.

```
          100
           12 loss.
           —
           88  :  6d.  : :  100
                  100
                 ———
              88)600(6d. 82.
                 528
                 ———
                  720
                  704
                 ———
                   160
                  ———
```

## CALCULATIONS.

### EQUAL TO ONE-HORSE POWER.

The number of spinning spindles, with and without preparation, equal to one-horse power. Spindles running about 7,000 revolutions per minute.

| Counts of Yarn. | Spindles with Preparation. | Spindles without Preparation. | One-Horse Power. |
|---|---|---|---|
| 10's | 400 | 985 | 1 |
| 20's | 450 | 990 | 1 |
| 30's | 480 | 995 | 1 |
| 40's | 500 | 1000 | 1 |
| 50's | 525 | 1005 | 1 |
| 60's | 540 | 1010 | 1 |
| 70's | 555 | 1015 | 1 |
| 80's | 570 | 1020 | 1 |
| 90's | 580 | 1025 | 1 |
| 100's | 590 | 1030 | 1 |

The universal rule in cotton spinning is that 840yds. in length equal 1 hank, whatever stage or process it may be in, and that 1 hank weighing 1lb. gives the counts to be 1's, or 1 hank in the lb.; therefore from this standard the various counts are all worked out.

There are 7000grs. in 1 pound avoirdupois; 24grs. make 1dwt.; 18dwts. 5½grs. make 1oz.; and 16ozs. make 1 pound avoirdupois. There are 54 inches in 1 thread, 4,320 inches or 80 threads are equal to 1 lea or wrap; 30,240 inches, or 560 threads, or 7 leas equal 1 hank or 840 yards; therefore in wraping cotton yarn, for as many wraps or leas as you weigh, you must take as many thousands for your dividend; the weight of the lea or wrap for your divisor, and the quotient will be the counts of your yarn.

Example—

| | | | | | |
|---|---|---|---|---|---|
| For | 1 lea | take | 1000 | for dividend. |
| ,, | 2 | ,, | 2000 | ,, |
| ,, | 3 | ,, | 3000 | ,, |
| ,, | 4 | ,, | 4000 | ,, |
| ,, | 5 | ,, | 5000 | ,, |
| ,, | 6 | ,, | 6000 | ,, |
| ,, | 7 | ,, | 7000 | ,, |

Divide any of the dividends by the known counts of roving or yarn, &c., and the quotient will be the weight of the length, which you will see opposite to it in the following table.

TABLE OF DIVIDENDS FROM 1 INCH TO 36 INCHES, AND FROM 1 YARD TO 120 YARDS.

| Inches. | Dividends. | Inches. | Dividends. |
|---|---|---|---|
| 1 | ·23148 | 19 | 4·39812 |
| 2 | ·46296 | 20 | 4·62960 |
| 3 | ·69444 | 21 | 4·86108 |
| 4 | ·92592 | 22 | 5·09256 |
| 5 | 1·15740 | 23 | 5·32404 |
| 6 | 1·38888 | 24 | 5·55555 |
| 7 | 1·62036 | 25 | 5·78702 |
| 8 | 1·85184 | 26 | 6·01848 |
| 9 | 2·08332 | 27 | 6·24996 |
| 10 | 2·31480 | 28 | 6·48144 |
| 11 | 2·54628 | 29 | 6·71292 |
| 12 | 2·77777 | 30 | 6·94444 |
| 13 | 3·00924 | 31 | 7·17588 |
| 14 | 3·24072 | 32 | 7·40736 |
| 15 | 3·47240 | 33 | 7·63884 |
| 16 | 3·70368 | 34 | 7·87032 |
| 17 | 3·93516 | 35 | 8·10180 |
| 18 | 4·16666 | 36 | 8·33330 |

| Yards. | Dividends. | Yards. | Dividends. |
|---|---|---|---|
| 1 | 8·3333 | 11 | 91·666 |
| 2 | 16·6666 | 12 | 100· — |
| 3 | 25· — | 15 | 125· — |
| 4 | 33·333 | 20 | 166· — |
| 5 | 41·666 | 30 | 250· — |
| 6 | 50· — | 40 | 333·333 |
| 7 | 58·333 | 60 | 500· |
| 8 | 66·666 | 80 | 666·666 |
| 9 | 75· — | 120 | 1000· — |
| 10 | 83·333 | | |

To find the hank roving or yarn, or the weight of any hank roving or yarn, from 1 inch to 120 yards.

Required the dividend for 10 inches.

| | yds. | grs. | | inches. |
|---|---|---|---|---|
| | 840 : | 7000 | : : | 10 |
| inches in a yard | 36 | 10 | | |
| | 30·240) | 70000(2·314 grains. | | |

If 1 lea of yarn weighs 30gr., what hank will it be?

30)1000

33·33 Hank.

Divide any of the dividends in the preceding tables by any counts of yarn or roving, and the quotient will be the weight of the length opposite to it in the table.

The following is the method of calculating the speeds of all the various shafts throughout the mill :—

Find the revolutions per minute of the first or main shaft, and when this is known, the principle on which to proceed in tracing out the speed per minute of all the other shafts is straightforward. Multiply the speed of the first shaft, wheel, or pulley, by all the driving shafts, wheels or pulleys successively, and divide their product by that of all the driven shafts, wheels, or pulleys, and the quotient will be the speed of the last shaft, wheel, or pulley.

Rule for finding a wheel or pulley necessary to produce a required speed :—

The product of the driven wheels or pulleys, and the required speed, divided by the product of all the driving wheels or pulleys and the speed given, will give the required wheel or pulley to produce the required speed. *Example* :—Suppose the main shaft revolves 50 a minute, and it is required to make the upright shaft revolve 98 a minute, having a wheel of 48 teeth. What wheel must the main shaft have on?

As 50 : 48 : ; 98
98

50)470·4

$94^4/_{50}$ teeth-wheel required.

POWER OF BELTS.

A 20 inch belt is moving at the rate of 2000 feet per minute; with 6 feet of its length in contact with the circumference of a 4 foot drum. What will be its horse power? 20 x 72 = 1440 ÷ 2 = 2000 = 1,440,000 ÷ 36,000 = 40 nominal horse power = 160 IHP.

Example reversed.—

$$\frac{40 \times 36{,}000 \times 2}{2000 \times 72} = \text{20-in. strap.}$$

It is the safest to take 33,000 per horse power.

POWER OF ROPES.

| | | | | |
|---|---|---|---|---|
| 5-in. circumferences | 150-ft. | per minute | = | 1 HP. |
| 6-in. do. | 110 | do. | = | 1 HP. |
| 7-in. do. | 87 | do. | = | 1 HP. |

Example:

Shaft 50 revolutions per minute.

Pulley 10-ft. diameter.

Circumference 32 feet.

32
50

87)1600(18 HP.

A scutcher beater, for nos. ranging from 12 to 50 hank yarn, runs as a rule from 1200 to 1400 revolutions per minute.

A scutcher should draw from 1-in. to 3-ins.

To find the draft of a scutcher, multiply all the drivers and the diameter of the feed rollers for a divisor; then multiply all the driven, and the diameter of the roller that the lap is made on for a dividend; the quotient will be the draft of the machine.

FOR DRAFT OF FINISHER SCUTCHER, WITH LORD'S FEED ATTACHED—

| | | |
|---|---|---|
| Wheel on calender end | 50 driving | 2" |
| ,, stud ......... | 13 | |
| ,, attached to stud .. | 50 driving | |
| ,, on cross shaft...... | 13 | |
| ,, attached to opposite end of do. | 93 | Driving bevils both ends |
| ,, Stud (driving) ... | 27 | Side-shaft mitred. |
| ,, spur stud ......... | 70 driving | |
| ,, on shaft ........... | 44 driving | |
| Shaft pulley ........... | 11-in. | |
| Cone do. ........... | 5-in. | |
| | W. | 9" |
| Wheel on feed end, &c. | 120 | |
| Draft... | 3.03 | |

If 1 yard of lap weighs 14oz.; what hank will it be? 7000 grains per lb. If there are 7000 grains in a lb., how many grains are there in 14oz.?

16 : 14 : : 7000
7000

16)98000

6125 grains in 14oz.
840 yards in a hank.

5145000)7000000

·00136 Hank answer.

To find the counts at the end of any operation, from the raw material to yarn.

Suppose 9 feet of a lap weighs 2lbs; 840yds being 1 hank, weighing 1lb; that multiplied by 3 brings it into feet, and divided by 9 gives 1-280th part of a hank.

140yds.
3 feet

9)2520

280th part of a hank.

The main cylinder of a carding engine is considered to run a medium speed when making from 140 to 150 revolutions per minute. When it exceeds 150 it is likely to prove injurious.

For the card's capacity: Multiply the speed of the delivery roller by its circumference, which will give the inches turned off per minute; multiply this result by 60 (minutes per hour), then by 56½ (hours worked per week), this result by 36 (inches in a yard), multiply this again by the weight of 1 yard of sliver, and the result equals the card's capacity.

To find the number of carding engines required to give a regular supply of cotton to each drawing frame:—

Multiply the inches taken in by the back roller per minute by the number of ends put up; and divide the product by the inches delivered by each carding engine per minute.

To find the Draft of a Carding Engine:—

Multiply the driving wheels on the end of doffer and side shaft together, with the diameter of the feed roller for a divisor; then multiply the driven wheels on the feed roller and side shaft together, with the diameter of the doffer for a dividend.

Example.—

| | | | |
|---|---|---|---|
| Wheel on doffer end | 40 | Wheel on end side shaft | 43 |
| Side shaft pinion ... | 15 | ,, ,, feed roller | 120 |
| Dia. of feed roller ... | 2in. | Dia. of doffer........... | 22in. |

30)2640

88 Draft.

If 5 yards of card sliver weigh 12dwts: what hank will it be?

12dwts.
24grs.
—
288grs. in 12dwts., 41666 is the dividend for 5yds.

288)41666
———
145 Hank.
———

To find the quantity of filletiing required to cover a card cylinder or doffer.

Rule.—Add the thickness of the filleting to the diameter of the cylinder or doffer, which total take for the diameter; then the circumference of the cylinder or doffer, multiplied by its length, and divided by the breadth of the filleting, will give the length required.

Example.—Required the quantity of filleting to cover a cylinder 50 inches diameter, and 40 inches wide; the fillet with the wire ½ inch thick, and two inches broad.

| | |
|---|---|
| 50-in. | 2-in. |
| — | 12 inches in 1 foot. |
| | — |
| 3.1416 | 24 |
| 50 | — |
| ——— | say 157 |
| 157.0800 | 40 |
| | ——— |
| | 24)6280(262 ft. nearly required. |

FOR DRAFT OF A DRAWING FRAME.

Multiply all the drivers and the diameter of the back roller for a divisor; then multiply all the driven and the diameter of the front roller for a dividend; the quotient will be the draft.

The total draft at the drawing frame is found by multiplying the three drafts into each other, as in the following example:

1·25 draft between 3rd and 4th rollers.
1·72 do. 2nd and 3rd do.
———
2·1500
2·7 do. 1st and 2nd do.
———
5·80500 total draft.

If 5 yards of drawing sliver weigh 10 dwts., what hank will it be? If there are 7,000 grains in 840 yds., how many grs. are there in 5 yds? Example:—

840 : 5 :: 7000
7000
———
840)35,000(41·6 grs. in 5 yds.

10 dwts.
24 grs.
———
240 grs. in 10 dwts.
41·6 dividend for 5 yds.
———
240)41·6(·173 hank. Ans.
240
———
1760

$$
\begin{array}{r}
1760 \\
1680 \\
\hline
800 \\
720 \\
\hline
80 \\
\hline
\end{array}
$$

TO FIND THE WEIGHT UPON A DRAWING FRAME BY SADDLE AND LEVER:—

Suppose a lever 10in. long from the fulcrum, with a weight of 8lb. suspended upon it, and $1\frac{1}{4}$ inches on the other side of the fulcrum; what weight will there be upon the rollers?

Rule.—Multiply the length of the lever 10in. by the 8lbs. weight, and divide by $1\frac{1}{4}$ inches, and the result will be the weight upon the rollers.

Example:—

$$
\begin{array}{r}
10\text{in.} \\
8\text{lbs.} \\
\hline
1{\cdot}25)80{\cdot}00 \\
\hline
64\text{lbs. Answer} \\
\hline
\end{array}
$$

TO FIND THE TWIST WHEEL IN CHANGING FROM ONE HANK TO ANOTHER.

In changing to a finer roving, a smaller twist wheel is required, because it will drive the front roller slower, therefore the roving is not delivered as quick from the front roller, and the spindle (which always runs at one speed) is enabled to put more twist in. In changing to a coarser hank roving it is *vice versa*. A coarser roving does not require the same quantity of twist as a finer roving, if produced from the same quality of cotton; hence the better the quality of cotton, the less twist is required.

Suppose you are making a 3-hank roving, with a 30 twist wheel, and change to 5 hank; what twist wheel is required?

Rule.—Square the present twist wheel, then multiply the result by the present hank rove, and divide by the future hank rove; extract the square root of the quotient, and you get the twist wheel required.

Example.— 30 present twist wheel.
30
——
900 squared.
3 present hank.
——
Future hank 5)2700
——
540 540($23\frac{1}{4}$ twist wheel required.
4
——
43)140
129
——
11

To find the rack wheel in changing from one hank to another.

In changing to a finer roving a larger rack-wheel is required, in order to make the shift less, when the lifter changes to go up or down. In changing to a coarser roving it is *vice-versa.*

Example.—A slubbing is making a 1 hank slub, with a 20 rack wheel. What wheel is required to change to $1\frac{1}{2}$ hank slub. Square the rack wheel on, then multiply by the hank slub required, divide by the present hank slub, extract the square root of the quotient, and the result is the wheel required.

```
                    20 present rack wheel
                    20
                   ———
                   400 squared.
                     1½ hank slub required
                   ———
present hank = 1)600
                   ———
                   600
                       600(24·4 or say 24½ = rack wheel
                       4             required.
                      ———
                    44)200
                       176
                      ————
                   484)2400
                       1936
                       ————
                        464
                       ————
```

HOW TO FIND THE TWIST NECESSARY PER INCH FOR ROVING OR YARN.

Rule.—The number of revolutions the spindle makes for the front roller 1, divided by the circumference of the front roller, will give the number of turns per inch of yarn delivered.

TO FIND THE NUMBER OF REVOLUTIONS OF THE SPINDLE, FOR ONE REVOLUTION OF THE FRONT ROLLER AT THE ROVING FRAME.

Example.—

Revolutions front roller, 96; revolutions of spindle, 864.

96)864(9. Answer.
864

EXAMPLE FOR TWIST PER INCH.

| | | | |
|---|---|---|---|
| Twist wheel ... | 43 | Top shaft wheel... | 45 |
| Wheel on end of top shaft......... | 68 | Wheel on end of front roller ... | 96 |
| Spindle wheel ...... | 24 | Wheel on spindle shaft ............ | 48 |
| Diameter of front roller ........... | $1\frac{1}{4}$in. | Circumference of front roller ... | 3·927 |

43
68
————
2924
24
————
70176

45
96
————
4320
48
————
207360

70176)207360(2954

3927)29540(·752 twist per inch. Ans.

EXAMPLE FOR SPEED OF BOBBIN—FLYER LEADING.

| | | | |
|---|---|---|---|
| Revs. frame shaft | 254 | Top shaft wheel ... | 45 |
| Twist wheel ...... | 44 | Dia. bottom cone .. | 2in. |
| | 11176 | | 135 |
| Dia. top cone ... | 6in. | Bevil bottom of upright | 48 |
| | 67056 | | 6480 |
| Cone drum bevil. | 26 | Sun wheel......... | 120 |
| | 1743456 | | 777600 |
| Bevil top of upright | 20 | | |
| | 34869120 | | |

Driven. Drivers.
777600)34869120(45 revs.
2
90 doubled.

254 revs. frame shaft.
90 revs. of wheel doubled.

164
48

24)7872(328 speed of bobbin at starting.

FOR THE SPEED OF THE BOBBIN IN THE SLUBBING, INTERMEDIATE OR ROVING FRAME.

The circumference of the bobbin, multiplied by the twist per inch, gives the twist in one revolution of the bobbin, (that is, the whole twist put in the length wrapped on, after one revolution of the bobbin, at of course whatever diameter), which divided into the speed of the spindle per minute, gives the difference in the speed between the bobbin and the spindle. If the flyer leads, subtract the product from the speed of the spindle, and you get the speed of the bobbin. If the bobbin leads, add the product to the speed of the spindle, and you get the speed of the bobbin.

Example.—If the tubes be 1·1875-in. diameter what will be their revolutions per minute? The diameter of the tubes 1·1875 x 3·1416 = 3·73065 x 2·4 = 8·95356 twist for 1 revolution of the bare tubes. Then 750 revolutions of spindles ÷ 8·95356 = 83·7655 the difference of speed between the empty tubes and the spindles. Then the speed of the spindles being 750 — 83·7655 = 666·2345, the revolutions per minute of the empty tnbes.

To find the weight of any given length of roving or yarn.

Rule.—As 840 yards is to 7000 grains, so is any number of yards to the weight of that number of yards wrapped.

Example.—840yds. : 7000grs. : : 60yds.

$$\begin{array}{r} 60 \\ \hline 840)420000 \\ \hline 500\text{grs.} \end{array}$$

If 30yds. of roving wrap 50grs., what hank is it?

```
30  :  840  : :  50
            50
        --------
     30)42000
        --------
        1400)7000(5 Hank.
             7000
             ----

Again:      5·0)25·0
                ---
                 5
                ---
```

If you weigh 30yds. of roving, and reduce its weight to grains, and divide them into the 250grs, the quotient will be the hank roving.

30yds are $\frac{1}{4}$ of a lea, or $^1/_{28}$ of a hank, therefore by taking $^1/_{28}$ part of a ℔; or of 7000grs, we get 250grs, and this number being divided by whatever number of grains, 30yds. wrap, will give the hank roving or counts.

Suppose 30yds. wrap $62\frac{1}{2}$grs., it must be divided into 250, the standard for 30yds.; and we get a 4 hank roving in the pound.

Example.—

```
625)250·0(4 hank roving in the pound.
    250·0
    -----
```

## THE THROSTLE.

To FIND A TWIST-WHEEL IN CHANGING FROM ONE COUNTS TO ANOTHER.

Rule.—Square the present twist-wheel, multiply this result by the counts spinning, and divide by the counts going to spin. Extract the square root of the quotient, and the result will be the twist-wheel required.

Example.—

```
                         40 twist wheel on.
                         40
                        ———
                        1600
                          34  counts spinning.
                        ————
                        6400
                       4800
                       —————
Counts going to     30)54400
      spin             —————
                       1813(44 or nearly 45 twist-wheel
                       16            required for 30's.
                       —
                    44)213
                        176
                        ———
                         37
                         —
```

### To find the twist per inch at the throstle.

Suppose a throstle frame to be spinning 18's hard twist, with a 40 tin roller wheel, and a 44 twist wheel, the carrier wheel being 138, and the front roller wheel 86, and the diameter of the tin roller $8\frac{1}{2}$ inches, and the front roller 1 inch.

Rule.—Multiply the tin roller wheel and the twist wheel together for a divisor; then multiply the carrier wheel, and the front roller wheel, and the diameter of the tin roller together for a dividend; and the quotient of this, divided by the circumference of the front roller, will give the turns per inch required.

Example.—

| | |
|---|---|
| 40 tin roller wheel. | 138 top carrier wheel. |
| 44 twist wheel. | 86 front roller wheel. |
| 1760 | 11868 |
| | $8\frac{1}{2}$in. dia. tin roller. |

1760)100878(57·3

3·14)57·3(18·24 required number of turns.

### To find the twist per inch on the yarn at the throstle, say Nos. 34's.

Rule.—For the divisor, the product of the revolutions of the front roller and its circumference; for the dividend, the revolutions of the spindle per minute. The quotient will be the twist per inch.

Example:—

66 revs. front roller.
$3\frac{1}{8}$ circumference do.

198
8 revs. sp.

206)5000(24 turns per inch.
412

880
824

To find a change pinion in changing from one counts to another.

Rule.—Multiply the number of teeth in the present pinion by the counts of yarn spinning, and divide by the counts going to spin.

Example:

34's counts spinning.
30 present pinion.

counts going to spin 32's)1020($31\frac{3}{4}$ pinion required.

If 34's requires 22 turns per inch, what will 24's require?

Less twist required as you go coarser.
More ,, ,, ,, finer.

As 34's : 24's : : 22
22

484
24

34)11616)342(18 turns per in. required,
1

28)242
224

18

HOW TO CHANGE FROM ONE NUMBER OF HANKS TO ANOTHER, WHEN THE CHANGE WHEEL AND HANK ROVING REQUIRE TO BE ALTERED.

Suppose a throstle is spinning 40's twist from a 5 hank roving, with a 40 change pinion, and you are required to alter and produce 50's twist from an 8 hank roving: what change wheel is required?

Rule.—The product of the hank rove given and nos. required for a divisor; then the product of the hank rove required and the nos. given for a dividend. The quotient will be the pinion required.

Example :— 40's No. of hank.
8 hank rove

320
40 change wheel.

50 x 5 = 250)12800(51·2 change wheel required.

To find the speed of the spindle.

Multiply the speed of the tin roller by its circumference, and divide this result by the diameter of the wharve.

Hanks of any number divided by that number equals weight.

Lbs. of any number, multiplied by that number equals hanks.

To get the number of hanks in one warp, multiply the number of ends by the yards in the warp; then divide the summary of that, by the number of yards in one hank (840). The quotient will be the number of hanks in the warp. This result divided by the counts will give the weight.

To find what change pinion to put on so as to change the present nos. of yarn to any other nos.

Rule.—Multiply the number of teeth in the present pinion by the counts of yarn spinning, and divide the product by the counts of yarn going to spin.

Example:—

30 present pinion.
34's counts spinning.

counts going to spin 30's)1020

34 Pinion required.

To find a back change wheel, in changing from one counts to another, when spinning weft.

Rule.—Square the present back change wheel, and multiply this result by the counts going to spin, and divide by the counts spinning. Extract the square root of the quotient, and the result will be the back change wheel required.

Example :—

```
                    52 back change wheel on.
                    52
                   ----
                   2704
                       40's counts going to spin
                   ------
counts spinning 36's)108160
                   ------
                    3004
                    25   (54¾ back change wheel
                  ----           required.
                104)504
                    416
                    ---
                     88
                    ---
```

RULE FOR FINDING TWIST WHEEL.

Multiply the length of the stretch by the turns per inch required, and divide by the revolutions of the spindle for one of the rim.

Example.—

```
                    66in. length of stretch.
                    22 turns per inch required.
                    ——
                   132
                  132
                  ———
revs. of spindle for 15)1452(97   Answer.
       1 of rim.        135
                        ———
                         102
                         105
                         ———
```

RULE FOR FINDING TWIST PER INCH.

Multiply the revs. of the rim shaft per stretch by the revs. of the spindles, for one rev. of the rim, and divide by the length of the stretch.

Example.—

Spinning 34's twist out of pernams.

```
                     ——
                     20in. dia. of rim.
                      6in. dia. of tin roller.
                     ———
Tin roller pulley 10in.)120
                     ———
                      12
                      16
                     ———
                  13)192
                     ———
                     14·8 revns. of spindle for 1
                     ——        revn. of rim.
```

Twist or worm wheel 50
40 drives twist finger.

On same stud as 20)2000
twist wheel
100 revns. of rim shaft per stretch.

100
14·8

Stretch 66in)14800(22·4 turns per inch.

To find the turns.

Multiply the worm wheel by the cam shaft wheel, and divide by the change wheel.

To find the revolutions of the spindle for one revolution of the rim.

Multiply the diameter of the rim band pulley, by the diameter of the wharve, for a divisor; then the diameter of the rim by the twist pulley for a dividend.

To find the revolutions of the spindles per inch.

Multiply the turns by the revolutions of the spindles for one of the rim; and divide by the number of inches put up.

For the speed of the front roller.

Revolutions of rim shaft, 610, multiplied by the rim pinion 27 teeth, which pinion drives the back change wheel of 48 teeth; on the other end of the same shaft is a bevel of 14 teeth, driving the front roller bevil of 30 teeth.

FOR SPEED OF RIM SHAFT.

Speed of line shaft, drum on do., pulley on counter shaft, drum on do., and the pulley on the rim shaft.

FOR SPEED OF SPINDLE.

Revolutions of rim shaft, tin roller pulley, tin roller, and spindle wharve.

FOR THE SPEED OF THE BACK SHAFT.

Speed of front spindle, wheel on do., driving a 92, on same stud a wheel of 44 teeth, driving catchbox wheel on back shaft.

FOR SPEED OF TAKING-IN SCROLL.

Speed of rim shaft, wheel on loose pulley of 22 teeth, driving wheel on line shaft of 51 teeth; on other end of same shaft a bevil of 19 teeth, driving bevil on top of taking-in friction, on the bottom of the same shaft is another bevil, driving the bevil on the scroll shaft.

HOW TO ASCERTAIN WHAT LENGTH OF YARN WILL BE PRODUCED FROM 1 YARD OF A COTTON LAP.

Suppose the draft of a carding engine to be 80, and the card box drawing from 1 to $1\frac{1}{2}$ inches, and the 1st, 2nd, 3rd, heads of drawing, each respectively having a a draft of 6; the slubber 5; the intermediate 5; and the roving 5; and the mule $6\frac{1}{2}$. The number of ends put up at each head of drawing, 6; at the slubbing, 1; intermediate and roving, 2 each; and at the mule 1: What will be the length of yarn delivered?

Rule.—The product of the drafts, divided by the product of the doublings, will give the length of yarn at the last process.

What length is there on 60lbs of 30's?

840 yds. in 1 hank.
30's

---

25,200
60lbs.

---

1,512,000yds. in 60lbs. of 30's

---

## THE ROVING FRAME.

First.—Find the diameter of one ply of roving.

Second.—The diameter and circumference of empty bobbin.

Third.—Of every different layer of roving wound on from commencement to finish.

### To find the diameter of one ply of roving.

Divide the difference between the empty and full bobbins, by the number of layers, which will be the diameter of one layer, one half of which will be the diameter of one ply, for there are two plies in each layer.

Having found the diameter and circumference of the bobbin at the different layers, now find how many revolutions of an empty bobbin will be required to take up a given length of roving, say 100 inches; and also the revolutions of spindles and cone-shaft for the same. Then substract the revolutions of the bobbins required, from the revolutions of the spindle. Multiply this result by the diameter of the bobbin pulley, and divide by the revolutions of the cone-drum shaft. The result will be the diameter of the cone required.

To find the revolutions of an empty bobbin required to take up 100 inches of roving.

Divide the given length of roving by the circumference of bobbin.

To find the revolutions of spindle for 100 inches of roving.

Multiply the given length of roving by the twist per inch.

To find the revolutions of cone-drum shaft for 100 inches of roving.

Multiply the revolutions of the cone-shaft per minute (say 210) by revolutions of spindle per 100 inches of roving (say 155), and divide by revolutions of spindle per minute (say 600).

To find the diameter and circumference of a circle—the one from the other.

Multiply the diameter by 3·1416, and the product will be the circumference.

Divide the circumference by 3·1416, and the product will be the diameter.

To FIND THE AREA OF A CIRCLE.

Multiply half the circumference by half the diameter, or multiply the square of the diameter by ·7854, and the result of either will be the area.

| Circumference. | | Area. | Squares. | |
|---|---|---|---|---|
| Area. | Circum. | Square. | Dia. | Cube. |
| ·7854 | 3·1416 | 1· | 1· | 1· |
| 3·1416 | 6·2832 | 4· | 2· | 8· |
| 7·0686 | 9·4248 | 9· | 3· | 27· |
| 12·5664 | 12·5664 | 16· | 4· | 64· |
| 19·6350 | 15·7080 | 25· | 5· | 125· |
| 28·2744 | 18 8496 | 36· | 6· | 216· |
| 38·4846 | 21·9912 | 49· | 7· | 343· |
| 50·2656 | 25·1328 | 64· | 8· | 512· |
| 63·6174 | 28·2744 | 81· | 9· | 729· |
| 78·5400 | 31·4160 | 100· | 10· | 1,000· |
| 95·0334 | 34·5576 | 121· | 11· | 1,331· |
| 113·0976 | 37·6992 | 144· | 12· | 1,728· |
| 132·7236 | 40·8408 | 169· | 13· | 2,197· |
| 153·9384 | 43·9824 | 196· | 14· | 2,744· |
| 176·7150 | 47·1240 | 225· | 15· | 3,375· |
| 201·0624 | 50·2656 | 256· | 16· | 4,096· |
| 226·9086 | 53·4072 | 289· | 17· | 4,913· |
| 254·4696 | 56·5488 | 324· | 18· | 5,832· |
| 283·5294 | 59·6904 | 361· | 19· | 6,859· |
| 314·1600 | 62·8320 | 400· | 20· | 8,000· |

Extract the square root of 1234567890.

Example:—

```
  1234567890(35·136, square root.
  9
  ———
65)334
   325
  ————
701)956
     701
    ————
7023)25578
      21069
     —————
70266)450990
       421596
       ——————
       29,394
```

## WRAP TABLES.

### Wrap Table for 15 Yards.

From ·5 Hanks to 5 Hanks.

| Hank. | Dwts. | Grains. | Hank. | Dwts. | Grains. |
|---|---|---|---|---|---|
| ·5 | 10 | 10 | ·63 | 8 | 6·41 |
| ·51 | 10 | 5·09 | ·64 | 8 | 3·31 |
| ·52 | 10 | 0·38 | ·65 | 8 | 0·3 |
| ·53 | 9 | 19·84 | ·66 | 7 | 21·39 |
| ·54 | 9 | 15·48 | ·67 | 7 | 18·56 |
| ·55 | 9 | 11·27 | ·68 | 7 | 15·82 |
| ·56 | 9 | 7·21 | ·69 | 7 | 13·15 |
| ·57 | 9 | 3·29 | ·70 | 7 | 10·57 |
| ·58 | 8 | 23·51 | ·71 | 7 | 8·05 |
| ·59 | 8 | 19·86 | ·72 | 7 | 5·61 |
| ·60 | 8 | 16·33 | ·73 | 7 | 3·23 |
| ·61 | 8 | 12·91 | ·74 | 7 | 0·91 |
| ·62 | 8 | 9·61 | ·75 | 6 | 22·66 |

| Hank. | Dwts. | Grains. | Hank. | Dwts. | Grains. |
|---|---|---|---|---|---|
| ·76 | 6 | 20·47 | 2·1 | 2 | 11·52 |
| ·77 | 6 | 18·33 | 2·2 | 2 | 8·18 |
| ·78 | 6 | 16·25 | 2·25 | 2 | 7·55 |
| ·79 | 6 | 14·22 | 2·3 | 2 | 6·34 |
| ·80 | 6 | 12·25 | 2·4 | 2 | 4·18 |
| ·81 | 6 | 10·32 | 2·5 | 2 | 2· |
| ·82 | 6 | 8·43 | 2·6 | 2 | 0·7 |
| ·83 | 6 | 6·6 | 2·7 | 1 | 22·29 |
| ·84 | 6 | 4.8 | 2·75 | 1 | 21·45 |
| ·85 | 6 | 3·05 | 2·8 | 1 | 20·64 |
| ·86 | 6 | 1·34 | 2·9 | 1 | 19·1 |
| ·87 | 5 | 23·67 | 3· | 1 | 17·66 |
| ·88 | 5 | 22·04 | 3·1 | 1 | 16·32 |
| ·89 | 5 | 20·44 | 3·2 | 1 | 15·06 |
| ·90 | 5 | 18·88 | 3·25 | 1 | 14·46 |
| ·91 | 5 | 17·36 | 3·3 | 1 | 13·87 |
| ·92 | 5 | 15·86 | 3·4 | 1 | 12·76 |
| ·93 | 5 | 14·4 | 3·5 | 1 | 11·71 |
| ·94 | 5 | 12·97 | 3·6 | 1 | 10·72 |
| ·95 | 5 | 11·57 | 3·7 | 1 | 9·78 |
| ·96 | 5 | 10·2 | 3·75 | 1 | 9·33 |
| ·97 | 5 | 8·86 | 3·8 | 1 | 8·89 |
| ·98 | 5 | 7·55 | 3·9 | 1 | 8·05 |
| ·99 | 5 | 6·26 | 4· | 1 | 7·25 |
| 1· | 5 | 5· | 4·1 | 1 | 6·48 |
| 1·1 | 4 | 17·63 | 4·2 | 1 | 5·76 |
| 1·2 | 4 | 8·16 | 4·25 | 1 | 5·41 |
| 1·25 | 4 | 4· | 4·3 | 1 | 5·06 |
| 1·3 | 4 | 0·15 | 4·4 | 1 | 4·4 |
| 1·4 | 3 | 17·28 | 4·5 | 1 | 3·77 |
| 1·5 | 3 | 11·33 | 4·6 | 1 | 3·17 |
| 1·6 | 3 | 6·12 | 4·7 | 1 | 2·59 |
| 1·7 | 3 | 1·52 | 4·75 | 1 | 2·31 |
| 1·75 | 2 | 23·42 | 4·8 | 1 | 2·04 |
| 1·8 | 2 | 21·44 | 4·9 | 1 | 1·51 |
| 1·9 | 2 | 17·78 | 5· | 1 | 1· |
| 2· | 2 | 14·5 | | | |

## WRAP TABLE FOR 30 YARDS.

### From 1 Hank to 10 Hanks.

| Hank. | Dwts. | Grains. | Hank. | Dwts. | Grains. |
|---|---|---|---|---|---|
| 1· | 10 | 10· | 3·75 | 2 | 18·66 |
| 1·1 | 9 | 11·20 | 3·8 | 2 | 17·78 |
| 1·2 | 8 | 16·33 | 3·9 | 2 | 16·1 |
| 1·25 | 8 | 8· | 4· | 2 | 14·5 |
| 1·3 | 8 | 0·3 | 4·1 | 2 | 12·97 |
| 1·4 | 7 | 10·57 | 4·2 | 2 | 11·52 |
| 1·5 | 6 | 22·66 | 4·25 | 2 | 10·82 |
| 1·6 | 6 | 12·25 | 4·3 | 2 | 10·13 |
| 1·7 | 6 | 3·05 | 4·4 | 2 | 8·81 |
| 1·75 | 5 | 22·85 | 4·5 | 2 | 7·55 |
| 1·8 | 5 | 18·88 | 4·6 | 2 | 6·34 |
| 1·9 | 5 | 11·57 | 4·7 | 2 | 5·19 |
| 2· | 5 | 5· | 4·75 | 2 | 4·63 |
| 2·1 | 4 | 23·04 | 4·8 | 2 | 4·08 |
| 2·2 | 4 | 17·63 | 4·9 | 2 | 3·02 |
| 2·25 | 4 | 15·11 | 5· | 2 | 2· |
| 2·3 | 4 | 12·69 | 5·1 | 2 | 1·01 |
| 2·4 | 4 | 8·16 | 5·2 | 2 | 0·07 |
| 2·5 | 4 | 4·0 | 5·25 | 1 | 23.61 |
| 2·6 | 4 | 0·15 | 5·3 | 1 | 23·16 |
| 2·7 | 3 | 20·59 | 5·4 | 1 | 22·29 |
| 2·75 | 3 | 18·9 | 5·5 | 1 | 21·45 |
| 2·8 | 3 | 17·28 | 5·6 | 1 | 20·64 |
| 2·9 | 3 | 14·2 | 5·7 | 1 | 19·85 |
| 3· | 3 | 11·33 | 5·75 | 1 | 19·47 |
| 3·1 | 3 | 8·64 | 5·8 | 1 | 19·10 |
| 3·2 | 3 | 6·12 | 5·9 | 1 | 18·37 |
| 3·25 | 3 | 4·92 | 6· | 1 | 17·66 |
| 3·3 | 3 | 3·75 | 6·1 | 1 | 16·98 |
| 3·4 | 3 | 1·52 | 6·2 | 1 | 16·32 |
| 3·5 | 2 | 23·42 | 6·25 | 1 | 16· |
| 3·6 | 2 | 21·44 | 6·3 | 1 | 15·68 |
| 3·7 | 2 | 19·56 | 6·4 | 1 | 15·06 |

| Hank. | Dwts. | Grains. | Hank. | Dwts. | Grains. |
|---|---|---|---|---|---|
| 6·5 | 1 | 14·46 | 8·3 | 1 | 6·12 |
| 6·6 | 1 | 13·87 | 8·4 | 1 | 5·76 |
| 6·7 | 1 | 13·81 | 8·5 | 1 | 5·41 |
| 6·75 | 1 | 13·03 | 8·6 | 1 | 5·06 |
| 6·8 | 1 | 12·76 | 8·7 | 1 | 4·73 |
| 6·9 | 1 | 12·23 | 8·75 | 1 | 4·57 |
| 7· | 1 | 11·71 | 8·8 | 1 | 4·4 |
| 7·1 | 1 | 11·21 | 8·9 | 1 | 4·08 |
| 7·2 | 1 | 10·72 | 9· | 1 | 3·77 |
| 7·25 | 1 | 10·48 | 9·1 | 1 | 3·47 |
| 7·3 | 1 | 10·24 | 9·2 | 1 | 3·17 |
| 7·4 | 1 | 9·78 | 9·25 | 1 | 3·02 |
| 7·5 | 1 | 9·33 | 9·3 | 1 | 2·88 |
| 7·6 | 1 | 8·89 | 9·4 | 1 | 2·59 |
| 7·7 | 1 | 8·46 | 9·5 | 1 | 2·31 |
| 7·75 | 1 | 8·25 | 9·6 | 1 | 2·04 |
| 7·8 | 1 | 8·05 | 9·7 | 1 | 1·77 |
| 7·9 | 1 | 7·64 | 9·75 | 1 | 1·64 |
| 8· | 1 | 7·25 | 9·8 | 1 | 1·51 |
| 8·1 | 1 | 6·86 | 9·9 | 1 | 1·25 |
| 8·2 | 1 | 6·48 | 10· | 1 | 1· |
| 8·25 | 1 | 6·3 | | | |

## WRAP TABLE FOR 60 YARDS.

From 5 Hanks to 15 Hanks.

| Hanks. | Dwts. | Grains. | Hanks. | Dwts. | Grains. |
|---|---|---|---|---|---|
| 5· | 4 | 4· | 7·75 | 2 | 16·51 |
| 5·1 | 4 | 2·03 | 7·8 | 2 | 16·1 |
| 5·2 | 4 | 0·15 | 7·9 | 2 | 15·29 |
| 5·25 | 3 | 23·23 | 8· | 2 | 14·5 |
| 5·3 | 3 | 22·33 | 8·1 | 2 | 13·72 |
| 5·4 | 3 | 20·59 | 8·2 | 2 | 12·97 |
| 5·5 | 3 | 18·9 | 8·25 | 2 | 12·6 |
| 5·6 | 3 | 17·28 | 8·3 | 2 | 12·24 |
| 5·7 | 3 | 15·71 | 8·4 | 2 | 11·52 |
| 5·75 | 3 | 14·95 | 8·5 | 2 | 10·82 |
| 5·8 | 3 | 14·2 | 8·6 | 2 | 10·13 |
| 5·9 | 3 | 12·74 | 8·7 | 2 | 9·47 |
| 6· | 3 | 11·33 | 8·75 | 2 | 9·14 |
| 6·1 | 3 | 9·96 | 8·8 | 2 | 8·81 |
| 6·2 | 3 | 8·64 | 8·9 | 2 | 8·17 |
| 6·25 | 3 | 8· | 9· | 2 | 7·55 |
| 6·3 | 3 | 7·36 | 9·1 | 2 | 6·94 |
| 6·4 | 3 | 6·12 | 9·2 | 2 | 6·34 |
| 6·5 | 3 | 4·92 | 9·25 | 2 | 6·05 |
| 6·6 | 3 | 3·75 | 9·3 | 2 | 5·76 |
| 6·7 | 3 | 2·62 | 9·4 | 2 | 5·19 |
| 6·75 | 3 | 2·07 | 9·5 | 2 | 4·63 |
| 6·8 | 3 | 1·52 | 9·6 | 2 | 4·08 |
| 6·9 | 3 | 0·46 | 9·7 | 2 | 3·54 |
| 7· | 2 | 23·42 | 9·75 | 2 | 3·28 |
| 7·1 | 2 | 22·42 | 9·8 | 2 | 3·02 |
| 7·2 | 2 | 21·44 | 9·9 | 2 | 2·5 |
| 7·25 | 2 | 20·96 | 10· | 2 | 2· |
| 7·3 | 2 | 20·40 | 10·1 | 2 | 1·5 |
| 7·4 | 2 | 19·56 | 10·2 | 2 | 1·01 |
| 7·5 | 2 | 18·66 | 10.25 | 2 | 0·78 |
| 7·6 | 2 | 17·78 | 10·3 | 2 | 0·54 |
| 7·7 | 2 | 16·93 | 10·4 | 2 | 0·07 |

| Hanks. | Dwts. | Grains. | Hanks. | Dwts. | Grains. |
|---|---|---|---|---|---|
| 10·5 | 1 | 23·61 | 12·8 | 1 | 15·06 |
| 10·6 | 1 | 23·16 | 12·9 | 1 | 14·75 |
| 10·7 | 1 | 22·72 | 13·0 | 1 | 14·46 |
| 10·75 | 1 | 22·51 | 13·1 | 1 | 14·16 |
| 10·8 | 1 | 22·29 | 13·2 | 1 | 13·87 |
| 10·9 | 1 | 21·87 | 13·25 | 1 | 13·73 |
| 11· | 1 | 21·45 | 13·3 | 1 | 13·59 |
| 11·1 | 1 | 21·04 | 13·4 | 1 | 13·31 |
| 11·2 | 1 | 20·64 | 13·5 | 1 | 13·03 |
| 11·25 | 1 | 20·44 | 13·6 | 1 | 12·76 |
| 11·3 | 1 | 20·24 | 13·7 | 1 | 12·49 |
| 11·4 | 1 | 19·85 | 13·75 | 1 | 12·36 |
| 11·5 | 1 | 19·47 | 13·8 | 1 | 12·23 |
| 11·6 | 1 | 19·1 | 13·9 | 1 | 11·97 |
| 11·7 | 1 | 18·73 | 14· | 1 | 11·71 |
| 11·75 | 1 | 18·55 | 14·1 | 1 | 11·46 |
| 11·8 | 1 | 18·37 | 14·2 | 1 | 11·21 |
| 11·9 | 1 | 18·01 | 14·25 | 1 | 11·08 |
| 12· | 1 | 17·66 | 14·3 | 1 | 10·96 |
| 12·1 | 1 | 17·32 | 14·4 | 1 | 10·72 |
| 12·2 | 1 | 16·98 | 14·5 | 1 | 10·48 |
| 12·25 | 1 | 16·81 | 14·6 | 1 | 10·24 |
| 15·3 | 1 | 16·65 | 14·7 | 1 | 10·01 |
| 12·4 | 1 | 16·31 | 14·75 | 1 | 9·89 |
| 12·5 | 1 | 16· | 14·8 | 1 | 9·78 |
| 12·6 | 1 | 15·68 | 14·9 | 1 | 9·55 |
| 12·7 | 1 | 15·37 | 15·0 | 1 | 9·33 |
| 12·75 | 1 | 15·21 | | | |

## WRAPPING TABLE FOR YARN.

From 1 to 60 Hanks in the pound.

The ounces are avoirdupois, and the pennyweights and grains are troy weight.

| Counts | 1 Lea. | | | 2 Leas. | | | 3 Leas. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Ozs. | Dwt | Grains | Ozs. | Dwt | Grains | Ozs. | Dwt | Grains |
| 1 | 2 | 5 | 5·00 | 4½ | 1 | 7·25 | 6½ | 6 | 12·25 |
| 2 | 1 | 2 | 14·50 | 2 | 5 | 5·00 | 3 | 7 | 19·50 |
| 3 | ½ | 4 | 18·58 | 1½ | ... | 10·41 | 2 | 5 | 5·00 |
| 4 | ½ | 1 | 7·25 | 1 | 2 | 14·50 | 1½ | 3 | 21·15 |
| 5 | ... | 8 | 8·00 | ½ | 7 | 13·25 | 1 | 6 | 18·50 |
| 6 | ... | 6 | 22·66 | ½ | 4 | 18·58 | 1 | 2 | 14·50 |
| 7 | ... | 5 | 22·85 | ½ | 2 | 18·96 | ½ | 8 | 17·82 |
| 8 | ... | 5 | 5·00 | ½ | 1 | 7·25 | ½ | 6 | 12·25 |
| 9 | ... | 4 | 15·11 | ½ | ... | 3·47 | ½ | 4 | 18·58 |
| 10 | ... | 4 | 4·00 | ... | 8 | 8·00 | ½ | 3 | 9·25 |
| 11 | ... | 3 | 18·90 | ... | 7 | 13·81 | ½ | 2 | 5·97 |
| 12 | ... | 3 | 11·33 | ... | 6 | 22·66 | ½ | 1 | 7·25 |
| 13 | ... | 3 | 4·92 | ... | 6 | 9·84 | ½ | ... | 12·01 |
| 14 | ... | 2 | 23·42 | ... | 5 | 22·85 | ... | 8 | 22·28 |
| 15 | ... | 2 | 18·66 | ... | 5 | 13·33 | ... | 8 | 8·00 |
| 16 | ... | 2 | 14·50 | ... | 5 | 5·00 | ... | 7 | 19·50 |
| 17 | ... | 2 | 10·82 | ... | 4 | 21·64 | ... | 7 | 8·47 |
| 18 | ... | 2 | 7·55 | ... | 4 | 15·11 | ... | 6 | 22·66 |
| 19 | ... | 2 | 4·63 | ... | 4 | 9·26 | ... | 6 | 13·89 |
| 20 | ... | 2 | 2·00 | ... | 4 | 4·00 | ... | 6 | 6·00 |
| 21 | ... | 1 | 23·61 | ... | 3 | 23·23 | ... | 5 | 22·85 |
| 22 | ... | 1 | 21·45 | ... | 3 | 18·90 | ... | 5 | 16·36 |
| 23 | ... | 1 | 19·47 | ... | 3 | 14·95 | ... | 5 | 10·43 |
| 24 | ... | 1 | 17·66 | ... | 3 | 11·33 | ... | 5 | 5·00 |
| 25 | ... | 1 | 16·00 | ... | 3 | 8·00 | ... | 5 | 0·00 |
| 26 | ... | 1 | 14·46 | ... | 3 | 4·92 | ... | 4 | 19·38 |

| Counts | 1 Lea. | | | 2 Leas. | | | 3 Leas. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Ozs. | Dwt | Grains | Ozs. | Dwt | Grains | Ozs. | Dwt | Grains |
| 27 | ... | 1 | 13·03 | ... | 3 | 2·07 | ... | 4 | 15·11 |
| 28 | ... | 1 | 11·71 | ... | 2 | 23·42 | ... | 4 | 11·14 |
| 29 | ... | 1 | 10·48 | ... | 2 | 20·96 | ... | 4 | 7·44 |
| 30 | ... | 1 | 9·33 | ... | 2 | 18·66 | ... | 4 | 4·00 |
| 31 | ... | 1 | 8·25 | ... | 2 | 16·51 | ... | 4 | 0·77 |
| 32 | ... | 1 | 7·25 | ... | 2 | 14·50 | ... | 3 | 21·75 |
| 33 | ... | 1 | 6·30 | ... | 2 | 12·60 | ... | 3 | 18·90 |
| 34 | ... | 1 | 5·41 | ... | 2 | 10·82 | ... | 3 | 16·23 |
| 35 | ... | 1 | 4·57 | ... | 2 | 9·14 | ... | 3 | 13·71 |
| 36 | ... | 1 | 3·77 | ... | 2 | 7·55 | ... | 3 | 11·33 |
| 37 | ... | 1 | 3·02 | ... | 2 | 6·05 | ... | 3 | 9·08 |
| 38 | ... | 1 | 2·31 | ... | 2 | 4·63 | ... | 3 | 6·94 |
| 39 | ... | 1 | 1·64 | ... | 2 | 3·28 | ... | 3 | 4·92 |
| 40 | ... | 1 | 1·00 | ... | 2 | 2·00 | ... | 3 | 3·00 |
| 41 | ... | 1 | 0·39 | ... | 2 | 0·78 | ... | 3 | 1·17 |
| 42 | ... | ... | 23·80 | ... | 1 | 23·61 | ... | 2 | 23·42 |
| 43 | ... | ... | 23·25 | ... | 1 | 22·51 | ... | 2 | 21·76 |
| 44 | ... | ... | 22·72 | ... | 1 | 21·45 | ... | 2 | 20·18 |
| 45 | ... | ... | 22·22 | ... | 1 | 20·44 | ... | 2 | 18·66 |
| 46 | ... | ... | 21·73 | ... | 1 | 19·47 | ... | 2 | 17·21 |
| 47 | ... | ... | 21·27 | ... | 1 | 18·55 | ... | 2 | 15·82 |
| 48 | ... | ... | 20·83 | ... | 1 | 17·66 | ... | 2 | 14·50 |
| 46 | ... | ... | 20·40 | ... | 1 | 16·81 | ... | 2 | 13·22 |
| 50 | ... | ... | 20·00 | ... | 1 | 16·00 | ... | 2 | 12·00 |
| 51 | ... | ... | 19·60 | ... | 1 | 15·21 | ... | 2 | 10·82 |
| 52 | ... | ... | 19·23 | ... | 1 | 14·46 | ... | 2 | 9·69 |
| 53 | ... | ... | 18·86 | ... | 1 | 13·73 | ... | 2 | 8·60 |
| 54 | ... | ... | 18·51 | ... | 1 | 13·03 | ... | 2 | 7·55 |
| 55 | ... | ... | 18·18 | ... | 1 | 12·36 | ... | 2 | 6·54 |
| 56 | ... | ... | 17·85 | ... | 1 | 11·71 | ... | 2 | 5·57 |
| 57 | ... | ... | 17·54 | ... | 1 | 11·08 | ... | 2 | 4·63 |
| 58 | ... | ... | 17·24 | ... | 1 | 10·48 | ... | 2 | 3·72 |
| 59 | ... | ... | 16·94 | ... | 1 | 9·89 | ... | 2 | 2·84 |
| 60 | ... | ... | 16·66 | ... | 1 | 9·33 | ... | 2 | 2·00 |

## TABLE FOR 4 DOFFINGS OF 10 HANKS EACH.

Equal 40 hanks.

| Counts | lbs. | oz. | dwts. | Counts | lbs. | oz. | dwts. |
|---|---|---|---|---|---|---|---|
| 10's | 4 | 0 | 0 | 26 | 1 | 8 | 11 |
| 11 | 3 | 10 | 3 | 27 | 1 | 7 | 12 |
| 12 | 3 | 5 | 6 | 28 | 1 | 6 | 15 |
| 13 | 3 | 1 | 4 | 29 | 1 | 6 | 1 |
| 14 | 2 | 13 | 9 | 30 | 1 | 5 | 6 |
| 15 | 2 | 10 | 12 | 31 | 1 | 4 | 11 |
| 16 | 2 | 8 | 0 | 32 | 1 | 4 | 0 |
| 17 | 2 | 5 | 12 | 33 | 1 | 3 | 7 |
| 18 | 2 | 3 | 10 | 34 | 1 | 2 | 15 |
| 19 | 2 | 1 | 12½ | 35 | 1 | 2 | 5 |
| 20 | 2 | 0 | 0 | 36 | 1 | 1 | 14 |
| 21 | 1 | 14 | 8 | 37 | 1 | 1 | 5 |
| 22 | 1 | 13 | 2 | 38 | 1 | 0 | 15 |
| 23 | 1 | 11 | 16 | 39 | 1 | 0 | 7 |
| 24 | 1 | 10 | 12 | 40 | 1 | 0 | 0 |
| 25 | 1 | 9 | 10 | | | | |

## PREPARATION PARTICULARS.

The following "preparation particulars," are simply and solely intended as a guide to beginners; it is of course, in such matters, quite impossible to lay down any hard and fast line to go by; but a little study of them will give the learner—by whom they may be taken as a basis—a good idea of how to set about arranging drafts, twists, hank, &c. Every practical man will, and of necessity must, arrange and lay out his machinery to the best possible advantage, and according to surrounding and local circumstances, such as the machinery itself, the cotton to be manipulated and the counts to be spun, &c., &c.

In the preceding chapters it has been endeavoured to point out, and at the same time strongly impress upon the reader, that the lighter you can treat cotton—during the various operations it has to pass through, during its progress from cotton to yarn,—the better, so that the dirt is taken out of the cotton, and consistent with a clear, level, and regular thread.

It may, with advantage, be mentioned, that at many mills now-a-days, the cotton is only passed through single (one) in place of double (two) scutchers; the sliver at the drawing frame is also in many instances only passed through two in place of three heads. By this arrangement you are enabled to run the machinery much slower; for instance, at the drawing frame, when only passing the sliver through two in place of three heads, the rollers will only require to run at two-thirds the speed; this slower speed enables the sliver to be drawn better; less waste and less bad work is made; less oil is required, and the machinery lasts much longer; also—a most important point,—these slower speeds require less power (turning), with the result of a considerable saving in fuel.

The cotton only passing through one in place of two scutchers, the fibres are less damaged, and in the after processes, you are able to run with less twist; the yarn is stronger, and the production is greater. It is found that, with care, the regularity with the above named system does not suffer single and light scutching; light and quick carding; slow speeds at the drawing, slubbing, intermediate and roving frames, with the quickest possible speed at the spinning machinery, will be hard to beat either as regards quality, quantity, or economy.

The following are nice weights and drafts when spinning 32's and 34's twist:—

| | Weights. | Drafts. |
|---|---|---|
| | 8 ozs. | |
| Weight in lap box - - - - | 2lbs. 12 ozs. | |
| Length of feed - - - - - | 36 inches | Scutcher Draft 3·00 |
| 3 yds. of finished lap - - | 2lbs. 06 oz. | |
| Hank lap - - - - - - - | ·00158 | |
| 15 yds. of card sliver - - | 31 dwts. 00 grains | 75 |
| 15 yds. of drawing sliver, 3rd head - - - - | 30 dwts. 00 grs. | eight ends 7.94 |
| 15 yards of slubbing - - | 7 dwts. 00 grs. | 4.04 |
| 30 yards of intermediate - | 6 dwts. 00 grs. | 4.71 |

| | | |
|---|---|---|
| 30 yards of roving - - - | 50 grains | 5.00 |
| | Mule - - - - - - - - | 6.75 |

A FAIR SPEED TO RUN THE FRONT ROLLER WHEN SPINNING 32's AND 34's AMERICAN:

| | | | |
|---|---|---|---|
| Drawing - - - - - | 300 | revolutions | per minute. |
| Slubbing - - - - - - | 200 | ,, | ,, |
| Intermediate - - - - | 150 | ,, | ,, |
| Roving - - - - - - - | 100 | ,, | ,, |

A FAIR SPEED TO RUN THE SPINDLES:—

| | | | |
|---|---|---|---|
| Slubbing - - - | 450 to 500 | revolutions | per minute. |
| Intermediate - - | 600 | ,, | ,, |
| Roving - - - - | 850 | ,, | ,, |

The time generally allowed for backing-off, and the return of carriage is about 5 seconds.

## ONE PREPARATION 12's MOCK.

MIXING.—Composed of 2nd fly and strips, 1st sweepings, top flat bits, clearer dirt, mule and throstle broken up cop bottoms, &c.

SCUTCHING.—Through 1st and 2nd double scutchers, both with porcupines.

Speed of porcupine 1125 revolutions per minute.

| | | | |
|---|---|---|---|
| ,, beaters | 1225 | ,, | ,, |
| ,, fans | 1800 | ,, | ,, |

Front bars, 12. Back bars, 8.

Draught of Scutcher, 3.00.

Weight fed on 1yd = 3lbs. 5oz.

Weight of 1 yard of finished lap, 14 ozs.

Hank lap ·00136.

Carding.—15 single cards, 45-in. diameter of cylinder, 22-in. diameter of doffer, 7 rollers and 5 clearers.

| | | |
|---|---|---|
| Speed of cylinder | | 136·3 |
| ,, | doffer | 11·5 |
| ,, | taker-in | 272·6 |
| ,, | clearers | 350·0 |

Draft of Card 74·1

,, Draw Box 1·5 = 115·6 total draft.

Drawing.—6 heads of 2 deliveries each, 6 working as 1st and 3 as 2nd heads; the sliver thus only passes 2 heads, which equals 6 finishing deliveries. Front roller 325 revolutions per minute.

Weight of 15 yards of drawing, 42 dwts. 12 grains.

Draft, 1st head, 5·50

,, 2nd ,, 6·50

Corrugated back rollers.

Slubbing.—Two slubbers of 64 spindles each, 128 spindles.

| | |
|---|---|
| Speed of spindle per minute - - | 450 |
| ,, front roller - - - - | 115 |
| Twist per inch - - - - - - - | ·98 |
| Hank - - - - - - - - - - | ·5 |
| Draft by slub - - - - - - - - | 4·00 |
| Draft by wheels - - - - - - | 4·8 |

Twist wheel 32. Top shaft wheel 45.

Weight of 15 yards slub, 10 dwts. 00 grains.

10-inch lift.

Corrugated back roller.

Roving.—Five frames of 128 spindles each, 640 spindles. 7-inch lift.

| | |
|---|---|
| Speed of frame shaft - - - | 290 |
| „ spindles - - - - | 825 |
| „ front rollers - - - | 100 |
| Twist per inch - - - - - | 2·56 |
| Weight of 30 yards roving - | 6 dwts. 0 grs. |
| Hank - - - - - - - - - | 1·75 |
| Draft by wheels- - - - - | 6·6 |
| „ sliver - - - - - | 6·8 |

Twist wheel 24. Top shaft wheel 56.
Corrugated back roller.

## ONE PREPARATION 24's MOCK.

Mixing comprises—

$\frac{1}{3}$ ordinary Mobile.
$\frac{1}{3}$ soft waste
$\frac{1}{3}$ first fly and strips.

Scutching through the opener and 1st and 2nd double scutchers. Speed of porcupine 920 revolutions per minute. Draft 3·00. Weight fed on 1 yard at the breaker scutcher, 3 lbs. 3 ozs. Weight of 1 yard of lap, 14 ozs. Hank lap ·00136.

Carding.—10 single carding engines, 45-in. cylinders, 22-in. doffers. Speed of main cylinder, 140 revolutions per minute. Doffer, 9 revolutions per minute. Taker-in, 275 revolutions per minute. Clearers, 350 revolutions per minute. Rollers, 9 revolutions per minute. Draft of card, 78. Draft of Draw-box, 1·52 = 109 total draft.

DRAWING.—3 heads of 4 deliveries each = 12 deliveries. Speed of front roller, 315 per minute. Weight of 15 yards of 3rd head of drawing, 45 dwts. 0 grains.

| | | |
|---|---|---|
| Draft, 1st head | 2·33<br>1·78<br>1·38 | 5·62 by wheels. |
| Draft, 2nd head | 3·01<br>1·66<br>1·31 | 6·56 ,, |
| Draft, 3rd head | 3·01<br>1·66<br>1·31 | 6·56 ,, |

Corrugated back rollers.

SLUBBING.—1 frame of 52 spindles.
Speed of frame shaft, 260 revolutions per minute.
,, spindles 520 ,, ,,
,, front roller, 180 ,, ,,
Twist per inch, ·71. Hank slub, ·50
Draft by slub, 4·28
,, wheels, 5·4
Weight of 15 yards, 10 dwts. 12 grains.
Corrugated back rollers.

INTERMEDIATE.—2 frames of 82 spindles each.
Speed of frame shaft, 286 per minute.
,, spindles, 572 ,,
,, front roller, 125 ,,
,, Twist per inch, 1·17.

ROVING.—5 frames of 128 spindles each.
Speed of frame shaft, 286 per minute.
,, spindles, 825 ,,
,, front roller, 101 ,,

Twist per inch, 2·06. Hank rove, 2·6.
Draft by wheels, 6·05.
Weight of 30 yards, 94 grains.

## ONE PREPARATION 30's & 32's THROSTLE TWIST OUT OF MIDDLING ORLEANS.

MACHINERY.—

1 opener with porcupine cylinder.

1 breaker scutcher, with two three-bladed beaters, 18-in. sweep.

1 finisher scutcher, with Lord's patent feed attached.

16 carding engines, *i.e.*, 8 breakers and 8 finishers, all self-stripping revolving flats, 47 to the set. Diameter: Cylinder, 40 in.; doffer, 18 in.

1 Derby doubler of 60 ends.

1 drawing frame of 3 heads and 4 deliveries, doubling 8.

1 slubbing frame of 64 spindles.

2 intermediate frames of 82 spindles each.

4 roving frames of 128 spindles each.

20 throstle frames of 240 spindles each—4,800 spindles.

| | | | | | | |
|---|---|---|---|---|---|---|
| Weight in lap box – – | 3 lbs. 00 ozs. | | | | | |
| Length of feed – – – | 36 inches. | | | | | |
| Weight of 3 yards lap – | 2 lbs. 6 ozs. | | | | | |
| Hank lap – – – – – | 00·153 | | | | | Hank. |
| Breaker card 15 yarns sliver | 48 | dwts. | 12 | grs. | | ·107 |
| Finisher ,, ,, | 39 | ,, | 20 | ,, | | ·130 |
| Last lead drawing 15 yards | 43 | ,, | 12 | ,, | | ·117 |
| Slubbing – – – – – – | 7 | ,, | 20 | ,, | | ·66 |
| Intermediate – – – | 7 | ,, | 12 | ,, | | 1·38 |
| Roving – – – – – – | | | 60 | ,, | | 4·16 |

| | | |
|---|---|---|
| Card cylinders | 150 revolutions per minute. | |
| Doffers – – | 11 ,, | ,, |
| Takers-in – – | 275 ,, | ,, |

DRAUGHT WHEELS, &c.

| | | | | | | | | | | Total Drafts. |
|---|---|---|---|---|---|---|---|---|---|---|
| Breaker cards | $\frac{30}{40}$ | $\frac{22}{120}$ | | $\frac{14}{48}$ | | | $\frac{6}{18}$ | | | 74·8 |
| Finisher cards | $\frac{40}{40}$ | $\frac{19}{120}$ | | $\frac{14}{48}$ | | | $\frac{6}{18}$ | | | 65·0 |
| 1st head drawing | $\frac{20}{48}$ | $\frac{35}{60}$ | 34 | $\frac{39}{48}$ | x | $\frac{20}{60}$ | $\frac{27}{50}$ | | 3·10, 1·80, 1·38 | 7·71 |
| 2nd ,, | $\frac{20}{4}$ | $\frac{35}{60}$ | 34 | $\frac{30}{50}$ | x | $\frac{20}{60}$ | $\frac{25}{50}$ | | 3·10, 2·18, 1·27 | 8·22 |
| 3rd ,, | $\frac{20}{48}$ | $\frac{35}{60}$ | 34 | $\frac{30}{50}$ | x | $\frac{20}{60}$ | $\frac{25}{50}$ | | 3·10, 2·18, 1·27 | 8·22 |

Diameters of rollers, $1\frac{1}{2}$, $1\frac{1}{8}$, $1\frac{1}{2}$, $1\frac{1}{4}$.

Corrugated back rollers.

Gauges, 1-24th, 3-16th, 7-16th.

| | | | |
|---|---|---|---|
| Slubbing | $\frac{28}{90}$ | $\frac{32}{56}$ | 5·26 total draft. |
| Intermediate | $\frac{32}{90}$ | $\frac{36}{56}$ | 4·37 ,, |
| Roving | $\frac{24}{90}$ | $\frac{32}{56}$ | 6·56 ,, |

| | | | |
|---|---|---|---|
| Slubbing | Twist wheel 36, | 40 | top shaft wheel. |
| Intermediate | ,, 32, | 52 | ,, |
| Roving | ,, 25, | 56 | ,, |

Diameter of rollers, $1\frac{1}{4}$-in., 1-in., $1\frac{1}{4}$-in.

All corrugated back rollers.

## ONE PREPARATION 32's & 34's MEDIO, OUT OF PERNAM COTTON.

Opener, Porcupine 26in. x $36\frac{1}{2}$in. Speed, 910 revolutions per minute.

Double beater breaker scutcher. Speed of beaters, 1200 revolutions per minute.

Double beater finisher scutcher, with Lord's patent feed motion. Weight fed on 1yd. at 1st scutcher 3lbs.

Weight of 3yds. of finished Lap, 2lbs. 8oz.; or 1yd., 13·3 oz. = ·00142 hank.

9 breaker roller cards, cylinders 40½in. x 40in.; doffers, 18in. x 40in.; takers-in, 9in.;—5 working rollers and 2 dirt rollers; 4 clearers, feed roller and plate. Diameter of feed rollers, 2¼in.

| | | | |
|---|---|---|---|
| Cylinders | - - - | 145 | revolutions per minute. |
| Doffers | - - - | 12 | ,, ,, |
| Clearers | - - - | 350 | ,, ,, |
| Takers-in | - - - | 275 | ,, ,, |
| Rollers | - - - | 12 | ,, ,, |

| | | |
|---|---|---|
| Doffer speed wheel | – – – | 42 teeth. |
| Side shaft pinion | – – – | 14 ,, |
| Draft by wheel | – – – | 105 |
| Draft by sliver | – – – | 92 |

Weight of 15yds. of sliver, 39dwts. = ·131 hank.

1 Derby doubler of 60 ends.

9 finisher revolving flat cards, 47 flats to the set. Feed rollers covered with fillet.

Weight of 15yds. sliver, 36dwts. 12grs. = ·142 hank.

The flats make one revolution in 1¾ hours.

1 drawing frame, 3 heads: 4 deliveries. Corrugated back rollers.

Front roller, 315 revolutions per minute.

Diameter of rollers 1½in., 1⅛in., 1½in., 1¼in.

Distance between rollers 3/16in., ¼in., 7/16in.

Distance from centre to centre of roller 1½in., 1 9/16in., 1 13/16in.

| | | | | | |
|---|---|---|---|---|---|
| | | | | dwt grs. | |
| Weight of 15yds. of | 1st | Hd. sliver, | 44 20 | = ·115 | hank. |
| ,, ,, | 2nd | ,, | 44 06 | = ·117 | ,, |
| ,, ,, | 3rd | ,, | 43 12 | = ·119 | ,, |

Draft by sliver—1st head - 4·88
,, 2nd ,, - 6·08
,, 3rd ,, - 6·08

Wheels—1st head = $\frac{20}{48}$ $\frac{35}{60}$ 30 $\frac{37}{40}$ x $\frac{20}{60}$ $\frac{37}{50}$
,, 2nd ,, = $\frac{20}{48}$ $\frac{30}{60}$ 37 $\frac{33}{52}$ x 30
,, 3rd ,, = $\frac{20}{43}$ $\frac{39}{60}$ 37 $\frac{33/4}{52}$ x 30

1 slubbing frame—52 spindle: 10in. lift.

Twist wheel, 51 teeth; top shaft wheel, 36in.

Front roller, 235 revolutions per minute; spindles, 470 revolutions per minute.

Twist per inch, ·51. Weight of 15yds. of slubbing, 8dwts. 16grs. = ·61 hank; draft, 4·5; diameter of rollers, $1\frac{1}{4}$in., 1in., $1\frac{1}{4}$in.

Distance between rollers, ... 7/32nds, 7/16ths.
,, from centre to centre of do. $1\frac{11}{32}$nds, $1\frac{9}{16}$ths.

2 Intermediate frames of 84 spindles each: 8in. lift.
Twist wheel ... 34 teeth.
Top shaft do... 40 ,,

Speed of front roller ... 173 revs. per minute.
,, spindle ... 573 ,, ,,

Twist per inch, ·85.

Weight of 30yds. of intermediate, 6dwts. 18grs. = 1·29 hank; draft, 5·1.

Rollers set as in slubbing frame.

3 Roving frames of 148 spindles each, 7in. lift.
Twist wheel ... 32 teeth.
Top shaft do... 52 ,,

Twist per inch, 1·72.

Speed of front roller ... 121 revs. per minute.
,, spindles ... ... 820 ,, ,,

Weight of 30yds. of roving: 60grs. = 4·16 hank.

Rollers as above.

## ONE PREPARATION 40's SINGLE ROVING EGYPTIAN COTTON.

MACHINERY.—

OPENER (1 porcupine). BREAKER SCUTCHER (2 beaters, 3 blades each). FINISHER SCUTCHER (1 beater, 3 blades) Lord's feed motion. 11 BREAKER CARDS (rollers and clearers). 12 FINISHER CARDS (revolving flats.) DERBY DOUBLER (60 ends). 1 SET OF DRAWINGS (3 heads, 4 deliveries each, doubling 6). 1 SLUBBER (52 spindles). 1 INTERMEDIATE (82 spindles). 4 ROVING FRAMES (128 spindles each).

OPENER.

Speed of porcupine, 963 revolutions per minute.

Distance of teeth on porcupine from feed roller; 5/16ths of an inch.

SCUTCHERS.

| | Breaker. | Finisher. |
|---|---|---|
| Weight in lap box ... ... | $3\frac{1}{4}$lbs. | = |
| Length of feed ... ... ... | 1yd. | |
| Revs. of beater No. 1. ... | 1150 | 1150 |
| Distance of ditto from feed rollers ... ... | $\frac{5}{16}$in. | $\frac{1}{4}$in. full |
| Revs. of beater No. 2. ... | 1150 | = |
| Distance of ditto from feed rollers ... ... | $\frac{1}{4}$in. full | = |
| Speed of fan ... ... | 1198 | 1198 |
| Draft of scutcher ... ... | 3· | 2·75 |
| Weight of 3yds. of lap ... | 2lbs.14oz. | 2lbs.10oz. |
| Hank lap ... | | ·00136 |

Cards—Breaker.

Rollers and clearers, 40in. on the wire.

Diameter of cylinder ... $40\frac{1}{2}$in.; Doffer ... 18in.
Speed of do. ... 147in.; do. ... 8
Taker-in ... 275

Draft of card ... 85.

Weight of 15yds. sliver: 46dwts 12grs. Hank sliver: ·112.

Cards—Finisher.

Revolving flats, 47 to the set.

Diameter of Cylinder ... $40\frac{1}{2}$in.; Doffer ... 18in.
Speed of cylinder...147; Doffer ... 8; taker-in ... 275
Draft of card ... 70.

Weight of 15yds. sliver, 34dwts. 12grs. Hank sliver, ·151.

Derby Doubler, 60 ends.

Drawing (1st head) Drafts.

| 1st to 2nd. | 2nd to 3rd. | 3rd to 4th. | Total. |
|---|---|---|---|
| 2·88 | 1·73 | 1·20 | 6·06 |

| | | | | |
|---|---|---|---|---|
| Diameter of rollers ... | $1\frac{1}{2}$in. | $1\frac{1}{8}$in. | $1\frac{1}{2}$in. | $1\frac{1}{8}$in. |
| Distances between rollers ... | $\frac{1}{4}$in. | $\frac{3}{8}$in. | $\frac{1}{2}$in. | |

The 2nd and 3rd heads are laid out the same as the 1st head.

15yds. of sliver from last head, 33dwts. Hank sliver, ·158.

| | Slubbing. | Intermediate. | Roving. |
|---|---|---|---|
| Total draft ... ... | 4·54 | 5·08 | 6·17 |
| Draft between 1st & 2nd rollers ... | 3·78 | 4·24 | 5·14 |

| | | | |
|---|---|---|---|
| Draft between 2nd & 3rd rollers ... | 1·20 | 1·20 | 1·20 |
| Twist per inch... ... | ·64 | 1·01 | 2·21 |
| 15yds. slub weighs | 7dwts. 10grs. | (30yds.)·138grs. | (30yds.)44grs. |
| Hank ... ... ... | ·70 | 1·81 | 5.68 |
| Diameter of rollers... | $1\frac{1}{4}$in., | 1in., | $1\frac{1}{4}$in. |
| Distance between rollers | $\frac{5}{16}$in. $\frac{1}{2}$in. | $\frac{5}{16}$in. | $\frac{7}{32}$in. $\frac{1}{2}$in. |

MULES (1868 head stock).

DRAFTS—Front, 6·48. Back, 1·16. Total, 752.

DIAMETER OF ROLLERS—1-in. $\frac{7}{8}$-in. 1-in.

DISTANCE BETWEEN ROLLERS.

Bottom Front to middle, 3/32nds.

Top ,, ,, 1/8th inch.

Twist per inch in yarn, 25 turns.

N.B.—When spinning 40's out of double roving Egyptian it is usual to have second intermediates as well as first; it is also advisable to make from 8 to 10 hank roving. Some spinners prefer to have the middle rollers (top) unweighted; it is also well to drag the yarn, and have the roller delivery motion working.

## ONE PREPARATION 36's TO 40's WEFT OUT OF SAVANNAH COTTON.

MACHINERY.—One opener with porcupine cylinder.

One breaker scutcher with one three-bladed beater.

One finisher scutcher with Lord's patent feeder attached.

| | | | |
|---|---|---|---|
| CARDS.—Wheel on doffer end ... | 30 | teeth. |
| Wheel on side shaft ...... | 40 | ,, |
| Side shaft pinion ......... | 17 | ,, |
| Feed roller wheel ......... | 120 | ,, |
| Diameter of doffer ......... | 88/4's | |
| Diameter of feed roller ... | 9/4's | |

$\frac{30}{40}\ \frac{17}{120}\ \frac{9}{88}$ — 92 draft.

Draw box shaft wheel 35 teeth, driving wheel of 25 teeth on the back roller; draw box shaft wheel 32 teeth, driving wheel of 18 teeth on front roller. $\frac{18}{32}\ \frac{35}{25}\ \frac{10}{12}$ 1·52 draft of draw-box x 92, the card draft = 119·4 total draft of card.

Ten single carding engines, self-stripping revolving flats. 57 flats to the set. Cylinder 45 inches diameter; doffer, 22 inches diameter, 40 inches on the wire; fluted feed roller and dish.

One set of drawings, three heads, four deliveries; doubling six.

Two slubbing frames of 64 spindles each.

Four roving frames of 128 spindles each.

Six mules, 924 spindles in each mule. Total spindles—5544.

| DRAWING.— | 1st | 2nd | 3rd Heads. |
|---|---|---|---|
| Wheel on front roller... | 20 | 20 | 20 |
| ,, ,, stud ... ... | 48 | 48 | 48 |
| ,, attached to stud... | 35 | 35 | 35 |
| ,, on 2nd roller ... | 32 | 32 | 32 |
| ,, ,, crown... ... | 60 | 60 | 60 |
| ,, ,, pinion ... ... | 39 | 38 | 36/37 |
| ,, ,, back roller ... | 40 | 40 | 40 |

Opposite end.

| | | | |
|---|---|---|---|
| Wheel on front roller ... | 20 | 20 | 20 |
| ,, ,, stud ... ... | 56 | 56 | 56 |
| ,, attached to stud... | 29 | 29 | 29 |
| ,, on 3rd roller ... | 50 | 50 | 50 |

Diameter of rollers $1\frac{1}{2}$in., $1\frac{1}{8}$in., $1\frac{1}{2}$in., $1\frac{1}{8}$in.

DRAFTS.—1st Head.

$\frac{20}{48}$ $\frac{35}{60}$ $\frac{39}{40}$ $\frac{9}{12}$ — 5·62 total draft.
$\frac{20}{48}$ $\frac{35}{32}$ $\frac{9}{12}$ — 2·92 front ,,
$\frac{20}{56}$ $\frac{29}{50}$—4·82 ÷ 5·62 — 1·16 back ,,
2·92 x 1·16 ÷ 5·62 — 1·66 middle ,,

2nd Head.

$\frac{20}{43}$ $\frac{35}{60}$ $\frac{38}{40}$ $\frac{9}{12}$ — 5·77 total draft.
$\frac{20}{48}$ $\frac{35}{32}$ $\frac{9}{12}$ — 2.92 front ,,
$\frac{20}{56}$ $\frac{29}{50}$—4·82 ÷ 5·77 — 1·19 back ,,
2·62 x 1·19 ÷ 5·77 — 1·66 middle ,,

3rd Head.

$\frac{20}{48}$ $\frac{35}{60}$ $\frac{37}{40}$ $\frac{9}{12}$ — 5·93 total draft.
$\frac{20}{48}$ $\frac{35}{32}$ $\frac{9}{12}$ — 2·92 front ,,
$\frac{20}{26}$ $\frac{29}{50}$ 4·82 ÷ 5·93 — 1·23 back ,,
2·92 x 1·23 ÷ 5·93 — 1·66 middle ,,

SLUBBING—Diameter of rollers $1\frac{1}{4}$in., 1in., $1\frac{1}{4}$in.

| | |
|---|---|
| Front roller wheel... | 28 teeth. |
| Crown wheel ......... | 90 ,, |
| Pinion................ | 32 ,, |
| Back roller wheel ... | 56 ,, |

$\frac{23}{90}$. $\frac{32}{56}$. — 5·6 Draft.

Twist wheel 30 teeth
Top shaft wheel 45 „ ·92 twist per in.
Speed of frame shaft... 236·6 rev. per min.
„ spindles ...... 473 „ „
„ front roller ... 111·5 „ „
= 437·4 inches delivered per minute.

Rovings.—Diameter of rollers $1\frac{1}{4}$in., 1in., $1\frac{1}{4}$in.
Front roller wheel... 24 teeth.
Crown wheel ......... 90 „
Pinion................. 33 „
Back roller wheel ... 56 „
$\frac{24}{90} \cdot \frac{33}{56} = 6{\cdot}37$ Draft.
Twist wheel 25 teeth.
Top shaft wheel 56 „ 2·4 twist per in.
Speed of frame shaft... 295·8 rev. per min.
„ spindles ...... 883 „ „
„ front roller... 93·5 „ „
= 366·5 inches delivered per minute.

| | dwt. | grs. | Hank. |
|---|---|---|---|
| Weight fed on 1yd at 1st scutcher ...... | 2lbs. | 8oz. | |
| „ of 3yds. of finished lap ............ | | 2lbs. | ·00178 |
| „ of 15yds. (single) carding sliver... | 25 | 18 | ·202 |
| „ of 15yds. (finished head) drawing | 26 | 12 | ·196 |
| „ of 15yds. of slubbing .............. | 4 | 13 | 1·15 |
| „ of 30yds. of roving ................. | | 60 | 4·16 |

## GEARING AND MACHINERY OF A MILL CONTAINING 70,000 SPINNING SPINDLES WITH ALL PREPARATION, AND DRIVEN BY A TURBINE OF 1080 HORSE POWER.

Speed of turbine, 50 revolutions per minute.
Depth of fall, 25 feet.
Usual depth of water on turbine, 7 feet
,, ,, under ,, 4 ,,
Diameter of turbine, 12ft. 2in.

78 teeth wheel on turbine, driving.
61 ,, lying shaft.
15¼ diameter turbine shaft.
11⅞ ,, lying ,,
63·9 revolution tunnel shaft per minute.
570 cubic feet of water passing through turbine per second.

MACHINERY.—
1 Crighton opener (double).
1 porcupine opener.
12 single beater scutchers.
100 breaker cards, 45-in. cylinders, rollers, and clearers.
14 Derby doublers.
100 finisher cards, S. S. revolving flats.
14 drawing frames.
14 slubbing frames.
28 intermediate frames.
60 roving frames.
35,000 mule spindles.
35,000 throstle spindles.
1 hydraulic packing press.

## GEARING.

| | Diameter. ft. | Diameter. in. | Pitch. in. | Breadth. in. | No. of teeth. | Speed. | |
|---|---|---|---|---|---|---|---|
| Bevil wheel turbine ......... | 12 | 0 | $5\frac{3}{4}$ | 19 | 78 | 50 | Into |
| ,, tunnel shaft ............ | 9 | 5 | $5\frac{3}{4}$ | 19 | 61 | 63·9 | Tunnel shaft |
| ,, tunnel driving upright. | 8 | 4 | $4\frac{1}{4}$ | 15 | 74 | 63·9 | |
| Bevil on upright............... | 6 | $2\frac{3}{8}$ | $4\frac{1}{4}$ | 15 | 55 | 86·0 | Speed of Nos. 1 & 2 uprights |
| Spur wheel driving pump ... | 2 | $6\frac{5}{8}$ | 3 | 8 | 32 | 63·9 | Into |
| | 4 | $1\frac{5}{8}$ | 3 | 8 | 51 | 40·0 | Crank shaft for pump |
| 1st Room Throstles. | | | | | | | |
| Bevil wheel on upright ...... | 7 | 2 | 3 | 8 | 90 | 86·0 | Into |
| Wheel on line shaft ......... | 3 | $1\frac{1}{4}$ | 3 | 8 | 39 | 198·4 | Two line shafts driving throstles |
| 2nd Room Cards. | | | | | | | |
| Bevil on upright ............ | 5 | 0 | $2\frac{3}{4}$ | 8 | 68 | 86·0 | Into |
| ,, line shaft ............... | 3 | 0 | $2\frac{3}{4}$ | 8 | 41 | 142·6 | Card and scutching shaft |
| ,, on line shaft driving cross shaft ......... | 3 | $3\frac{5}{8}$ | $2\frac{3}{4}$ | 7 | 45 | 142·6 | Into |
| ,, on cross shaft ......... | 3 | $2\frac{5}{8}$ | $2\frac{3}{4}$ | 7 | 44 | 145·8 | Speed of cross shaft |
| ,, other end of ditto...... | 3 | $9\frac{1}{2}$ | $2\frac{1}{4}$ | 6 | 64 | 145·8 | Into |
| | 2 | $5\frac{3}{4}$ | $2\frac{1}{4}$ | 6 | 42 | 222·2 | Speed of frame shaft |
| ,, on cross shaft ......... | 2 | $11\frac{3}{4}$ | $2\frac{1}{2}$ | $6\frac{1}{2}$ | 45 | 145·8 | Into |
| | 3 | $0\frac{1}{2}$ | $2\frac{1}{2}$ | $6\frac{1}{2}$ | 46 | 142·6 | Speed of card shaft |
| 3rd Room Cards. | | | | | | | |
| Bevil on upright ............ | 6 | $7\frac{3}{8}$ | $2\frac{3}{4}$ | 7 | 90 | 86·0 | Into |
| ,, line shaft ............... | 2 | $7\frac{3}{4}$ | $2\frac{3}{4}$ | 7 | 36 | 215·0 | Roving & mule shafts |
| ,, ,, ,, ............... | 2 | $4\frac{1}{2}$ | $2\frac{1}{4}$ | 6 | 40 | 215·0 | Into |
| | 2 | $10\frac{3}{8}$ | $2\frac{1}{4}$ | 6 | 48 | 179·1 | Cross shaft |
| ,, on cross shaft ......... | 2 | $1\frac{1}{2}$ | 2 | 8 | 40 | 179·1 | Into |
| ,, card shaft ............... | 2 | $7\frac{1}{2}$ | 2 | 6 | 50 | 143·3 | Speed card shaft |
| ,, on upright No. 2....... | 5 | 0 | $2\frac{3}{4}$ | 8 | 68 | 86·0 | Into |
| | 3 | 0 | $2\frac{3}{4}$ | 8 | 41 | 142·6 | Speed card shaft from upright No. 2 |
| 4th Room Mules. | | | | | | | |
| Bevil upright No. 2. ......... | 6 | $7\frac{3}{8}$ | $2\frac{3}{4}$ | 7 | 90 | 86·0 | Into |
| ,, line shaft ............... | 2 | $7\frac{3}{4}$ | $2\frac{3}{4}$ | 7 | 36 | 215·0 | Short cross shaft |
| On other end cross shaft ... | 3 | $1\frac{1}{4}$ | 3 | 9 | 39 | 215·0 | Into |
| | 3 | $3\frac{1}{8}$ | 3 | 9 | 41 | 204.5 | Speed mule shaft |

GEARING—*Continued.*

| PULLEYS, &c. | Diameter. | Breadth. | Speed. | |
|---|---|---|---|---|
| | in. | | | |
| 1st Room Throstles......... | 32 | 5½ | 198·4 | Revolutions. |
| On Frame ................. | 12 | | 529 | Revolutions Tin R Shaft, 8½ × 7/8 = 5,138 spindles. |
| For roving frames............ | 17½ | 5½ | 198·4 | Revolutions. |
| On frames ................. | 12 | | 289 | Revolutions frame shaft. |
| For reels........................ | 14 | 4·8 | 76·8 | Revolutions. |
| On reels..................... | 7½ | | 143 | Revolutions reels swift. |
| For press .................... | 16 | 5 | 190 | Revolutions. |
| On press....................... | 14 | | 217 | Revolutions bundling press shaft. |
| For hydraulic press ......... | 16 | 5 | 190 | Revolutions. |
| | 18¼ | | 166·5 | Counter shaft driving pump. |
| 2nd Room Cards .......... | 16 | 8 | 142·6 | Revolutions. |
| On cards..................... | 16 | | 142·6 | Revolutions card cylinder. |
| For roving frames ........... | 24 | 5 | 142·6 | Revolutions. |
| | 12 | | 585·0 | Revolutions frame shaft. |
| For roving middle shaft...... | 16 | 8 | 221·2 | On to |
| On frame .................. | 12 | | 296·0 | Roving frames. |
| For drawing ................. | 17½ | 5 | | |
| ,, slubbing ................. | 16 | | | |
| ,, intermediate ............ | 15 | 5 | | |
| Scutching Machines......... | 36 | 6 | 142·6 | On main driving shaft. |
| On counter shaft ............ | 17 | 12 | 301·9 | Counter shaft. |
| On counter shaft driving ... | 36 | 6 | 301·9 | On to |
| On beater .................. | 9 | | 1207·0 | Revolution beater. |
| On opener .................. | 12 | | | |
| Slow motion ..... ............ | 7½ | 7 | 301·0 | |
| | 24 | | 94·0 | Revolution slow motion shaft. |
| 3rd Room Cards, &c. | | | | |
| On main shaft .............. | 16 | 8 | 142·6 | On to 16-in. cards. |
| | 24 | 5 | 142·6 | ,, 12-in. roving. |
| | 16¾ | 5 | 215·0 | ,, 12½-in. ,, |

For Mules.........215· 24⁹ × 15 = 344 C. S. pulley.
20⁹· 344 × 15 = 457 speed rim shaft.
Hoist 100 feet per minute.

## PLAN OF A SMALL MILL, CONTAINING 21,000 SPINNING SPINDLES, SHOWING THE WAY THE MACHINERY IS LAID OUT.

See Plates 1, 2, 3.

3 steel boilers with tubes, mud settler, and steam chest. Boilers 7ft. diameter.

1 economiser, 196 pipes.

1 60-horse horizontal high-pressure condensing engine, with Corliss valves, rope driving, cotton ropes, 24ft. diameter wheel; making 52 revolutions a minute.

Line shafts running 255 revolutions per minute.

## MACHINERY.

1 Oldham willow.

1 Crighton-opener, double.

4 single scutchers (2 breakers and 2 finishers).

40 single carding engines; rollers and clearers, 50-in. cylinders, 22-in. doffers.

4 sets drawing frames, 3 heads each, doubling 8.

4 slubbing frames, 72 spindles each; in all 288 spindles.

8 intermediate frames, 108 spindles each; in all 864 spindles.

16 roving frames, 140 spindles each; in all 2240 spindles.

12 twist mules, 756 spindles in each mule; in all 9072 spindles.

12 weft mules, 924 spindles in each mule; in all 11088 spindles.

3 ring frames, 280 spindles in each frame; in all 840 spindles.

## MODELS OF BOOKS.

The following few "models of books" are given to prove the necessity of having a thorough and perfect system on this head; the serious importance of which,—for many and various reasons,—will be apparent to any careful or thinking mind. Every mill has, more or less, its own peculiar system of book-keeping, which nevertheless should be based upon the same fundamental principles, and which cannot be too minute, searching or elaborate, so that, at all times, and even to the minutest detail, a true, accurate, and correct statement of affairs may be made out.

The manager should strictly and regularly *most especially* keep his eye on the following; namely :—production, dead loss, cost per lb. in wages, stores, &c., &c.

# MODELS OF BOOKS.

## COTTON COME IN.

| Date of Arrival. | By whom carried. | No. of Bales. | Machine Weight. | Loss % |
|---|---|---|---|---|
| | | | | |

## SPINNING A/C.

| Hanks. | No. of Warps. | Total Hanks. | Counts. | Weight. | Calculation Weight. |
|---|---|---|---|---|---|
| | | | | | |

## COTTON BOOK.

| Date of Contract or Advice. | No. of Bales. | Class of Cotton. | Marks. | Out of what Ship or from whom boug't | Price. | Landing Weight. |
|---|---|---|---|---|---|---|
| | | | | | | |

## PRODUCTION OF TWIST AND CALICO.

| Year. | Spindles. | Lbs. | Looms. | Yds. |
|---|---|---|---|---|
| 1882...... | | | | |
| 1883...... | | | | |
| 1884...... | | | | |

## PRICES OF OIL AND COAL.

| Oils. | 1880 Price per Gallon. | Coals. | 1882 Price per Cwt |
|---|---|---|---|
| Mineral ............... | | | |
| Sperm.................. | | | |
| Gallipoli.............. | | | |

## AVERAGE COST OF STORES, OIL AND PACKING EXPENSES.

| | 1882 Decimals of 1d. |
|---|---|
| Cost of Packing, per lb., in Bales... ... ... ... ... ... | |
| Do. do. Skips ... ... ... ... ... ... ... | |
| Cost of Stores (not including Oil), per lb. of Yarn Spun ... | |
| Cost of Oil per lb. of Yarn Spun ... ... ... ... ... ... ... | |
| Cost of Twine per lb. of Yarn Packed in Bales ... . . ... | |
| Cost of Tie Yarn per lb. Reeled ... ... ... ... ... ... ... | |
| Total Cost in Stores per lb. Spun ... ... ... ... | |

# BANDING.

AVERAGE CONSUMPTION PER MONTH OF 1,000 SPINDLES.

| Banding. | 1882 Lbs. | 1883 Lbs. | 1884 Lbs. |
|---|---|---|---|
| | | Example. | |
| Throstle ... ... ... | 3·00 | 3·05 | 3·10 |
| Mule ... ... ... ... | 1·00 | 1·05 | 1·10 |
| Rim .. ... ... ... | 1·50 | 1·75 | 1·60 |
| Scroll ... ... ... ... | 3·25 | 3·10 | 3·15 |

# PRODUCTION OF YARN,

AND

# AVERAGE WAGES PER LB. OF YARN SPUN.

| | 1882 Lbs. | 1882 Pence. |
|---|---|---|
| January ... ... ... ... ... ... | | |
| February ... ... ... ... ... ... | | |
| March ... ... ... ... ... ... | | |
| April... ... ... ... ... ... ... | | |
| May ... ... ... ... ... ... ... | | |
| June... ... ... ... ... ... ... | | |
| July ... ... ... ... ... ... ... | | |
| August .. ... ... ... ... ... | | |
| September ... ... ... ... ... | | |
| October ... ... ... ... ... ... | | |
| November... ... ... ... ... .. | | |
| December... ... ... ... ... ... | | |
| Total... ... ... ... ... ... | | |

# CONSUMPTION OF STORES.

PER MONTH.

| | |
|---|---|
| Strapping... ... ... ... ... ... | In Lbs. |
| Laces ... ... ... ... ... ... | Doz. |
| Roller Skins ... ... ... ... ... | ,, |
| Roller Cloth ... ... ... ... ... | Yds. |
| Clearer Cloth ... ... . ... .. | ,, |
| Scroll Banding... ... ... ... ... | Lbs. |
| Rim Banding .. ... ... ... ... | ,, |
| Mule Banding ... ... ... ... ... | ,, |
| Throstle Banding ... ... ... ... | ,, |
| Gallipoli Oil ... ... ... ... ... | ,, |
| Mineral Oil ... ... ... ... ... | ,, |
| Sperm Oil ... ... ... ... ... | ,, |
| Tallow ... ... ... ... ... ... | ,, |
| &c., &c. | &c., &c. |

## COST PER LB. IN SPINNING WAGES.

| | Pence or decimals. |
|---|---|
| Scutching Room ... ... ... ... ... ... ... ... ... | |
| Card Rooms ... ... ... ... ... ... ... ... ... ... | |
| Roving ... ... ... ... ... ... ... ... ... ... ... | |
| Throstles... ... ... ... ... ... ... ... ... ... ... | |
| Mules ... ... ... ... ... ... ... ... ... ... ... | |
| Reeling ... ... ... ... ... ... ... ... ... ... ... | |
| Roller Covering ... ... ... ... ... ... ... ... ... | |
| Press Room ... ... ... ... ... ... ... ... ... ... | |
| Cotton Magazine ... ... ... ... ... ... ... ... ... | |
| Mixing and Waste Picking ... ... .. ... ... ... ... | |
| Watchmen ... ... ... ... ... ... ... ... ... ... | |
| Mechanics' Shop ... ... ... ... ... ... ... ... ... | |
| Engine House... ... ... ... ... ... ... ... ... ... | |
| Boiler House ... ... ... ... ... ... ... ... ... ... | |
| Total Average for the Year... ... ... ... ... ... | |

# BOOK OF WHEELS AND PARTICULARS OF FRAMES.

| | |
|---|---|
| No. of Preparation ... .. ... ... | |
| Sorts Working... ... ... ... ... | |
| Gauges ... ... ... ... ... ... | |
| No. of Spindles ... ... ... ... | |
| Dia. Frame Pulley ... ... ... ... | |
| Revn. Frame Shaft ... ... ... ... | |
| Do. Spindles... ... ... ... ... | |
| Do. Front Roller ... ... ... ... | |
| Twist Wheel ... ... ... ... ... | |
| Top Shaft Wheel ... ... ... ... | |
| Do. End... ... ... ... ... | |
| Front Roller End ... ... ... ... | |
| Do. Wheel... ... ... ... | |
| Crown Wheel ... ... ... ... ... | |
| Pinion ... ... ... ... ... ... | |
| Back Roller Wheel ... ... ... ... | |
| Wheel on Back Roller Driving ... | |
| Do. Middle Roller ... ... ... | |
| Bolster and Spindle Shaft Wheels ... | |
| Do. Do ... | |
| Lift Pinion ... ... ... ... ... | |
| Ratchet Wheel... ... ... ... ... | |
| Back Draft ... ... ... ... ... | |
| Total Draft ... ... ... ... ... | |
| Drum End Wheel ... ... ... ... | |
| Top of Upright Wheel ... ... ... | |
| Bottom Do. ... ... ... | |
| Lift of Frame ... ... ... ... ... | |
| Length of Spindle ... ... ... ... | |
| Fork and Flyers ... ... ... ... | |
| Maker and Date of Frame ... ... | |

## BOOK OF WHEELS AND PARTICULARS OF MULES.

| No. of Mules. | Revns. of Line Shaft. | Drum on Line Shaft. | Rim Pulley. | Rim. | Revns. of Rim. | Back Ch'nge Wheel. | Drag Wheel. | Twist Arrangem't. | Tin Roller Pulley. | Tin Roller. | Wharve. | Revns. of Spindle. | Revns. of F. R. | Stretch. | 3 or 4 draws in seconds. | Counts. | Turns per inch. | Gain per Stretch. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | |

## COTTON TRIALS.

| Date. | Lot. | Mark. | Class. | Where Tried. | Carded Cotton. | Fly and Strips. | Sweepings. | Blowings and Blow Fly | Sand. | Loss. | Total Lbs. o/o | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |

## COTTON STORE BOOK.

| Date. | No. of Bale. | Mark. | Description. | Gross Weight. | | Real Weight. | | Tare. | | Difference. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | lbs. | oz. | lbs. | oz. | lbs. | oz. | lbs. | oz. |
| | | | | | | | | | | | |

## COTTON MIXED.

| Year. | Egyptian. | | Pernam. | | American. | | Surat. | | Total Cotton Mixed. | Average Price. | Per Cent. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | lbs. | o/o | lbs. | o/o | lbs. | o/o | lbs. | o/o | lbs. | | Yarn Produc'd | Waste Sold. | Dead Loss. |
| | | | | | | | EXAMPLE | | | | | | |
| 1881 | 25,000 | 25 | 25,000 | 25 | 25,000 | 25 | 25,000 | 25 | 100,000 | 6d. | 90 o/o | 0·50 o/o | 9·50 o/o |

## COTTON ACCOUNT.

| 1882 | | lbs. | 1882 | | lbs. |
|---|---|---|---|---|---|
| | Stock in process, 1st Jan., 1881 ... | | Jan. 1st. | Twist delivered in Bales and Skips. | |
| | Cotton mixed........................ | | | Mule and water yarn sent to weaving mill .............. | |
| | | | | Card and roving waste ........... .. | |
| | | | | Waste made—cotton................. | |
| | | | | Stock in process, 1st Jan., 1882 .. | |
| | | | | Dead loss .................... ........ | |

| lbs. | | o/o |
|---|---|---|
| | Twist produced. | |
| | Waste Sold. | |
| | Dead loss. | |
| | Cotton consumed. | |

## WEAVING.

Power looms have been brought to such great perfection that it is now both profitable and possible to produce almost any kind of textile fabric on them. In these pages a few hints will be given on the management of weaving mills, and on the art of managing the patent power loom. A description is also given of the loom with Howard and Bullough's electric stop motion; and a short notice on sizing will likewise be found.

In weaving, it is as equally necessary and essential to have good yarn, as it is in spinning to have good cotton. If the yarn be of a good or fair quality, the cloth, as a natural consequence, will likewise be of a good quality, and will therefore command a good price, and take a leading place in the market. There will be no occasion to hawk it about; but, on the contrary, it will be eagerly sought after. The production will be far greater than when using an inferior quality of yarn, and the waste made all through, both at the winding, warping, slashing, and weaving will be considerably less. As a consequence of good weaving and extra production, the hands will make more money, and be better satisfied, and this will result in bringing together or securing a better class of workpeople all through the establishment.

In the management of a weaving mill the main thing is to keep ahead with both the production and quality of the cloth. By looking well after the machinery, and seeing that everything is in first-class working order, and by keeping the hands up to the work, the production will be good; the quality likewise depends upon these points, taken in conjunction with a fair yarn and good sizing. The waste made in a weaving mill is a very serious item, and should be strictly watched so as to be kept down as much as possible, and within reasonable limits. The winders' waste should be carefully examined and weighed-in regularly every day, and the weavers should be made to run off the cop bottoms as low as possible. It is equally necessary, and likewise of the greatest importance, to keep down the cost of production; this will be accomplished by the exercise of careful and wise economy; any false economy, however, such as the use of inferior articles—strapping, pickers, &c.—should be strictly avoided.

## WINDING.

The winding frame is a very simple machine, and needs no particular explanation. The spindles on either side are driven by bands from the tin roller which extends the whole length of the frame. For the traverse motion, there is a small pinion which drives the mangle wheel, the teeth of which are so contrived that the pinion works on both sides; when the mangle wheel has moved round a certain length, the pinion, by shifting to the opposite side, draws it as much in the contrary direction, and the wheel being fixed on the end of the shaft, which raises and depresses the bobbin rail or traverse motion, by means of the pinion acting into the rack, the alternate movement of the mangle wheel causes a constant alternate ascending and descending motion of the bobbin rail or traverse. In winding throstle yarn, the full throstle bobbins are put on the small spindles which run in a step and collar; when the yarn is winding the spindles run round with the bobbin; the thread passes through a brush and over a woollen cloth, which acts as a drag and likewise cleans the yarn. The guide wire consists of a thin plate of iron, the slit in the iron plate, through which each thread passes, is made like an arrow, with a slit on each side of the main slit; if the winder attempts to lift the end up it slips into either one or other of these slits, so that she is obliged to break the thread and knot it anew. In the old arrangement, with only one slit, it was easy for the winder to lift the thread out of the slit, when stopped by a bad piecing or a bad end, and allow it to pass. The slit also, as the yarn passes through it, helps to clear the yarn of shell and dirt.

The machine for winding mule yarn is of the same construction, except that the cops are put on skewers; the skewers are fitted into a small step, and stand in a slanting position, and the yarn in being wound on the warper's bobbins is passed round the flannel and through a brush, which also in this instance acts as a drag and clears the yarn. The guide is the same as described above, and the yarn in passing through the slits is guided to the bobbins, and considerably cleared of impurities, &c. If the yarn does not run off to the very bottom, as frequently happens, the skewer is put in a horizontal position, and allowed to run in centres, and at the same time free and steady. It is well to have 3 or 4 spindles so running for each winder, and by putting larger wharves on the bobbin spindles to run them at about half the speed of the other spindles.

In winding yarn from the hank swifts are used.

## BEAMING.

The creel of the beaming frame is of a V shape, and care should be taken to have an equal quantity of bobbins in each half or side of the creel, so that there will be an equal quantity of yarn on each side of the beam from its centre, otherwise the yarn will be badly warped. The yarn in beaming passes through the reed, round the measuring roller, and under the rods—there are generally 5 of these rods, and they are for taking up the slack yarn as the beamer runs back the beam to find a broken end—on to the winder beam; this beam should be equally weighted at both ends, so that the yarn will build hard and equal. Care should be taken to set the measuring apparatus at its proper place before commencing to run the beam. All being in order, and the beam running, it is the warper's duty to watch when an end breaks, stop the machine, and draw it in. There is also a patent stop motion for stopping the frame when an end breaks. Each end or thread passes through a wire eye, which is supported by the end in its position; and when the end breaks it drops and comes into contact with a lever which is moving under the needles, and the belt is shifted from the fast to the loose pulley, and the frame stops.

The use of the fly wheel is to stop the frame gradually, otherwise the bobbins in the creels would overrun themselves.

The beamer should look well after her work, and take out all bad or soft ends, and when an end breaks, in piecing it up, and drawing it, in she should be careful not to cross it.

## REELING.

The reel is a very simple machine, and the reeling process is likewise very simple. The machine itself consists of a light framework; a row of small spindles, upon which the throstle bobbins run; the traverse; and the swift upon which the yarn is reeled. The swift is 54 inches in circumference, 80 revolutions of which make 1 lea or 120 yards; this is the first shift made on the reel, and seven of these shifts make one hank or 840 yards. The reeler's duty is to replace as they run off the empty throstle-bobbins by full ones; to piece up any broken ends, and in doing so to be very careful not to get the threads crossed or entangled one with another; to put in the yarn, and keep each lea separate and distinct; and lastly, her duty is to doff. The reeled yarn is put up into say 10lb. bundles, when it will easily be seen by counting the hanks in the bundle, whether or not the proper counts of yarn are given, by multiplying the weight of the bundle by the number of hanks it contains; for instance, a 10lb. bundle of 32's should contain 320 hanks, because 32 x 10 = 320.

When the yarn is made up in the bundle, the proper length is given; but no more than the weight in lbs., in fact the pure yarn given in a 10lb. bundle is generally 9lb. 14oz. Every knot (a knot contains 10 hanks) is weighed separately on a quadrant, and when spinning, say 32's twist, all the knots of exact 32's are, of course, bundled: the knots of 31's and the knots of 33's are mixed in equal quantities, and therefore come out 32's, and they in their turn are bundled the same as the exact 32's. In spinning, it is impossible always to keep the yarn exact counts; sometimes it gets on the heavy side, and at other times on the light side; when this is the case, and if the yarn comes in heavy, it is necessary to spin a quantity of light; or if the yarn comes in light it is necessary to spin a quantity of heavy; the light and heavy are then mixed in equal quantities—as already stated—to make them average right counts and weight.

## SIZING.

This is the most important department in a weaving mill, and in importance may be compared to the mixing room of the spinning mill. The whole process of sizing or slashing requires the very greatest care and attention, for unless the twist be well and nicely sized it cannot possibly weave well, any carelessness in this department will result in great loss. The right number of warper's beams are placed at the back of the tape frame, in such a manner as to allow the yarn on the beam next to the machine to unwind from the top, the second beam from the bottom, the third from the top, the fourth from the bottom, and so on alternately from top and bottom, according to the number of beams being slashed or taped. The yarn is warped on these beams as wide as possible, so as to give it the greatest power of drying. The yarn from these beams passes through the boiling size in the size box, and between the calender rollers, and round the copper cylinder which is charged with steam; it next passes under and over the fans, and is wound on to the front or weaver's beam, properly sized and dried. It is better not to subject the yarn to too much steam or cylinder drying; it is far more preferable to introduce more fans for the purpose of drying the yarn, which will be thus less liable to get burnt or hardened, and will retain both its nature and the size far better; the weaving is thereby greatly improved, as also are the yarn and cloth.

The quantity and strength of the size to be put on to yarn depends upon circumstances, and can only be regulated by experience; but when this is once determined upon, the taper himself must look after and keep the temper of the size regular and at one thing. The twist should not be allowed to go on to the weaver's beam until it is nicely dried. When the frame is standing the yarn should be taken out of the boiling size, otherwise the ends will all get glued together: to do this it is simply necessary to wind the roller that keeps the yarn submerged out of the size box.

When working fine reeds, or if the yarn is not up to the mark, the rods, which keep the ends clear and separate, should be changed at every beam, otherwise the ends get crossed and entangled. If the yarn is of good quality, and when working coarse reeds, these rods do not require changing so often. For 5 beams there are 4 rods, for 6 beams 5 rods, for 7 beams 6 rods, and so on. If the selveges are made from doubled twist they must be kept separate by a separate and distinct rod of their own. The speed of the machine is regulated by the cone drums, and the yarn is thus made to run quicker or slower according to the requirements of drying it. When all is properly set about the machine, and it is running nicely, the taper has to move about with his eyes on his work, to piece any broken ends, and to see that the yarn is properly sized and dried.

## MIXINGS.

MIXING FOR $8\frac{1}{4}$LBS. SHIRTINGS. 32's TWIST; 32's WEFT.—$3\frac{3}{4}$lbs. twist, $3\frac{1}{4}$lbs. weft, $1\frac{1}{4}$lbs. size = $8\frac{1}{4}$lbs.

1 pack (240lbs.) best white flour.
16lbs. best Russian tallow.
4lbs. best white soap.
Fomenting degrees 35 to 40.
To twaddle for usage 16 or 17 degrees.
Boiling at 212° in the size box.

For preparing this size, the best and most approved system is to have four large square bins, with two agitators in each bin. The flour and water are mixed cold in the first bin to 35 or 40 degrees of density, and this must be allowed to stand for 3 or 4 weeks, until it becomes *perfectly sour*; after which, run off a certain amount into the second bin, and at once refill the first bin with the exact amount run off, again bringing the mixture in this first bin to the original strength, and so on to the last bin, reducing the strength to 30° in the second bin, 25° in the third bin, and 17° in the last or fourth bin, running so much out of one bin into the next, and regularly refilling as run off, in exactly the same proportion. The first is the fomenting bin where the flour and water are mixed cold to 35 or 40° of density or strength; the second is the washing bin, and receives the mixture of flour and water in a cold sour state from bin No. 1; it must now be reduced in this No. 2 bin to 30 degrees. The mixture is now washed in the following manner:—When the agitators are standing, the flour settles to the bottom, the water remains of course at the top and gathers all the light dirt and impurities; after standing a time, this dirty water is run off and carries away all undesirable matter; the proper amount of fresh water is again run in, and the agitators are once more set to work. The third bin receives its share of the clean, cold mixture of flour and water, which is now reduced or brought down to 25 degrees. This is next run into the fourth bin, and again further reduced to the right strength, say 16 or 17 degrees. It is now boiled at 212° through the introduction of steam. Into this is run the prepared or boiled tallow and soap, thus completing the mixing, which is at length pumped through 1½ or 2 inch pipes into the tape frame size box. The tallow and soap are boiled or prepared in a small boiler above the fourth bin, or in a separate tub, as most convenient. The finished size, in the size box, at the tape frame, must be kept *well boiling* through the injection of steam.

## SUNDRY MIXINGS.

For 30's/40's twist, and 50's weft—

80lbs. Farina
4lbs. Tallow
2lbs. Wax
To twaddle $3\frac{1}{2}^\circ$

———

240lbs. Flour
10lbs. Tallow
To twaddle $6^\circ$

———

224lbs. Farina
2lbs. Tallow
3lbs. Wax
To twaddle $3\frac{1}{2}^\circ$

1 Sack Farina
2lbs. Tallow
30lbs. Flour
4lbs. Wax
To twaddle $3\frac{1}{2}^\circ$

———

140lbs. Flour
224lbs. Farina
12lbs. Tallow
4 Buckets of China Clay and Antiseptic
To twaddle $3\frac{1}{2}^\circ$

For heavy goods, say 30's twist.—Boil 3 bags of China clay, 100lbs. of antiseptic, and 50lbs. of tallow, mix with 3 buckets of flour and farina. This mixing will work well.

For 30's/60's twist, and 40's/90's weft.—Mix to 25 gallons of water, 40lbs. of sago, and 40lbs. of farina, 4lbs. of tallow, $1\frac{1}{2}$lbs. of best white soap or soft soap, and 1lb. of wax.

The general average is 1 gallon of water to 1lb. of farina.

Mixing for plain calico, 34's twist, 38's weft; 18 x 17; 72's reed.—

36lbs. potatoe flour
1lb. best tallow
2lbs. soft or white soap
2lbs. glycerine.

The tallow, soap, and glycerine to be mixed with 72lbs. of water, after which this and the flour all to be boiled together to the required strength.

MIXING FOR 60's TWIST; 100 REED, 35 PICKS.—

10 gallons of water
14lbs. farina
$1\frac{1}{2}$lbs. tallow
1lb. wax
To twaddle 6°.

Another. 140lbs. flour
112lbs. farina
5lbs. tallow
2lbs. cocoa-nut oil
To twaddle 6°.

## DRAWING-IN.

The weaver's beam has next to be drawn-in or through the healds and reed. The beam is fixed or hung up in a wooden framing, some five feet from the floor, and a sufficient length of yarn is turned off, so as to allow the end of it to come down to the drawer-in, who sits on a stool, with the healds and reed before him. The warp being spread out to its proper width, and the ends being separated with the comb put in by the taper, the reacher-in, who also sits on a small stool at the back of the beam, takes the threads one by one, and holds or hands them to the drawer-in, who draws them two at a time through the eyes of the healds and through the dent of the reed; one end or thread through each heald, and two ends through a dent. The ends are drawn-in in regular succession one after another from left to right of the beam. The beam is now ready for the loom, and is called a weaver's beam. Great care should be taken by the drawer-in so as not to get the ends crossed or entangled, otherwise they will give much trouble in weaving.

## TWISTING.

Twisting as a rule is performed by young men. When new healds are not required, and when working the same class of goods, or rather weaving the same cloth, beam after beam, it is not necessary to re-draw-in the warp, but it is twisted-in. The healds and reed as they come from the loom with the yarn in them, are hung up in the twisting frame, opposite the new beam. The twister puts a piece of rope round the pulley, on the beam end, and hangs a weight to the end of it. He then takes a portion of the yarn, and fixes it to a hook fastened to a cord, which cord or strap goes round his waist, with the hook hanging to the cord at the front of his body. After he has brushed out the yarn, and made the ends straight, he begins to twist the ends of the warp to the ends that are in the healds and reed. He picks out the yarn from the warp with his right hand, and twists with his left.

## THE LOOM.

THE DRIVING PULLEYS are fixed on the end of the top or main shaft of the loom; there are two of them, one, the fast pulley, gives motion to the loom; the other is the loose pulley on which the strap runs when the loom is standing.

THE CRANK SHAFT.—The lathe or slay receives its motion from this shaft by means of the connection rods; the bottom shaft likewise receives its motion from this shaft through a range of wheels, driven by the wheel on the out end of the crank shaft.

THE CONNECTING RODS.—These two rods are attached at one end to the crank shaft, and at the other end to the lathe or slay swoards.

THE BOTTOM SHAFT is driven from the crank shaft, and makes only one revolution for the crank shaft two; the healds and the picking motion are worked from this shaft.

THE YARN BEAM consists of a round piece of wood, with iron flanges on either end; this beam when filled with yarn is called the weaver's beam; it stands at the back of the loom, and when fixed in its place ready for working, a rope is passed twice or thrice round either neck, to which rope is attached a lever and weight to keep the beam steady.

THE CLOTH BEAM is the beam or roller, at the front of the loom, upon which the newly woven cloth is wound.

THE SLAY SWOARDS, SLAY, AND ROCKING SHAFT.—The slay swoards are fixed at one end to the slay, and their other end is fixed to the rocking shaft, which stretches across the loom near the floor; the slay is fastened to the upper ends of the swoards, and the race of the slay in the bevelled piece of wood, upon which the shuttle runs when travelling across the loom; the top shell is that part of the slay which holds the reed by the top rim, the bottom rim of the reed is placed—in loose reed looms—between the strip and the back of the lathe.

THE BREAST BEAM is an iron plate at the front of the loom, over which the newly woven cloth passes on its way to the cloth beam; an iron rod is fixed to the breast beam, and on this iron rod the self-acting temples are fixed.

THE PICKING SHAFT.—On the top end of this shaft is the picking stick, and on the bottom end the bowl; the picking scroll on the bottom shaft strikes against this bowl, and thus gives motion to the shuttles.

## THE REED.

The reed is a very important article in weaving; it both divides the warp threads, and determines the fineness of the cloth; a coarse cloth, however, may be made in a fine reed, and a fine cloth may be made in a coarse reed; the number of threads or ends contained in a given space—say 1 inch—determines the fineness of the cloth. It is a general thing to put two threads or ends in a dent, and when speaking about the fineness of a piece of cloth, it is taken for granted, or understood, that there are two ends in a dent. The reed is rated by the number of dents to the inch. The magnifying glass, for counting the number of ends to the inch, is made with squares of ¼ and ½ inch. If the ½in. glass is used, and 24 threads are seen, it is called a 48; or if 36 threads are seen it is called a 72, and so on.

The length of yarn to make a piece varies with the picks and counts of weft put in: ·02 per lb. should cover the waste in twist, and ·05 per lb. in weft.

| Counts per ¼ inch. | | | Reed counts per inch. |
|---|---|---|---|
| 12 | ... | ... | 44 |
| 13 | ... | ... | 48 |
| 14 | ... | ... | 52 |
| 15 | ... | ... | 56 |
| 16 | ... | ... | 60 |
| 17 | ... | ... | 64 |
| 18 | ... | ... | 68 |
| 19 | ... | ... | 70 |
| 20 | ... | ... | 74 |
| 21 | ... | ... | 78 |
| 22 | ... | ... | 82 |
| 23 | ... | ... | 86 |
| 24 | ... | ... | 90 |
| 25 | ... | ... | 94 |
| 26 | ... | ... | 98 |

The reed space of a power loom is from the weft grate on one side to the back board on the other side. A 26in. loom has 30 inches reed space. The scale from a 30 inch loom to a 60 inch loom is 5 inches, and above a 60 inch loom 6 inches.

A 60's Manchester and Stockport reed has 30 dents in one inch—this reed is equal to a Bolton 36's, or a full 67's Blackburn.

CONTRACTION.—The general contraction is about $2\frac{1}{4}$ inches in the cloth, consequently the yarn must stand about $2\frac{1}{4}$ inches wider in the reed than in the cloth.

MILLING-UP.—In plain goods the general rule for "milling"-up is 1 yard in 20 yards; this, however, is more according to circumstances; it varies as the counts of twist and weft differ from medium counts, and with the number of picks put in the cloth.

## MAKING OF CLOTH.

To make a good cloth is of course the most essential point in weaving, every effort should therefore be brought to bear with this object in view. To attain this end the following are the three most important items to be considered. First, to make an even cloth; second, to put a good cover on the cloth; and third, to make good edges.

UNEVEN CLOTH.—There are many things which make the cloth uneven; if the yarn does not come off the beam regularly the cloth will be uneven, this may be caused through the weight ropes being damp, in which case they should be replaced by dry ones. Sometimes the collars upon which the weight ropes work become rusty, and if so, they and the ropes should be well rubbed with black lead. If the weights touch the floor, or the beam necks be loose, the cloth will be uneven. If the neck of the emery roller be loose, or the wheel on the neck loose, the cloth will be uneven. If the cloth beam or emery roller be crooked the cloth will be uneven. If the pivots be strained the cloth will be uneven. If the wheels are not deep enough in gear, they will slip back, and the cloth will be uneven; or if they are too deep in gear, and bind, or if the taking-up catch sometimes takes up two teeth, and at other times one tooth, the cloth will be uneven. If the flanges of the beam touch the roller or bearer, if the springs of the cloth beam are too weak, or the weights too light, the cloth will be uneven. If the finger at the end of the breast beam be set too near the fork lever, and will not let the catch drop so as to catch the teeth of the wheel, it will cause the cloth to be uneven. When the crank is on the front centre with the reed touching the cloth, the catches ought to be set so that the taking-up catch will drop off the tooth; when the crank is on the back centre, the holding catch should drop clear of the tooth. If the taking-up catch takes up two teeth at once, lower the stud or monkey tail, which is screwed to the lathe swoard; if it does not take up one raise it. The foregoing are the main things which cause the loom to weave uneven cloth.

### To put a good cover on Cloth.

In the making of good cloth this is one of, if not the most important and necessary point to be attended to; at the same time it is one of the most simple and easy things to attain.

If the tapits tread too late the loom will make bare cloth, therefore see that they do not tread too late; raise the bearer, and tie the rods farther back; if it is a heavy cloth set the lathe lower, and draw the rail to which the lathe swoards are attached somewhat nearer the front of the loom, this has a great tendency to throw the fibres on the top of the cloth, and thus produce a full dawny material. In a word, to put a good cover on the cloth it is necessary to both pick and tread soon.

It is very important to prevent cracks or thin places in the cloth when setting the loom on; this is a difficult job, especially when making light cloth, and on the loose reed loom. The best preventative for this is to have everything about the loom in first class working order, to have all nuts and bolts screwed up tight; all stopping and starting should be performed rapidly, and with precision; the crank arms should be tight so as not to shake the lathe, and the strip that keeps in the reed at the back of the lathe must fit properly to the reed balk. Cracks in cloth may be to a great extent be avoided if the weaver understands the proper conditions necessary for stopping and starting the loom, when taking-in the broken threads, &c. A thoughtful weaver by attention to the skewering of cops, seeing to the shuttle pegs being the right thickness, the peg to be firm and fast, pointing direct to the shuttle eye, no part of the cop to project above or below the shuttle, seeing there is no cutting of weft in the shuttle boxes, weft grate, temples, or reed, &c., and starting the loom properly, will have few cracks compared with the indifferent weaver, who neglects these conditions. If the fulcrum of the taking-up lever be at the top of the loom it will be liable to make cracks, because it takes-up when the slay is at front centre; the tension of the warp being easy allows the catch sometimes to take a tooth, whereas if the catch were at the top of lever the conditions would be reversed, the most strain being on the warp when it is taking up at back centre tends to prevent a tooth going after the weft comes off. Should the weft break when the shuttle is at the fork side, the weft lever is pulled off, suspending the taking-up, and extra picks are not required. Should the weft break and catch hold of the side, and the trail of weft be sufficient to lift the weft fork a number of picks, then extra picks are required. The weaver's judgment being required to adjust the loom before starting, it is very difficult to prevent cracks altogether with the present system of weft fork.

### How to make good edges or sides, and how to make them weave well.

To make good edges the yarn must be drawn in rightly at the sides, and the sheds must be set right. The shuttle must not rebound in the box, nor must the weft come off too freely; this (the weft coming off too freely) may be remedied or avoided by glueing a small piece of flannel in the eye of the shuttle, which will act as a drag on the weft. If the loom picks at its proper time, and picks strong enough, and the tapits be set correctly, the edges of the cloth will be good.

To MAKE THE SIDES WEAVE WELL the temples must hold out the cloth to its proper width, the temples must be in good working order, one side must not be tighter than the other, the pickers also must be good and in good condition. If the picker is broken it will cause the shuttle to break the sides of the cloth; if the shuttle tip has worn a hole away from the right centre of the picker it will cut the sides; if the reed is broken, the healds badly pieced, or the twist be not right in the rods, healds, or reed, the sides will break. Care also should be taken to have the sheds equal, and to have the healds the proper height.

Give attention to the above and the sides will weave well.

## GATING A LOOM.

Looms are generally set out in groups of 4 or 6, and are thus nicely arranged in their places for either 2, 3, or 4 loom weavers. When the loom is in its proper place, i.e., where it is intended to stand and work, the first thing to be done is to square, level, and fasten it firmly down. Now put on the heald roller straps, check straps, and springs, pickers, and picking straps, &c.; fit the shuttles to the shuttle boxes, and put in the reed; next see that the loom picks at the proper time, and with just enough force to drive the shuttle across the cloth into the opposite box, neither too hard nor too easy. Lastly, set the temples, treading tapits, and weft fork as described later on; also set the taking-up motion to take one tooth at a time. Screw up tight all the nuts and bolts, oil the loom well, put on the driving strap, and run the loom a few hours to see that all is right before putting in the warp. After which put in the warp, gate it carefully, and commence weaving.

### Gating the Warp.

Gating the warp is a very important matter, for unless this is well done it is impossible to make good cloth or make the warp weave well. The loom should be well examined before the warp is put in, to attend to whatever repairs may be wanted, and to screw up whatever may have come loose. Now also is the time to give the loom a thorough good cleaning and oiling. After putting the warp in the loom lay in the lap, and put on the weight ropes and weights, put to the top (heald) cords and make them all of one length; the heald roller straps should likewise be of one length, fasten to the bottom cords, and see that the healds are not too high or too low, and make the sheds perfectly equal, and of a medium size. If the sheds are too large the cloth will be bare, and the shuttle will strike against the spindle-studs, and so get worn, and splinter, and be liable to break the yarn and cause smashes. The front stave should rise when the loom picks from the left hand side of a right hand loom, and from the right hand side of a left hand loom.

If the shuttle picks under the twist the healds are too high, and if over the twist the healds are too low, unless the loom is picking too soon or too late. If the above be attended to the healds will work smoothly and easily, and the warp, if all else about the loom is right, is sure to weave well.

### The Lathe or Slay.

The lathe is one of the most important parts of a loom, and it should be well and accurately set to make the loom weave well. When the crank is on the top centre, the lathe swoards must be set so as to stand $2\frac{1}{4}$ or $2\frac{1}{2}$ inches nearer the front of the loom at the bottom than at the top; the lathe must be set level, and the race-board about 1 inch below the breast plate, on the loom front. In fast reed-looms, the stop-rod blades should fit to the frogs in a dovetail fashion, so that when the loom bangs they will not fly over the frogs. When the loom is working, the fingers on the stop-rod should be set so as to cause the blades of the stop-rod to clear the frogs, and the fingers should have $\frac{1}{4}$ of an inch play from the swell when the shuttle is in the box; the spring that holds the stop-rod down should not be too tight. The fingers should be screwed fast to the stop-rod, and the steps in which the stop-rod works should be kept clean and well oiled, so that it may work freely and easily.

In loose-reed looms when the crank is on the top centre, the lathe swoards should be set from $2\frac{1}{4}$ to $2\frac{1}{2}$ inches nearer the front of the loom, at the bottom, than at the top of the swoard; the lathe must be set level, and the race-board about 1 inch below the breast plate on the loom front. The fingers under the lathe are to make the reed fast when it touches the cloth, and should be so set as to go under the brackets which are fixed to the breast plate, from a $\frac{1}{4}$ to $\frac{1}{2}$ an inch; they should be set as fine as possible, but so that they will get under the bracket and not over; the reed will thus be firmer when it strikes the cloth; all the springs that are in connection with the reed should be tight, so as to keep the reed perfectly steady when the loom is working; when the crank is on the top centre there should be 2 inches play between the spring that holds the reed when the shuttle is working, and the brackets on the breast plate, so that if the shuttle catches in the shed, it will throw the reed out. The rod which holds the strip that allows the reed to fly out, is held by carriers and brackets to the lathe swoards, and these should be well and regularly cleaned and oiled, so that the rod will work free and easy.

## The Weft Fork.

The weft fork is to make the loom stop when the weft is broken, and when weft runs off; also to prevent the loom from stopping when the weft is not broken. The weft fork must be set so as not to touch or come in contact with any part of the grate, but should have a clear road right through. If the fork touches any part of the grate, the loom will not knock off when the weft is broken, and on the other hand it will probably stop the loom when the weft is not broken. When the loom is running, the fork should go through the bars of the grate just far enough for the weft to lift the fork so high as to nicely clear itself from the hammer. When the loom is weaving, the weft fork to do its duty properly, must be set so that it will touch nothing but the weft, and when the weft does not touch the fork the loom should stop. When the crank is on the front centre, and the reed is close up to the cloth, set the bowl on the weft tapit close to the weft lever, and if the lever is properly set it will stop the loom when the weft breaks; the weft lever and fork holder can be adjusted and regulated just as required, and to a very great nicety; all that is necessary to make the weft motion work well and accurately is simply a little study and patience.

There are many causes for the loom stopping when the weft is not broken, namely: if the fork does not go far enough through the grate; if the loom pick too late or too weak; if the shuttle rebound in the box, the weft will run slack and the loom will stop; if the fork has too much play, or be strained, touches the wires of the grate, or stands too high, the loom will stop when the weft is not broken, and not stop when the weft is broken; if the lathe has too much play at the bottom, and moves backwards and forwards, or swerves from one side to the other, it may stop the loom, or otherwise cause it not to stop; if the setting-on rod be too weak, so that it springs backwards and forwards against the fork-holder when the loom is working, it will not stop when the weft is broken, &c., &c. There are innumerable other things which occur daily and cause the loom to stop and prevent it from stopping; these, however, will easily be found out and remedied upon examination.

### The Picking Motion.

When running from 180 to 200 picks a minute the loom should pick just before the crank gets on to the bottom centre. The loom can be made to pick either sooner or later, according to the setting of the boss to which the scroll is fastened. To give a nice easy pick set the point of the scroll as near as possible to the end of the bowl on the picking shaft; this bowl can be set according to the requirements of the case, and can be set higher or lower as needed. The scroll should be set to give the pick, say $1\frac{1}{4}$ inches, before the crank gets to the bottom centre. The picking motion, with a little care and judgment, can be set to a very great nicety, and in all cases should be so set as to give a gentle and easy pick.

### The Treading Tapits.

To put a good cover on the cloth, and make the yarn weave well, with as little strain on the healds as possible; it is of the first importance that the tapits be rightly set. One side of the tapit is about 5/16ths of an inch in diameter larger than the other, and this larger side is to tread the back shaft, as it is farther away from the reed; the least side is to tread the front shaft, which is of course nearest the reed. If the treadle tapits are set too late, the loom will make bare cloth; if too soon the shuttle will rattle as it enters the box. The tapits should be set perfectly level, that is, they should be set so that the treadles will be level, when the crank is on the top centre.

### The Temples.

The duty of the temples is to keep in the selvage ends, and also by stretching out the cloth to keep it to its right width. They should be set so as to stand as near as possible to the reed without touching it; when the crank is on the front centre, and about $\frac{1}{4}$ of an inch lower on the reed side than on the opposite side, and when the loom is working, they should be set as near the lathe bottom as possible without touching it.

There are several kinds of temples, but the trough and roller temple is most generally in use; one advantage it has is that it helps to throw the reed out when it catches in the shed; there is also a better cover got on the cloth with this temple. For heavy work the other, or side temples are preferable, as they keep the clother better stretched than the trough and roller temples do.

For light goods the lathe should be set a little higher, and the temples a little farther from the reed.

### The Taking-up Motion.

When the crank is at the front centre the taking-up catch must be set so as to drop one tooth on the ratchet wheel, and when the crank is at the back centre the holding catch must be so set that it will drop $\frac{1}{8}$th of an inch over the ratchet wheel tooth; the monkey tail, which works the taking-up catch, must be set to take up one tooth at a time; all the taking-up wheels should be set just nicely in gear, deep enough and not too deep, so that they will not bind nor take up two teeth instead of one. If they are too deep in gear the teeth will be liable to break; if not deep enough they will slip backwards and forwards, and so cannot possibly take up uniformly. To make a regular cloth, everything about the taking-up motion must he set accurately, so that it will work smoothly and regularly. To put more or less picks in the cloth it is simply necessary to change the pinion. For more picks, or heavier, a less pinion; for less picks, or lighter, a larger pinion.

## The Break.

The break is to regulate the stopping of the loom, to prevent it from overrunning when the weft is broken, or runs out, and also to stop the loom when the shuttle is at the fork side. If the break acts properly, the loom, when it stops, will not lose more than two picks. The loom should stop when the lathe is at the back, the weaver has then simply to take out the empty shuttle, put in another, and hold the holding catch finger until the loom has picked two or three times, so as to prevent irregularity in the cloth. Regulate the break by putting on more or less weight; if the loom lose more than two picks, when the weft breaks or runs out, put on more breakage. If the loom is made to stop when the crank is just over the back centre, it has a better chance of starting again in a proper manner. The setting-on of the loom is a very important matter; a little extra care on this head will prevent both cracks in the cloth, and smashes.

### Smashes.

It is the duty of the weaver to keep his eyes open, and by attending properly to his work, prevent smashes as far as possible. In loose reed looms, when the shuttle stops in the shed, the reed, if everything about it is in order, should fly out, without breaking the twist. If the loom does make a smash, when the shuttle catches in the shed only, it may arise from some one of the following causes, namely:—If the reed does not fly out, the finger which is screwed to the stop rod has probably caught hold before the shuttle forces out the reed; if the reed balk be too thick and it fits too tight, and will not go out easily, it will make a smash; if the springs at the back of the shuttle boxes be too strong, or if the spring which acts on the finger to keep in the reed, be too strong, the reed cannot go out easily; there are other causes, such as the shuttles splintering or breaking, and many little things that can only be found out in practice; but if the reed be set so that it will, in case of any accident, fly out easily, smashes will be reduced to a minimum.

The Shuttle flying out, turning over, or rattling in the box:—May and often does arise from one and the same cause, namely: If the lathe stands higher at one side than the other; if the reed is broken or crooked; if the picker is broken; if the shuttle is round at the bottom; if the shuttle tip strike the picker too high; if the loom picks too soon, too late, or too strong; if the healds are too high, or too low, &c., &c. There are many other causes, which will be found out in practice, and which to a practical eye are easily visible.

Cops Knocking-off.—This may be caused by the loom picking too strong, by the shuttle peg being too small, or the top spring too weak, or by the weaver not skewering the cops in a proper manner, &c., &c.

If a tackler is called to a loom and cannot at first find out what is wrong, or in other words gets fast, he will, upon closer examination, be sure to find out the cause which produces the effect.

## Pickers and Strapping.

Pickers form a very serious and most important item in the wear and tear of a weaving shed, and unless they are of a good quality they soon become useless, and cause nothing but bad work, besides being a great hindrance to the weaver in keeping the loom at work. Much care is necessary in preparing the pickers, so as to make them durable and to get them in good working condition. Before using them they should be hung up in a dry but not too warm place for at least six weeks, after which they should be steeped in good Gallipoli oil for a month; they should then be hung up again and gradually dried for another six weeks; after which they will be ready for work, and if of a good quality will work well and satisfactorily.

The strapping (lever straps, check and picking straps, &c.) should likewise be of the best quality, it will last longer, give far less trouble, and altogether in the long run will prove more serviceable and economical than strapping of a poor or inferior quality.

## Conclusion.

The plain calico loom is a very simple machine, and its mode of working may be easily understood by even the meanest capacity. To make it perform its work in a satisfactory manner all that is required may be summed up in the two words, care and attention. It would be useless to go on enumerating the scores of things that occur daily and prevent the loom, or the various motions, from working with precision and accuracy. If the loom be kept in good working order, clean, and well oiled, if everything be set right in its proper place, and screwed up tight, and if all and every motion work in unison one with another the loom will run as a machine ought to do, and the numerous mishaps that—through carelessness—are so continually taking place, will seldom be heard of. When the loom does get out of order, or when any one of the motions requires the tackler's attention, he should, at a glance, be able to tell what is wrong; the cause as a rule will arise from some trifling thing which may be easily remedied on account of the simplicity of the whole machine, and everything in connection with it.

## The Loom, with Howard and Bullough's Electric Stop Motion.

(See Plate 32.)

The three great improvements that have been made in the power-loom, at different times, since its first invention, are the following:—

First, the performance of work automatically, which was done before by the weaver. For example—the positive or tooth and pinion taking-up motion, which regulates the number of picks by wheels, instead of as formerly by hand; the self-acting temples which keep the cloth stretched out to its proper width, at the front of the reed, doing away with the necessity of moving them by hand every few minutes. There are also improvements by which undue strains on the yarn, or parts of the loom itself are reduced, and unnecessary breakages avoided, as by modifiations in the treading tapits, by shedding motions, and improvements in weighting. Lastly, there are those contrivances which cause the loom to stop, when the attention of the weaver is required to prevent damage, or the production of imperfect work. Such are the arrangements, for instance, for stopping the loom when the shuttle from any cause is badly thrown, and the weft fork, with its accompanying mechanism, by means of which the loom stops when the weft breaks, or when the shuttle is emptied.

All these improvements tend to the production of more perfect cloth, and saving of material; and at the same time they enable the weaver to get more work off, either by allowing the looms to be run faster, or by his minding more of them.

The new improvements in looms now being made by Howard & Bullough aim at two of the objects just mentioned; namely, easing the yarn and the healds from unnecessary strain, and by a further extension of the same device, stopping the loom when a portion of the threads of the warp become entangled together in the manner that causes a "float" in the cloth.

For the first of these objects, in place of leaving the staves (Fig. 1. AB), on which the healds (EE) are stretched, bare, as is usual, an india-rubber tube (C) is secured along the upper edge of the top stave (A). These india-rubber tubes provide an elastic bed for the healds, and thereby afford some relief to any over-strained threads of the warp, at the place from which the strain chiefly proceeds, in place of the dead resistance of unyielding wood, and the sensitiveness of this packing to unavoidable variations in tension, saves, it is alleged, the breakage of many ends, and so improves the weaving. A saving of the healds themselves will also be effected by this contrivance. So far, the gears of the loom, rather than the machine itself, are improved by this simple expedient, by which, in certain cases, the yielding india-rubber becomes an agent to stop the loom. In order to explain how this is managed, it is necessary to premise that excessive tension of a single thread, or even of two or three, though it causes a slight giving-way of the india-rubber, will not collapse the tube, for sufficient ease is obtained, in an ordinary way, by much less yielding; but when a "float" is about to be made, or, in other words, when the "shed" is imperfectly formed, in consequence of an entanglement of the yarn, the whole resistance of the tube is overcome, and it gives way entirely. This will be readily understood when we consider that while one set of healds is forcibly lifting the alternate threads of the warp, another set of healds is pulling each other one downwards, in order to make a passage for the shuttle when a thread breaks, and the end of it falling between, and athwart the other ends, prevents them from crossing each other. The amount of strain thrown on the india-rubber depends, of course, upon the number of threads implicated; but, half a dozen or even less, so entangled or webbed together, are sufficient to collapse the tube, and on this happening, the loom is caused to stop, by means of electricity. For this purpose a thin metallic tape is cemented within the india-rubber tube (Fig. 1, C.), on its upper surface, from end to end; and also in the inside of the tube, lying on the bottom of it, and occupying nearly half of the internal space, is a brass tube. At the corner of the loom top, on the right-hand side, is fixed a bracket, to hold a battery (Figs. 2 and 3 $H^3$), one pole of which is connected with the healds. The connexion is made by a flexible metallic tape, which is divided into two parts, a short distance from the healds. One of these is joined to the metallic tape, inside the india-rubber tube of the front stave, of the front set of healds, and the other to the front stave of the back set. The other staves—there are four in all at the top—are fitted with plain india-rubber, and no electrical appliances. The brass tube lying inside the india-rubber is connected at the farthest extremity, or left hand, with the loom side by a metallic tape. The india-rubber tubes are made up at the ends, which both keeps out dust that abounds in most weaving sheds, and at the same time, by confining the air, aids its elasticity. Forming the front of the loom is the polished breast beam, over which the cloth, as it is woven, is drawn forward, and wrapped on the cloth roller below it. At the right hand side, projecting from it, opposite the end of the reed space of the lathe, is the weft fork, working beneath which is the oscillating lever, ever ready to catch the hook of the former, should there be no weft passing to lift it out of the way. In a line with the oscillating lever, and fastened to the outside of the breast beam—with which its upper surface is about level—is the magnet of the electric stop motion. Above it is an arm, connected with the knocking-off lever, of the weft motion; and suspended from the under side of this, over the magnet, is its armature. This has a long flat tail, extending about four inches on the other side of the pivot by which it hangs, and this lies inert on the breast beam, until called into action by the following means:—It will be remembered that one pole of the battery is connected with the healds, the other is connected by a wire with the magnet. The brass tube inside the india-rubber on the heald stave is connected with the metal on the loom, and all that is required to complete the circuit, is that the metallic tape within the india-rubber tube be brought in contact with the brass tube beneath it. This is brought about, as we have seen, by the collapsing of the india-rubber tube, whenever an imperfect "shed" is formed in any part of the warp, in consequence of an entanglement of the yarn; the armature is then immediately drawn to the magnet, and the other end of it starts up from the breast beam, half an inch or more. It remains that this changed position of the catch, or lever, should bring it in the way of something to push it back, together with the knocking-off lever with which it is connected. The oscillating lever belonging to the weft motion might be made to do this duty; but it only completes one oscillation with each revolution of the tappet shaft, by which the two sets of healds are alternately pulled up and down, or every two picks; therefore if this lever were depended on, it would only answer to the call of the front set of healds, and the electric fittings of the back set would be ineffective. On this account it became necessary to provide another oscillating lever, to work behind the one belonging to the weft fork. As, then, the armature joins the magnet, the other end, springing up from the breast beam, is caught by the oscillating lever and pushed back, drawing with it the knocking-off lever with which it is connected, and so throwing off the driving strap, stops the loom.

Though the object of the stop motion is to prevent "floats," it will also stop the loom if the yarn becomes entangled behind the heald; this is, of course, if the entanglement gets pretty near to the healds. At first sight it might be thought that the stopping motion is too sensitive, and that the loom would be continually stopping, from the giving way of the india-rubber; or, at any rate, that its thickness would require very nice adjustment to the kind of work, and also that slight variations in the temperature would make its performance variable. It does not appear, however, that this is the case, so far as may be judged, without a more prolonged experience of its working.

Some manufacturers might wish for a stop motion that would act for every broken thread of the warp, as the weft fork does for the weft; but this would be of doubtful utility in most instances, for in the case of ordinary plain calicoes, the four-loom weaver, anxious to get along with his work, would certainly block it. But "floats" are different, for they will not pass the cut-looker—being little better than holes—unless they are of very trifling extent, and then only with much trouble of scratching up the adjoining threads; more frequently they require unweaving, a job that a weaver hates, and a trustworthy and reliable stop motion for "floats" must prove welcome to the weaver and beneficial to the employer.

The marked and practical success that has attended the application of Howard and Bullough's Electric Stop Motion to Drawing and Intermediate Frames, will doubtless attend in due time the application of this motion to the Power Loom.

## WEAVING CALCULATIONS.

### To find the weight of yarn on a beam.

Rule.—Multiply the length by the number of ends for a dividend; then multiply 840 (yards in a hank) by the counts, for a divisor; the quotient will be the lbs. of yarn.

Example.—How many lbs. of yarn on a beam 10,000 yds. long, 30's counts.

$$\frac{10{,}000 \text{ yds.} \times 500 \text{ ends.}}{840 \times 30\text{'s counts}} = 198{\cdot}4 \text{ lbs.}$$

### To find the length of a wrap on a warping (beam) frame.

Rule—Multiply the number of teeth in the wrap wheel, stud wheel, and the number of inches in the circumference of the measuring roller together, and divide by 36 (inches in a yard); the quotient will be the number of yards in a wrap.

### The tape frame.—To find the length of yarn in a mark.

Rule.—Multiply the bell wheel, stud wheel and circumference of tin roller together, and divide by the tin roller wheel; the quotient will be the inches in a mark.

Example— 86 stud wheel.
40 bell wheel.

3440
15in. circumference tin roller.

17200
3440

Tin R. W. 100)51600

36)516(14yds. 12in. Ans.

To find the number of teeth in the tin roller wheel.

Rule.—Multiply the bell wheel (40), stud wheel (86), and circumference (15in.) of tin roller together, and divide by the inches in the mark; the quotient will be the tin roller wheel.

Example— 40
86

3440
15

Inches in mark—516)51600

100 Ans.

To find the stud wheel.

Rule—Multiply the length (516) by the tin roller wheel (100), and divide by the circumference (15in.) of the tin roller multiplied by the bell wheel (40).

Example— 516
100

15 x 40 = 600)51600(86 Ans.

To FIND THE BELL WHEEL.

Rule—Multiply the length (516) by the tin roller wheel (100), and divide by the circumference (15in.) of the tin roller, multiplied by the stud wheel (86).

Example.— 516
100

15 x 86 = 1290)51600(40 Ans.

To FIND THE CIRCUMFERENCE OF THE TIN ROLLER.

Rule.—Multiply the length (516), by the tin roller wheel (100), and divide by the bell wheel (40), multiplied by the stud wheel.

Example.— 516
100

40 x 86 = 3440)51600(15 Ans.
3440

17200
17200

If the stud wheel and the tin roller wheel contain the same number of teeth, the length of a mark will be the product of the circumference of the tin roller and bell wheel.

Example.—15 x 40 = 600 ins. = $16\frac{3}{4}$yds.

WHAT BELL WHEEL IS REQUIRED TO MARK AT 20yds. WHEN THE TIN ROLLER WHEEL AND THE STUD WHEEL ARE ALIKE.

Rule.—Divide the inches in the length of the mark (720), by the circumference (15in.) of the tin roller; and the quotient will be the bell wheel.

Example— 20 x 36 = 720

$$\begin{array}{r} 15)720 \\ \hline 48 \text{ Ans.} \end{array}$$

TO FIND THE DIVIDEND OF A POWER LOOM.

Rule.—Multiply the driven parts together for a dividend, and the driving parts together for a divisor; the quotient will be the mathematical dividend of the loom.

Example — Rack wheel, 50; beam wheel, 75; carrier wheel, 120; pinion, 15; and circumference of emery beam, 15 inches.

$$\frac{50 \times 75 \times 120}{15 \times 60} \quad \begin{array}{rl} 500 & \text{Mathematical dividend.} \\ \text{add } 7 & \text{to meet contraction.} \\ \hline 507 & \text{the practical dividend.} \end{array}$$

TO FIND A PULLEY TO PUT ON A LOOM TO GIVE ANY REQUIRED NUMBER OF PICKS PER MINUTE.

Rule.—Multiply the speed of the driving shaft per minute, by the diameter of the drum on same; and divide by the picks wanted per minute. The quotient will be the diameter of the pulley to put on.

To CHANGE FROM ONE NUMBER OF PICKS TO ANOTHER.

Multiply the pinion-on, by the number of picks it is making, for a dividend, and divide by the number of picks wanted; the quotient will be the change pinion required.

To FIND THE PICKS PER INCH.

The rack wheel has 50 teeth, on the same arm is a pinion with 30 teeth, working into a carrier of 120 teeth; on the same stud is a 15 tooth wheel working into the 75 tooth beam wheel; circumference of emery beam 15 inches. Picks per inch required.

Multiply the 50 x 120 x 75 for a dividend; then multiply the 30 x 15 x 15 for a divisor; the quotient will be the picks per inch.

| | |
|---|---|
| 50 | 30 |
| 120 | 15 |
| 6000 | 450 |
| 75 | 15 |
| 450,000 | 6750 |

6750)450000

66 Ans.

To FIND THE WEIGHT OF TWIST CONTAINED IN A PIECE.

Rule.—Multiply the number of ends in the piece by the length of the cut, as delivered at the tape frame, for a dividend, then multiply the counts of the yarn by 840 for a divisor; the quotient will be the weight of twist in the piece.

To find the weight of weft required to fill a piece of cloth.

Rule.—Multiply the picks per inch, the width of the piece at the reed, and the length of the piece in yards for a dividend; then multiply 840 (the length of one hank) by the counts of the yarn for a divisor; the quotient will be the weight of weft required for the piece.

To find the counts of the weft and the twist to make a piece of cloth.

The calculation is the same as finding the weight of weft and twist, only use the weight of each wanted, instead of the counts, and the answer will be the counts instead of the weight.

To find the weight of 32's yarn required to make a piece $37\frac{1}{2}$ yards long, 60's reed and 39in. wide.

In this instance the yarn should stand 2 inches wider in the reed than the width of the cloth, and the yarn is taken as 31's.

Rule.—Multiply the length, counts of reed, and width in the reed together for a dividend. Multiply the yards in one hank by the hanks in a pound for a divisor. The quotient will be the weight of twist in the piece.

Example—

| | |
|---|---|
| 40 | 840 |
| 41 | 31 |
| 1640 | 840 |
| 60 | 2520 |
| 98400 | 26040 |

26040)98400(3·77
78120
202800
182280
205200

To find the counts of weft required to make the above piece $8\frac{1}{4}$ lbs. with 30% of size in it,' and 15 picks to the quarter. First find the weight and twist and size; thus: 30 on 3·77
is 1·13

Twist and size 4·90

Then 8·25 — 4·90 = 3·35 weight of weft required. To find its counts.

Rule.—Multiply the length of the piece, picks per inch, and the width the yarn stands in the reed, together for a dividend. Divide by 840 (yards in one hank), multiplied by the weight of weft required; the quotient will be its counts.

Example— $\frac{60 \times 38\frac{1}{2} \times 41}{840 \times 3{\cdot}35}$ 34's. Ans.

RULES, &c., HOW THE PRICES ARE RECKONED UP, TO SEE WHETHER YOU CAN AFFORD TO TAKE THE PRICE OFFERED FOR THE CLOTH.

1. THE DIVIDEND FOR THE TWIST is got by multiplying the number of ends by the length of the cut, and dividing by 840 (the yards in a hank.) The divy, divided by the counts, gives the weight.

2. THE DIVIDEND FOR THE WEFT.—The width of the warp in the reed, multiplied by the number of picks per inch, and by the length of the cut; divide this result by 840 (the yards in a hank). The divy, divided by the counts, gives the weight.

S.S.—Short Stick—36in. to the yard.

L.S.—Long Stick—37in. to the yard.

20yds. S.S. is taken at or as 19½yds. L.S.

Example— T W

Cloth 36in. wide; 20 yds. long S.S.; 12 x 12; 40's twist; 50's weft.

| | Divy. | W'ht of yarn. | C'ts. | Price. | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| T. | 45 | 1lb. 2oz. | 40's | 10d. | 0 | 0 | 11¼ |
| W. | 48 | 15 | 50's | 10¼d. | 0 | 0 | 9½ |
| | | 2 1 | | | 0 | 1 | 8¾ |
| | | Add 5% for waste, &c. (say) ...... | | | 0 | 0 | 1 |
| | | Weaving 4¾ doubled .................. | | | 0 | 0 | 9½ |
| | | Cost or quoting price per piece ........ | | | 0 | 2 | 7¼ |

EXAMPLE HOW TO GET THE DIVY.

THE TWIST DIVY.

12 x 12, i.e., 12 ends to the $\frac{1}{4}$ inch or 48 ends to the inch, therefore

48 ends to the inch.
38 inches wide at the reed (2 inches added for contraction.)
———
384
144
———
1824 ends in the piece.
21yds. length (1yd. added for milling-up.)
———
1824
3648
———
840)38304
———
45 Divy.
———

Counts 40's)45
———
1lb. 2oz. weight of twist in the piece

THE WEFT DEVY.

48 ends to the inch.
$38\frac{1}{2}$ in width at the reed ($2\frac{1}{2}$ in. added for contraction.)
———
384
144
24
———
1848
$21\frac{1}{2}$ yds. long ($1\frac{1}{2}$yds added for milling-up.)
———
1848

```
      1848
     3696
      924      Counts 50's)48
     -----                ---
840)39732           15oz. weight of weft
     -----                  in the piece.
Divy   48
```

The length of yarn varies (to make a piece), as the picks and counts of weft put in.

The yarn should stand from 2 to $2\frac{1}{4}$ inches wider in the reed than in the cloth.

The contraction in the length of a piece is about 1yd. in 20 yds; but it also varies as the counts of twist and weft differ from medium counts, and as the number of picks put in.

The calculations, however, are the base work or standard upon which to work.

Another example—

19 REED 70.

| wth. in. | l'gth. yds. | square. T. W. | divy. | c'ts. | lb. | oz. | price. | £ | s. | d. |
|---|---|---|---|---|---|---|---|---|---|---|
| 36 | $37\frac{1}{2}$ | 19 x 22 | 136 | 32T. | 4 | 4 | $9\frac{3}{4}$ | 0 | 3 | $5\frac{1}{2}$ |
| | | | 161 | 36w | 4 | 8 | $9\frac{3}{4}$ | 0 | 3 | 8 |
| | | Weight of piece | | | 8 | 12 | | 0 | 7 | $1\frac{1}{2}$ |
| | Add 5% for waste, &c., (say) ............ | | | | | | | 0 | 0 | $4\frac{1}{4}$ |
| | Price for weaving, 1/$6\frac{1}{4}$ doubled ......... | | | | | | | 0 | 3 | $0\frac{1}{2}$ |
| | Cost or quoting price per piece............ | | | | | | | 0 | 10 | $6\frac{1}{4}$ |

THE TWIST DIVY.

19 x 4 = 76 ends to the inch.
76 ends to the inch.
38 inches wide at the reed (2in. added for contraction.)

2888
39½ yds. long (2yds. added for milling-up.)

840)114076

136 Divy. 32's)136(4lbs. 4oz. weight of twist in the piece.

THE WEFT DIVY.

88 ends to the in. (22 to the ¼in. x 4=88 to the in.)
38½in. wide at the reed (2½in added for contraction.)

704
264
44

3388
40yds. long (2½ yds. added for milling-up.)

840)135520

161 Divy. Counts 36's)161

4lbs. 8oz. weight of weft in the piece.

In working out these divys and calculations, surrounding circumstances, state of trade, &c., must always be taken into account. It is necessary at times to give and take a little.

HOW TO GET THE NUMBER OF ENDS TO MAKE THE CLOTH A CERTAIN WIDTH, AND HOW TO FIND THE REED FOR SAME, &c., &c.

Take a piece 36 inches wide 19 x 19 square. This cloth should stand say $2\frac{1}{4}$ inches wider in the reed than the woven cloth itself. 19 ends to the $\frac{1}{4}$ inch multiplied by 4 gives 76 ends to the inch; thus the cloth counts 76 ends to the inch—as seen through the glass when examined on the counter.

19 x 4 = 76 x 36 = 2736 ends in the piece.

38·25 inches at the reed.

71·50 reed.

2735 ends in $38\frac{1}{4}$in. at the reed with a $71\frac{1}{2}$ reed.

If a $71\frac{1}{2}$ reed gives 2735 ends, how many ends will a 70's reed give? Less, therefore.

As $71\frac{1}{2}$ : 70 :: 2735
70

71·50)19155000(2679 ends. Ans.

Or 38·25 x 70 = $2577\frac{1}{2}$ ends. 2736
2677
59
28 selvege
87

Or 36 x 76 = 2736
$28\frac{1}{4}$

36)103660(2879
2736
36)143(4 ends to the inch
144 contraction.

| | | |
|---|---|---|
| Or 36 x 70 = 2520 | | 2736 |
| 143 | | 36 |
| —— | | —— |
| 2663 | | $38\frac{1}{4}$)10449600 |
| 28 | | —— |
| 59 | | 2732 |
| | 2677 | 4 |
| —— | 2663 | —— |
| 2750 | —— | 2736 |
| 14 | 14 | —— |
| —— | —— | |
| 2736 | | |
| —— | | |

If a 76 gives $38\frac{1}{4}$ what for 36in.? Less, therefore.

As $38\frac{1}{4}$ : 36 : : 76

36

38·25)2736·00($71\frac{1}{2}$

Again—

19 x 4 = 76 x 36 = 2736    2736

70 x $38\frac{1}{4}$ = 2677    2677

| | | |
|---|---|---|
| 59 | 2667 | 59 difference. |
| 28 | 28 selvege | 28 selvege. |
| — | —— | — |
| 87 | 2705 | 31 over. |
| | 31 | |
| | —— | |
| | 2736 | |
| | —— | |

It is therefore seen that a 70's reed is required.

To find the reed—

$$\frac{2736 \text{ ends wanted or in the cut.}}{\times 36}$$

$$38\tfrac{1}{4})\overline{104496}00$$

$$2732$$

Per centage of contraction—

As 36 : $38\frac{1}{4}$ : : 100

$$100 \times 38\tfrac{1}{4}$$

$$36)\overline{3825}$$

$106\frac{1}{4}$ or $6\frac{1}{4}$% contraction.

76 ends to the inch in the reed is really a 76 reed (the cloth standing in the reed $38\frac{1}{4}$ inches.) The cloth when on the counter will measure 36in., thus milling-up $2\frac{1}{4}$in. or $6\frac{1}{4}$% ; therefore the reed required to give the exact right number of ends for this price is—

$$76 \times 6\tfrac{1}{4}$$

$$456$$

$$19$$

$$100)\overline{475} \qquad\qquad 76 - 4\tfrac{3}{4}$$

$4\frac{3}{4}$ less $71\frac{1}{4}$ so that a 70's reed will do or pass in this case.

For the length, number of back beams, and length required for each beam.

An order for say 100 pieces, 100 yards long. 100 x 100 = 10,000 yards woven cloth.

If it will mill up 1 yard in 20 yards, how many yards will it mill up in 10,000 yards?

20 : 10,000 :: 1
1

20)10,000

It will mill up 500 yards in 10,000 yards, therefore you require 10,500 yards of yarn in length for these 100 pieces; in addition to which a further allowance must be made for waste, *i.e.*, for what remains on the warpers, tapers, and winders' beams. The general allowance is 2 yards to each finished taper's beam, or for every beam doffed at the tape frame, and also 2 yards extra to be allowed for the waste on each weaver's beam; it is likewise necessary to still further allow or add a little more for the length left on the tape frame, round the cylinder and between the rods, &c. Divide the total length of yarn by the number of beams required, and you get the right length to put on each warper's beam.

For the number of ends in each warper's beam say 2736 ends in a piece of cloth 36 in. wide, as above:

If 5 beams. 2736 ÷ 5 = 547 ends each per beam.
If 6 „ 2736 ÷ 6 = 456 „

According to the number of bobbins the creel will hold.

# CONCLUSION.

Technical education has now become one of the institutions of this country (as for some time past it has been with our neighbours), and is recognised by all, both at home and abroad, as a matter of the very first importance; we would, therefore, in conclusion, draw the reader's attention to the few following remarks in connection therewith. England has undoubtedly in the past been a long way behind other countries with regard to Technical Instruction. On the Continent generally, Technical Schools and Institutes are and for many years have been doing good sound work, in teaching the student how to work with both head and hand. When, however, it became fully realised that we compared so very unfavourably with foreign countries, the matter was taken up in real and serious earnest, and now we have established all through the country colleges, institutes, and science classes, for imparting technical education that may be favourably compared with that of other countries; in fact, it may with confidence be said, that we are now well abreast of our foreign competitors. We in England have not taken in hand this subject of technical education one moment too soon; and it is earnestly to be hoped, now that the rising generation have the opportunity, that young men will take advantage of the grand opportunities that are placed within their reach. The actual working day in England is so short, and the number of hours worked per week in our factories and workshops are so very few compared with the hours worked on the continent, that no young man can reasonably complain of want of time; an hour or two in the evening easily may and should be spent at the Technical School, and this should be joined with quiet, careful, and thoughtful study at home, of some of the technical books and journals which may now-a-days be had at almost any of the public libraries, or bought for a mere nominal sum. Thus, as we have already pointed out, is placed within the easy reach of young men the means of becoming educated in both theory and practice, so that when they may have to take charge of and manage an establishment or any portion of it, they may be able to bring to bear an intelligent and practical knowledge, which has become absolutely necessary to ensure success and keep pace with the times.

It should, and doubtless will ere long be insisted upon, that before any young man is given any position of trust in any one of our numerous factories, he must have gone through a regular course of study at the Technological College, and have obtained a certificate of merit there. By some such means as these the general standard of proficiency will be raised, and in the future, Englishmen and English trade will be enabled to compete successfully with our now many and increasing rivals, as has ever been the case.

From England's unique and peculiar position, it is incumbent upon her that she should not only hold her own in all the markets of the world, but she must of necessity be ever ahead of all her compeers. In the past she has held, as she still does hold, this proud and enviable position. It behoves each and all of us, individually and collectively, to maintain this supremacy. Although the English workman is, at the present time, no doubt, at the head of *all* workmen in practical knowledge of his work, mechanical skill, physical endurance, and "all round" capacity, he would, certainly, with more education, be even better than he is. The near future certainly makes it plain that all our skill and learning will be required to enable us to hold our own; for it must be remembered—and the sooner this is fully recognised the better—that foreign competition, strengthened by the growing skill of foreign operatives, is no nightmare, but a stern reality. Without fear of contradiction we assure our readers, from personal experience, that such is the case.

Many of the continental factories are built upon the model of the foremost mills in Lancashire, and are also furnished and fitted up with the newest and best of English machinery; in numberless instances English skill and energy likewise manage and direct these establishments.

As proof of what rapid strides and real progress our foreign competitors have made and are making, it only needs to be pointed out that many of their industrial establishments are completely furnished and fitted up with machinery of their own make, and are successfully managed and carried on by themselves, without any outside aid whatever. It will therefore be seen that our Continental rivals—notably France, Germany, Belgium, and Switzerland—are fast approaching, if they have not already reached, our own high standard, both as regards the making of machinery and the quality and quantity of work turned off; their young men have the considerable advantage of high-class, well organized, and well established technical schools, and besides being brought up upon their own home-made machinery, and under their own native management, have the additional advantage of working upon the best English machinery, and learning their respective trades under the most skilled English managers and overlookers. That they are fully alive to the many and great advantages with which they are surrounded, and that they very wisely enjoy and make the most of them, no one, who knows anything at all about the matter, will attempt to deny; that they are now well able and do successfully compete with us in our own markets and upon our own terms, our own merchants and manufacturers are well able to bear witness to.

England is no longer alone, and no longer holds undivided sway in all the markets of the world; on every hand we meet friendly and clever rivals; it would be well if this fact were better recognised, and if Englishmen would throw off some of that narrow minded egotism, for which they are so well known all the world over. Let us realise and grasp the situation, there will then be no doubt as to the result. We shall and must prove equal to the occasion.

H. E. W.

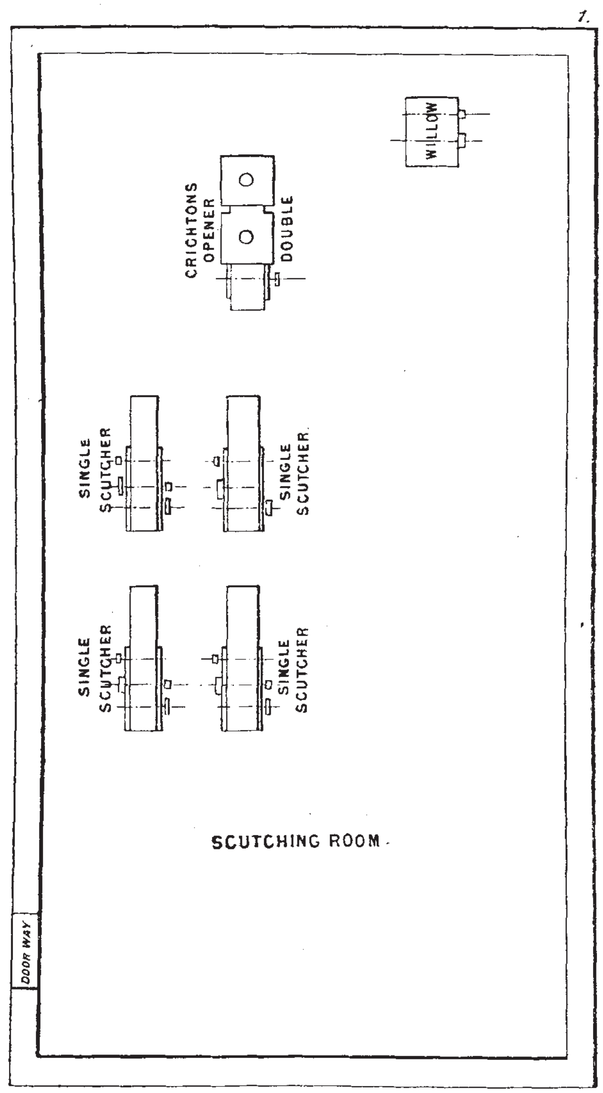
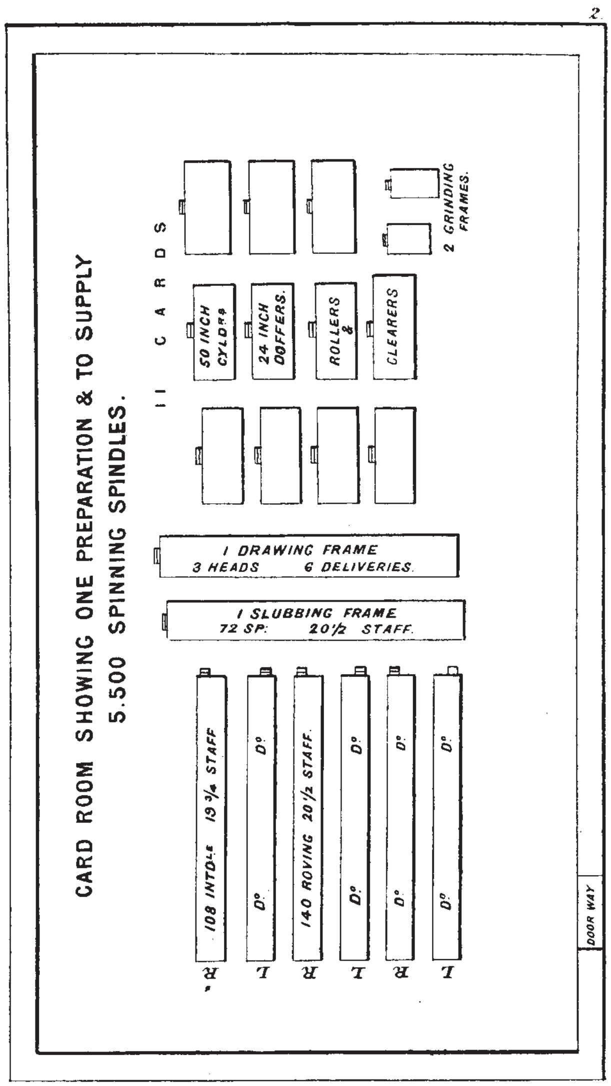

1.
WILLOW
CRICHTONS OPENER
DOUBLE
SINGLE SCUTCHER
SINGLE SCUTCHER.
SINGLE SCUTCHER
SINGLE SCUTCHER
SCUTCHING ROOM.
DOOR WAY

PLATE 1.

Q



2
CARD ROOM SHOWING ONE PREPARATION & TO SUPPLY
5.500 SPINNING SPINDLES.
11 CARDS
50 INCH CYLDRS
24 INCH DOFFERS.
ROLLERS & CLEARERS
2 GRINDING FRAMES.
1 DRAWING FRAME
3 HEADS 6 DELIVERIES.
1 SLUBBING FRAME
72 SP: 20½ STAFF.
108 INTDLE 19¾ STAFF
140 ROVING 20½ STAFF.
Do
R
L
DOOR WAY


PLATE 2.

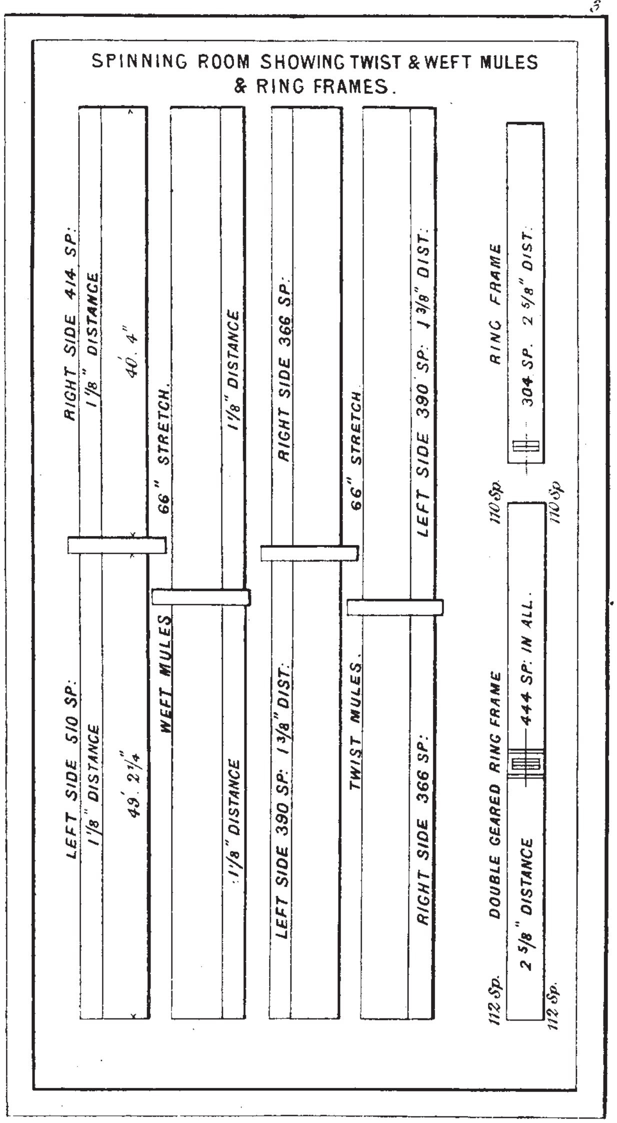

SPINNING ROOM SHOWING TWIST & WEFT MULES & RING FRAMES.
RIGHT SIDE 414 SP.
1⅛" DISTANCE
40' 4"
LEFT SIDE 510 SP.
1⅛" DISTANCE
49' 2¼
66" STRETCH.
WEFT MULES
1⅛" DISTANCE
1⅛" DISTANCE
RIGHT SIDE 366 SP.
LEFT SIDE 390 SP. 1⅜" DIST.
66" STRETCH.
TWIST MULES.
LEFT SIDE 390 SP. 1⅜" DIST.
RIGHT SIDE 366 SP.
RING FRAME
304 SP. 2⅝" DIST.
110 Sp.
110 Sp.
DOUBLE GEARED RING FRAME
444 SP. IN ALL.
2⅝" DISTANCE
112 Sp.
112 Sp.

PLATE 3.

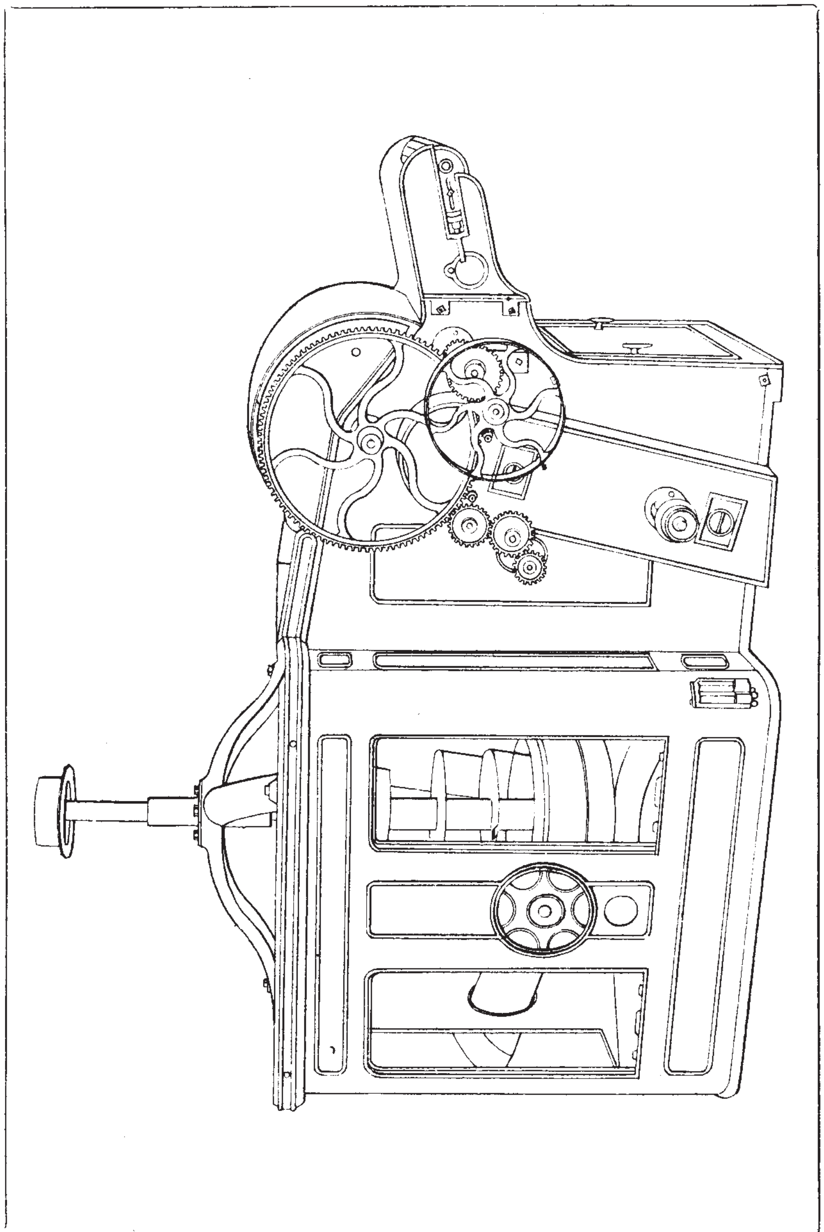


PLATE 4.—CRIGHTON'S OPENER.

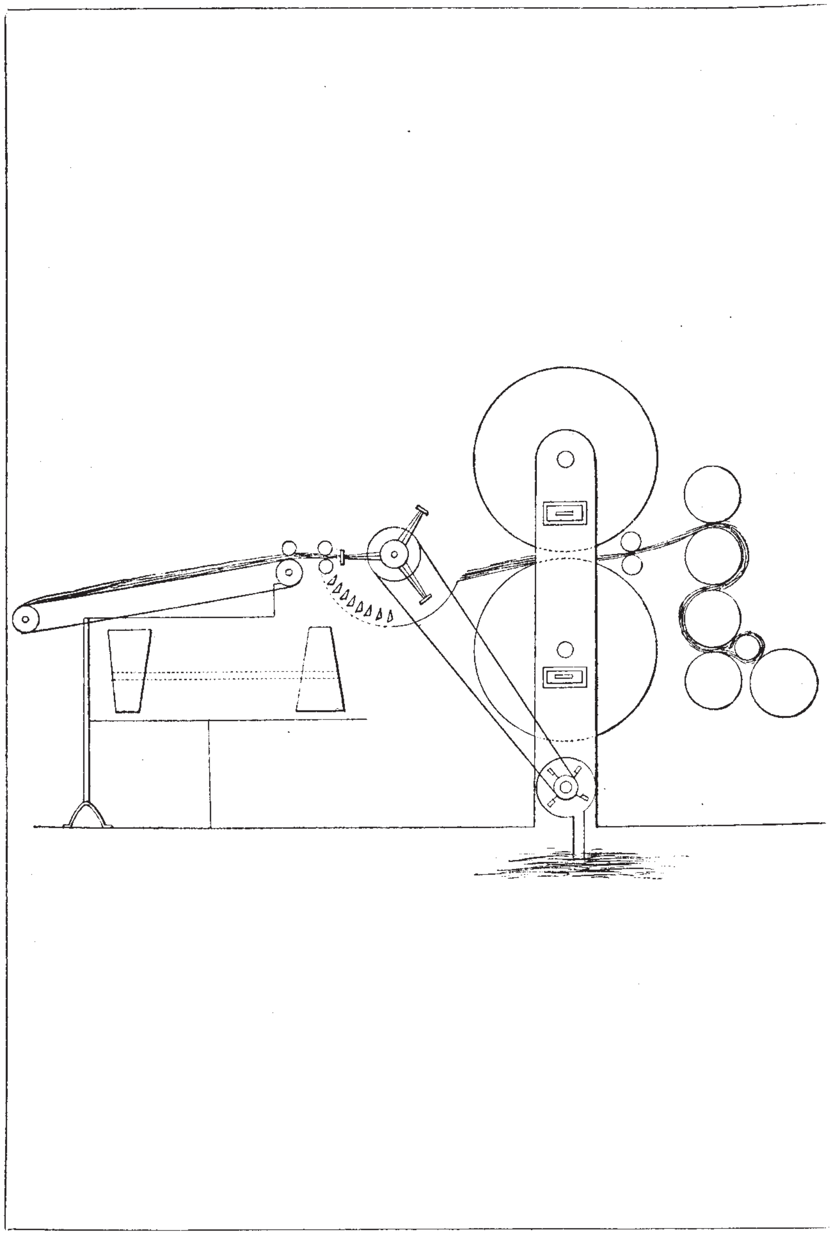


PLATE 5.—SINGLE BEATER SCUTCHER.

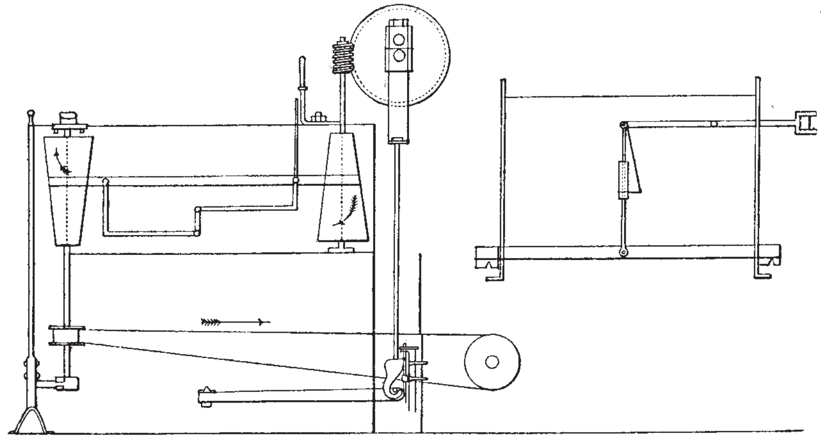


PLATE 6.—LORD'S PATENT FEED MOTION.

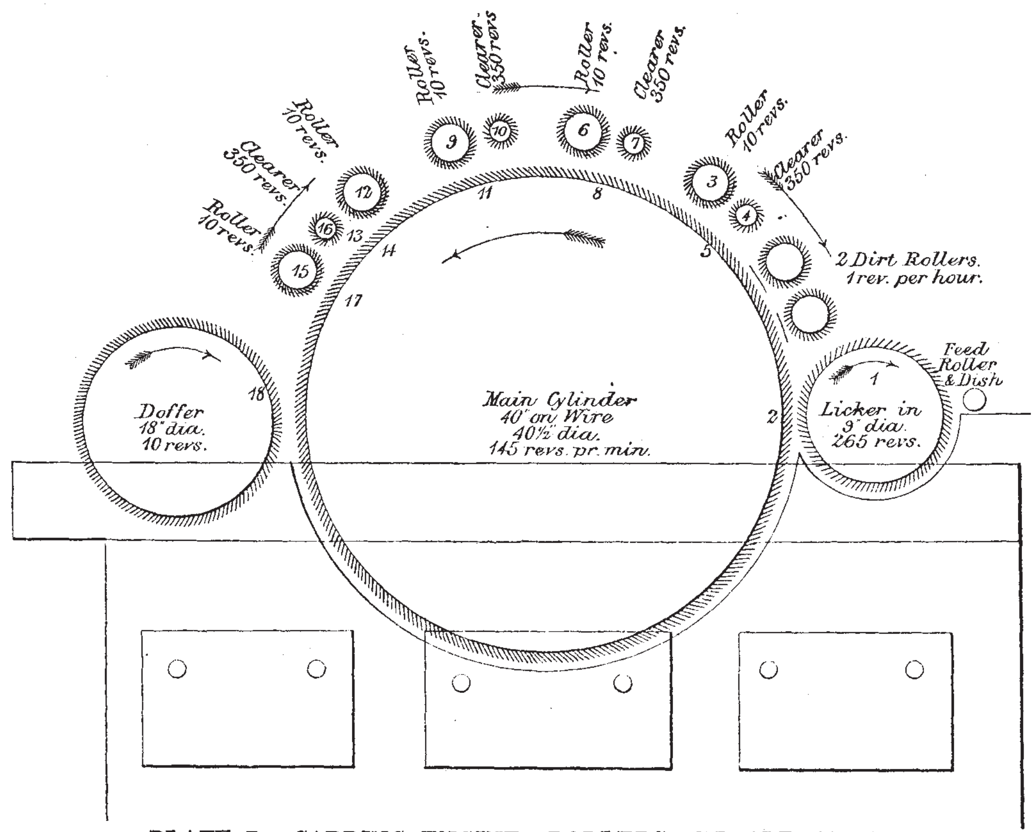



PLATE 7.—CARDING ENGINE—ROLLERS AND CLEARERS.

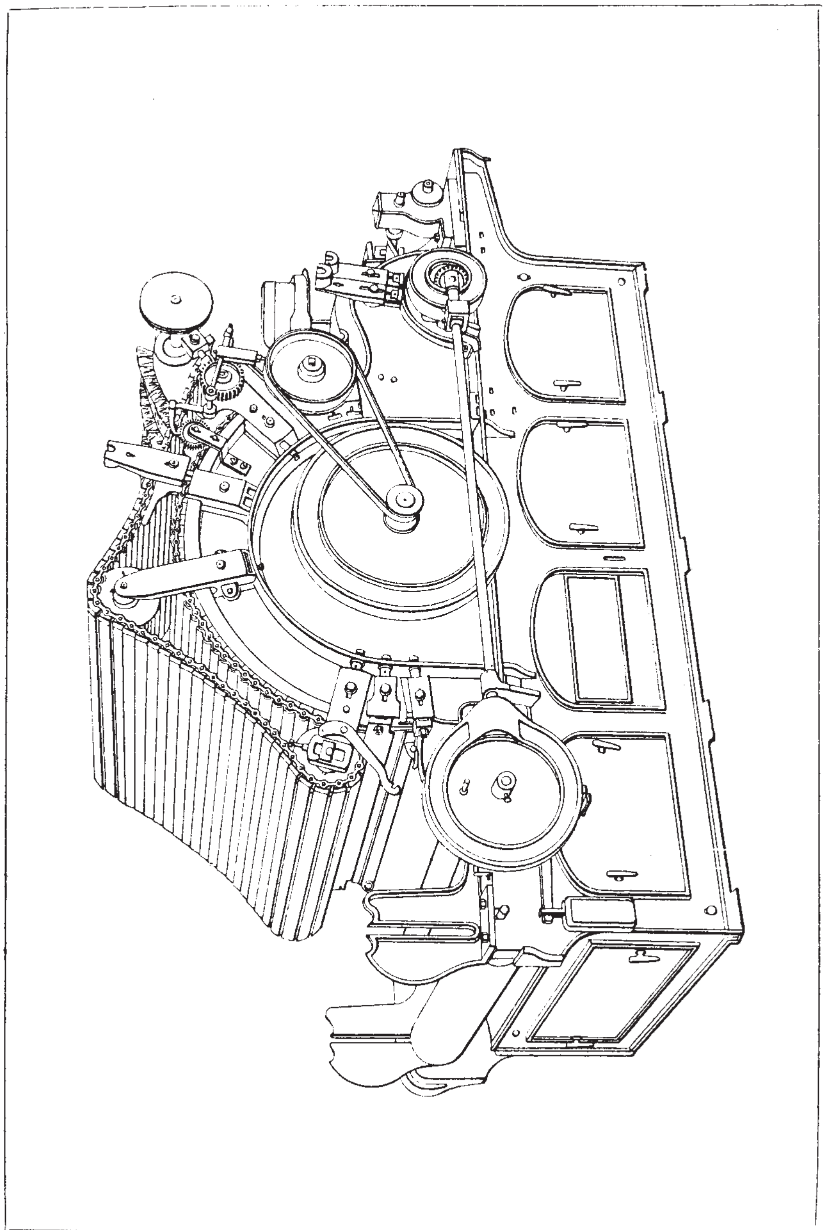


PLATE 8.
CARDING ENGINE—SELF-STRIPPING REVOLVING FLATS.

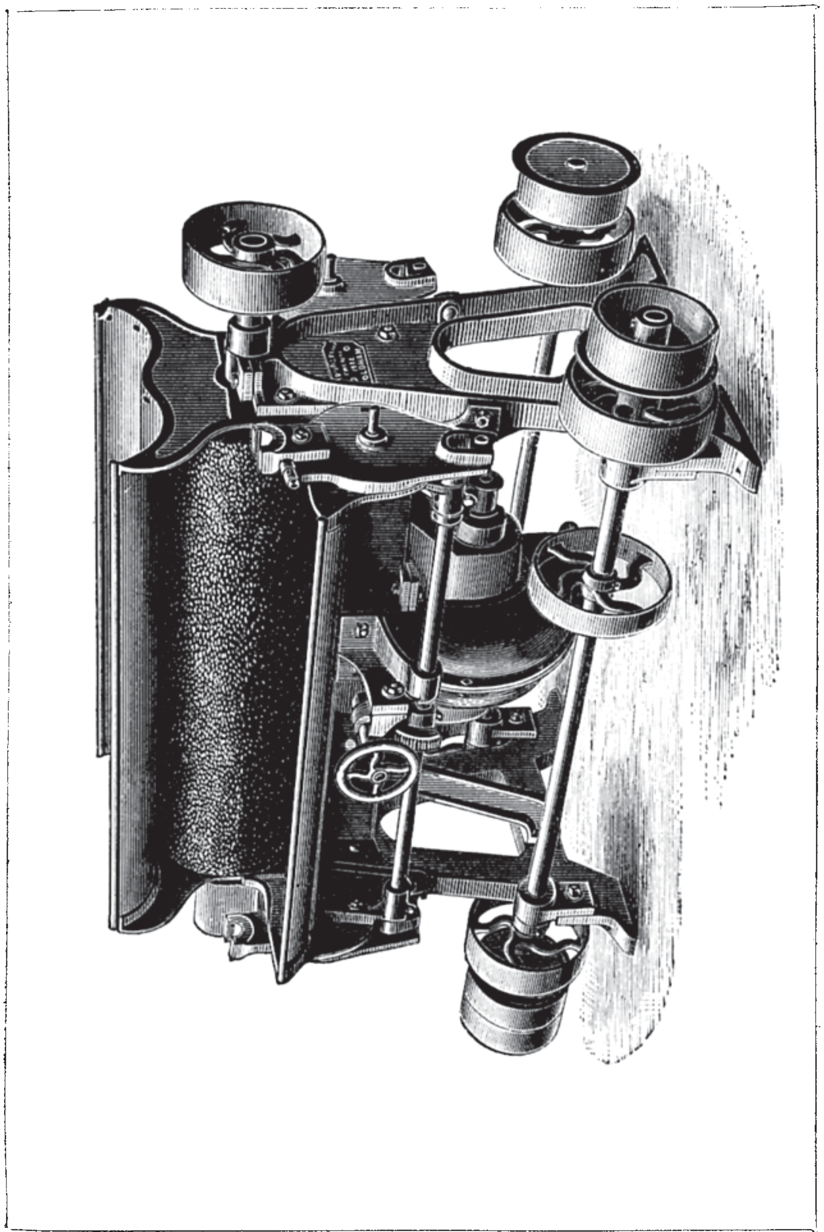


PLATE 9.—DRONSFIELD'S PATENT GRINDING FRAME.

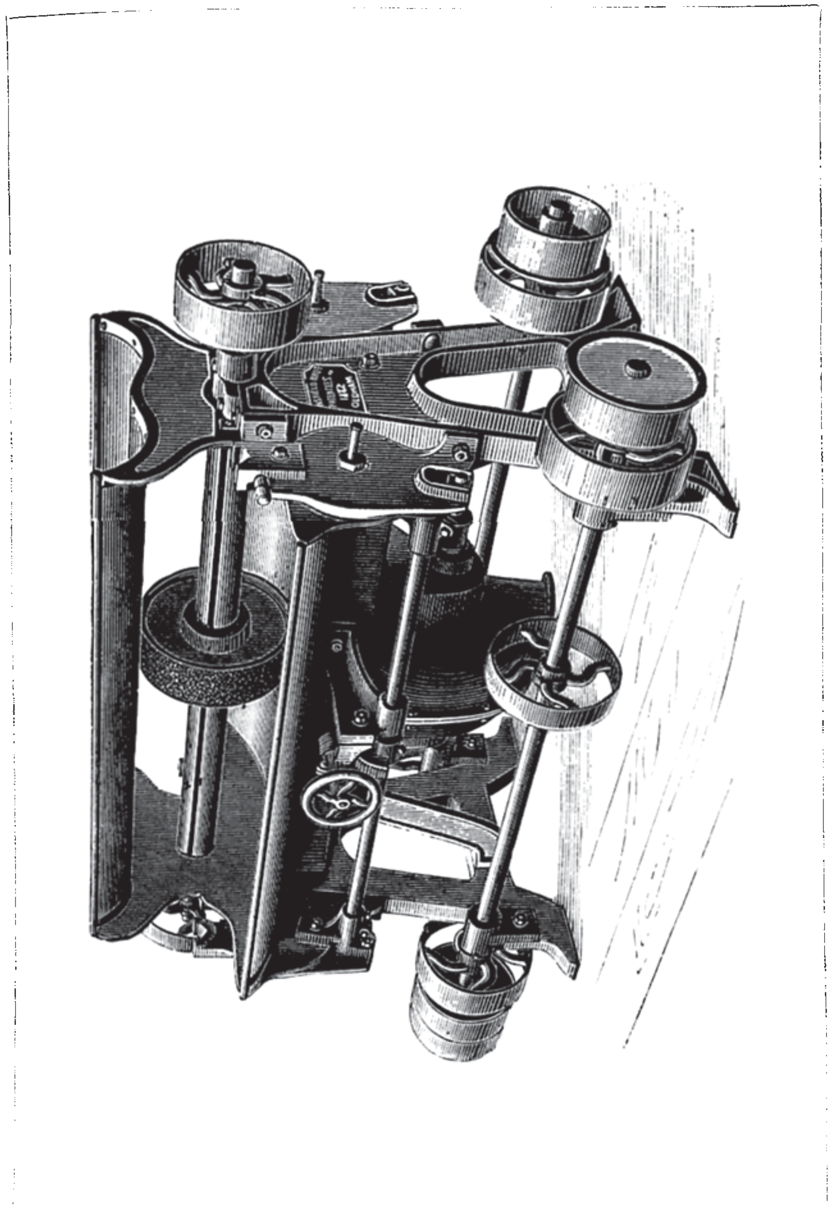


PLATE 10.—DRONSFIELD'S PATENT GRINDING FRAME.

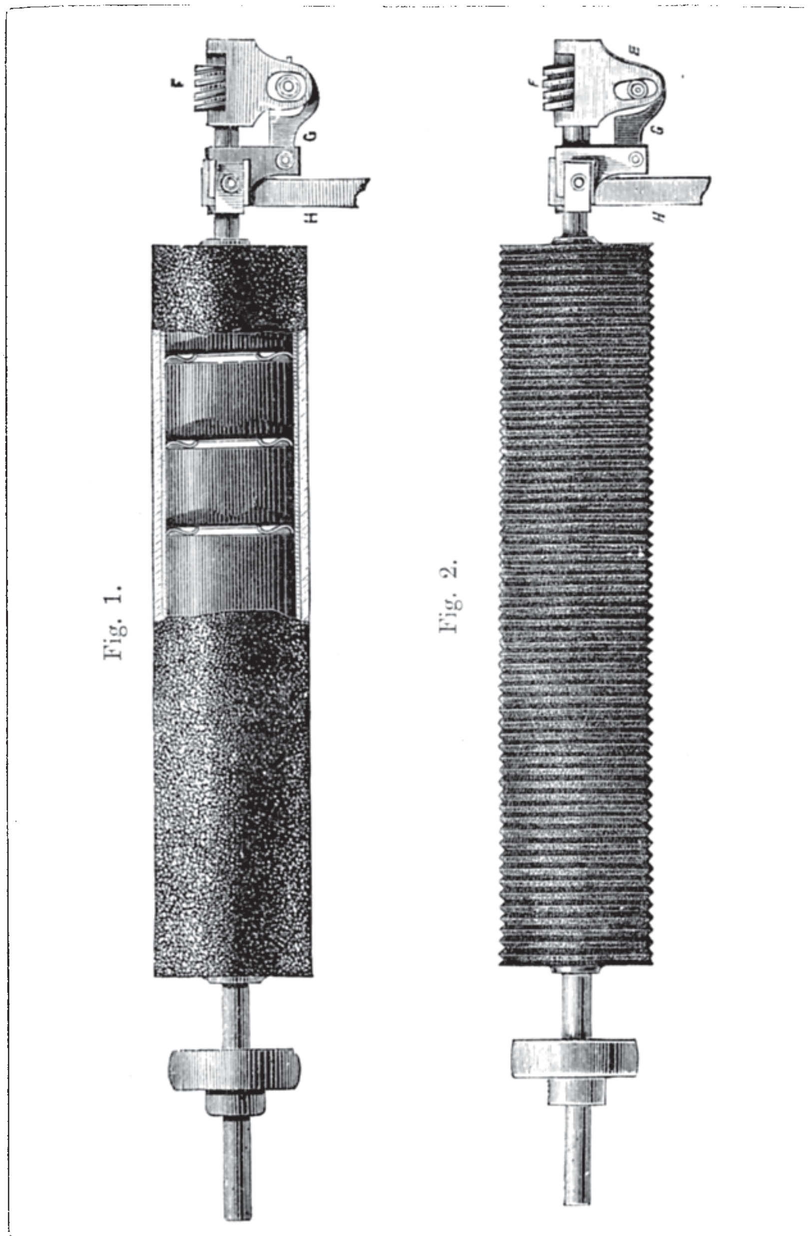



PLATE 11.—GRINDING ROLLERS.

Fig. 1.

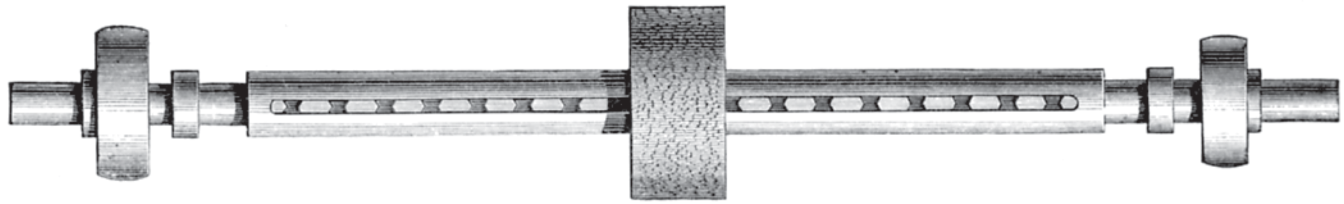


Fig. 2.

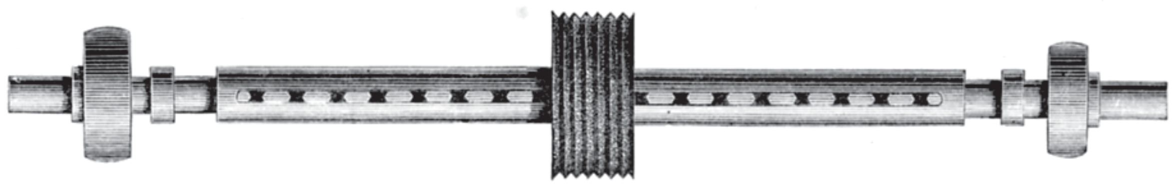


PLATE 12.—THE HORSFALL TRAVERSING EMERY WHEEL GRINDER.

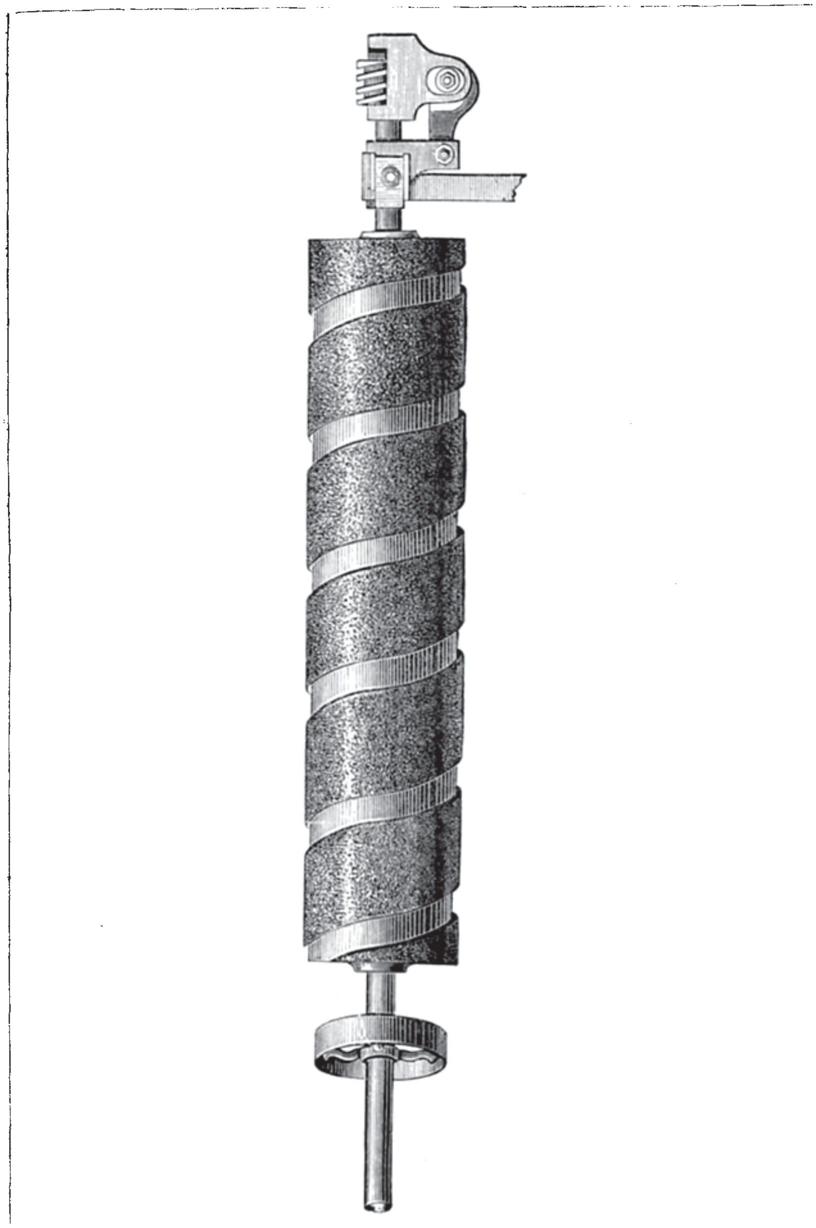


PLATE 13.—IMPROVED GRINDING ROLLER FOR CARDS.

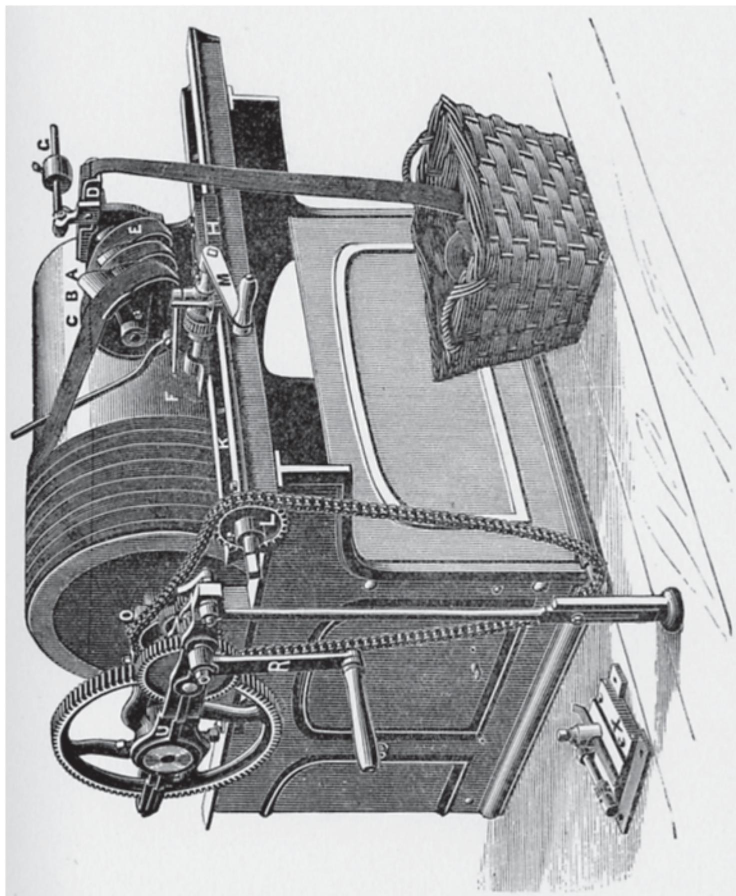


PLATE 14.—DRONSFIELD'S PATENT CARD MOUNTING MACHINE.

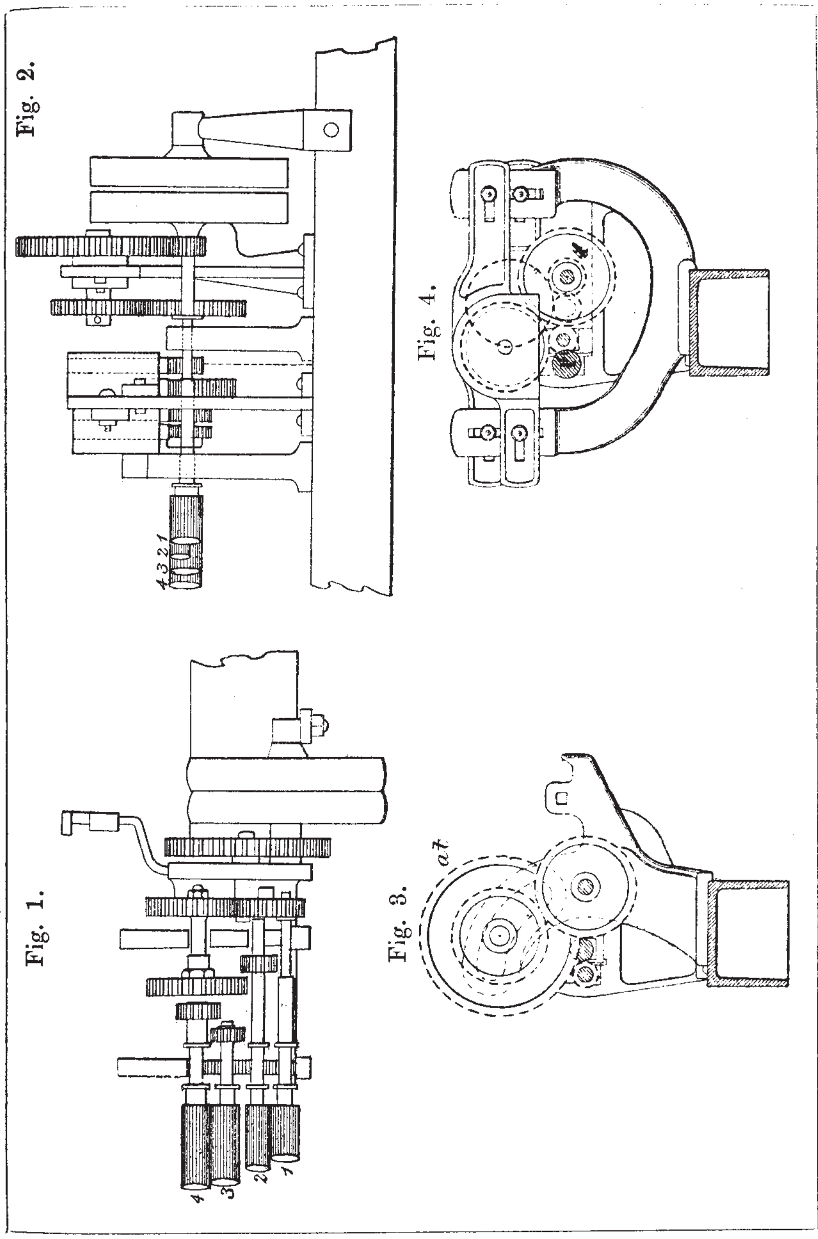



PLATE 15.—PLATT'S DRAWING FRAME.

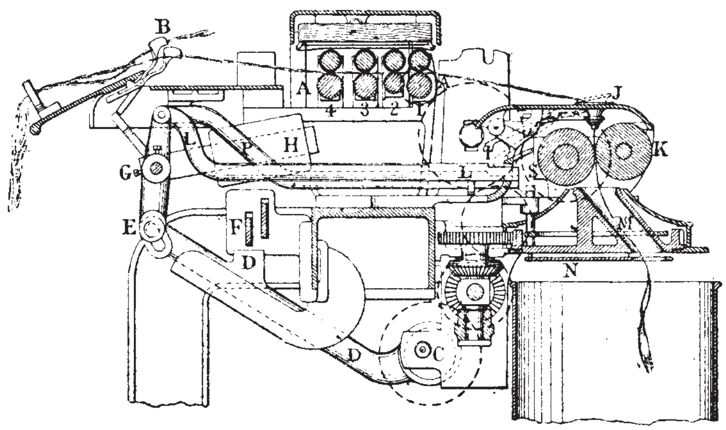



PLATE 16.—PLATT'S DRAWING FRAME, SHEWING FRONT AND BACK STOP MOTIONS AND CAN STOP MOTION.

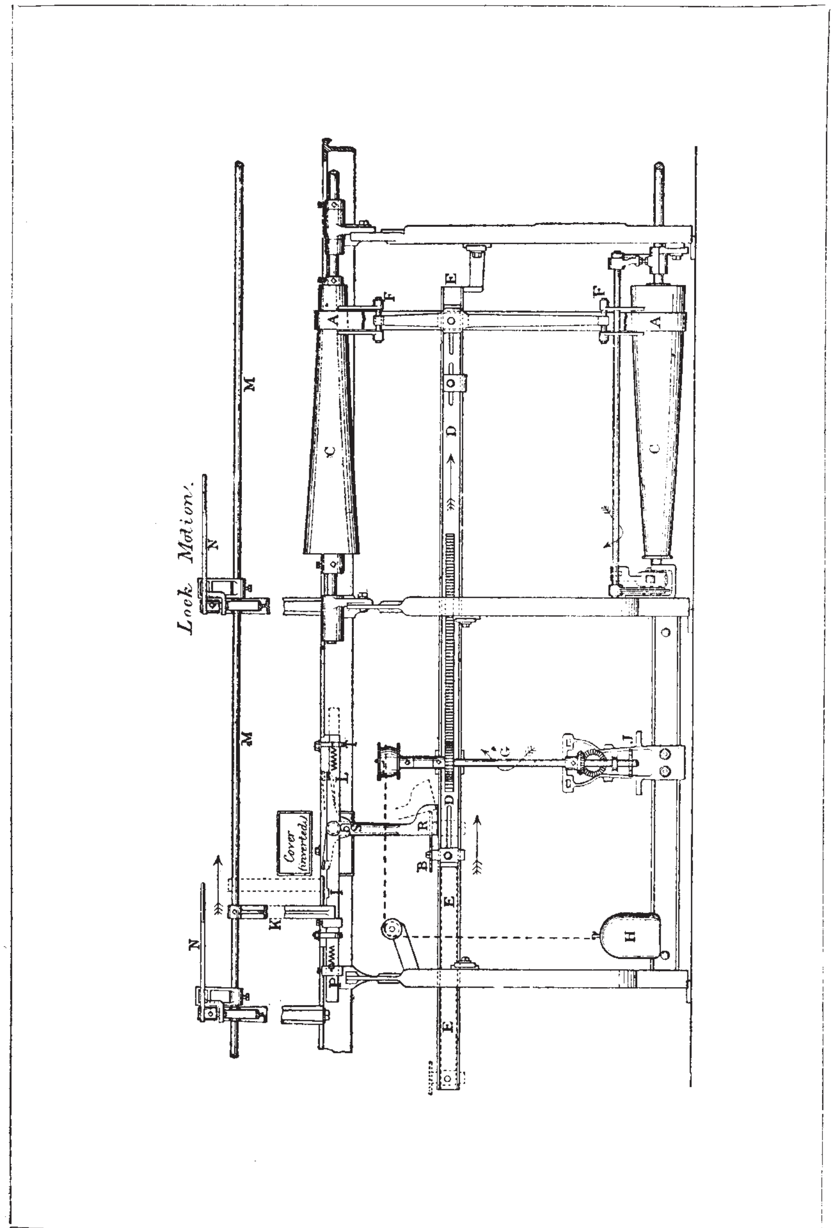



PLATE 17.—LOCK MOTION, &c.—SLUBBING, INTERMEDIATE, AND ROVING FRAMES.

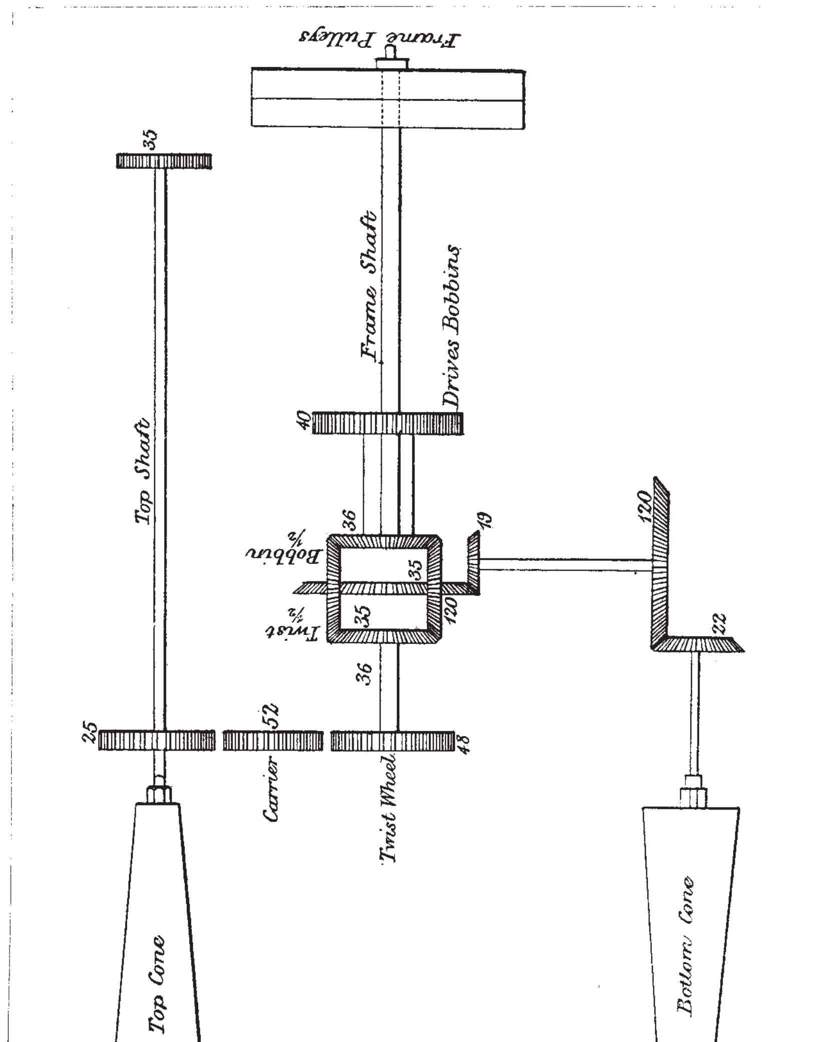



PLATE 18.—SLUBBING, INTERMEDIATE, AND ROVING FRAMES.

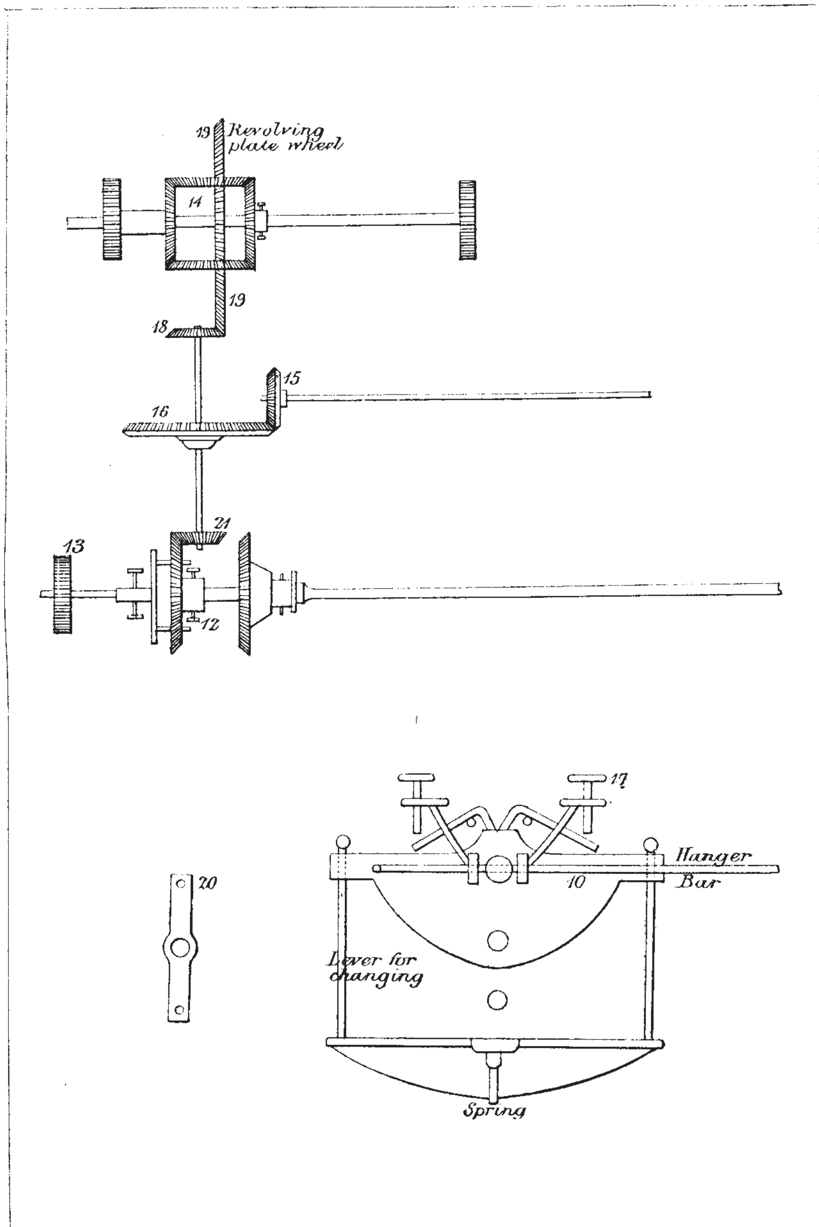



PLATE 19.—SLUBBING, INTERMEDIATE, AND ROVING FRAMES.

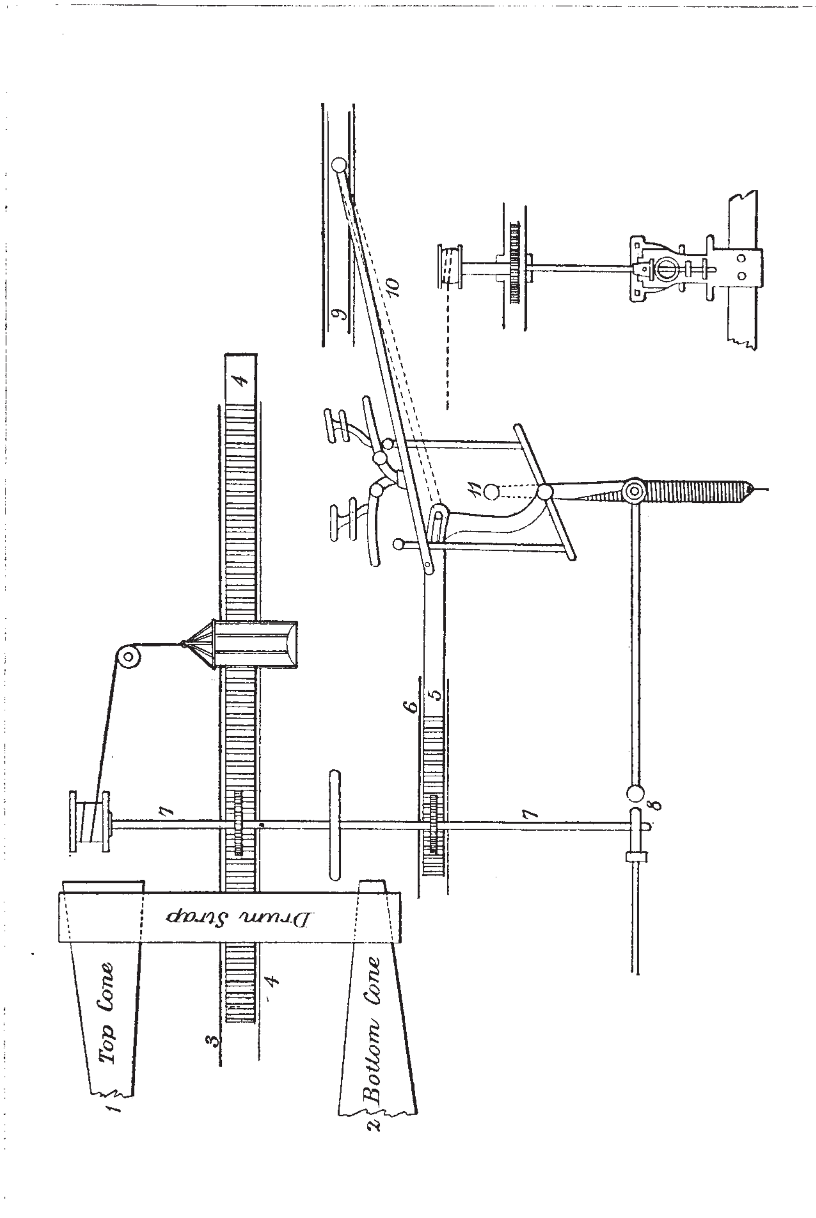
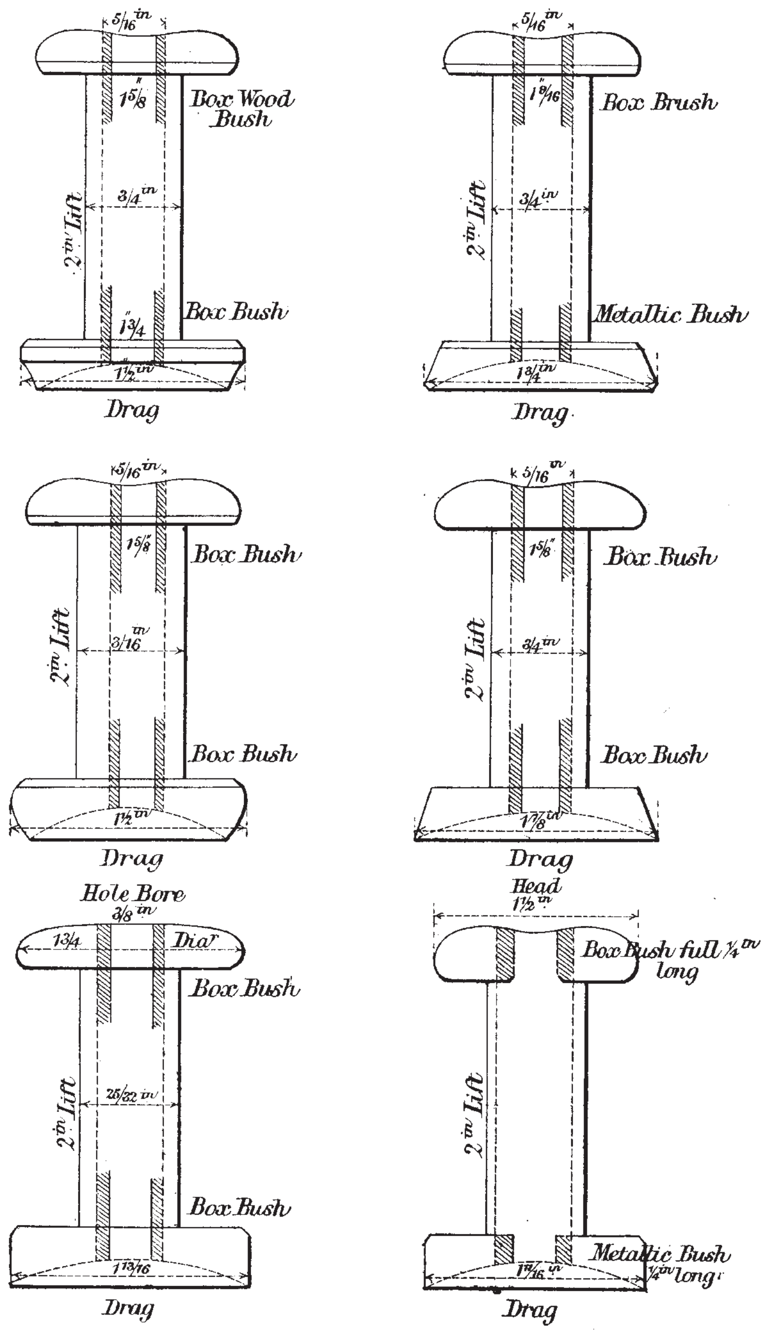



PLATE 20.—SLUBBING, INTERMEDIATE AND ROVING FRAMES.



5/16 in
1 5/8"
Box Wood Bush
3/4 in
2 in Lift
1 3/4"
Box Bush
1 1/2 in
Drag
5/16 in
1 9/16"
Box Brush
3/4 in
2 in Lift
Metallic Bush
1 3/4 in
Drag
5/16 in
1 5/8"
Box Bush
3/16 in
2 in Lift
Box Bush
1 1/2 in
Drag
5/16 in
1 5/8"
Box Bush
3/4 in
2 in Lift
Box Bush
1 7/8 in
Drag
Hole Bore
3/8 in
1 3/4
Diar
Box Bush
25/32 in
2 in Lift
Box Bush
1 13/16
Drag
Head
1 1/2 in
Box Bush full 1/4 in long
2 in Lift
Metallic Bush
1/4 in long
1 11/16 in
Drag


PLATE 21.

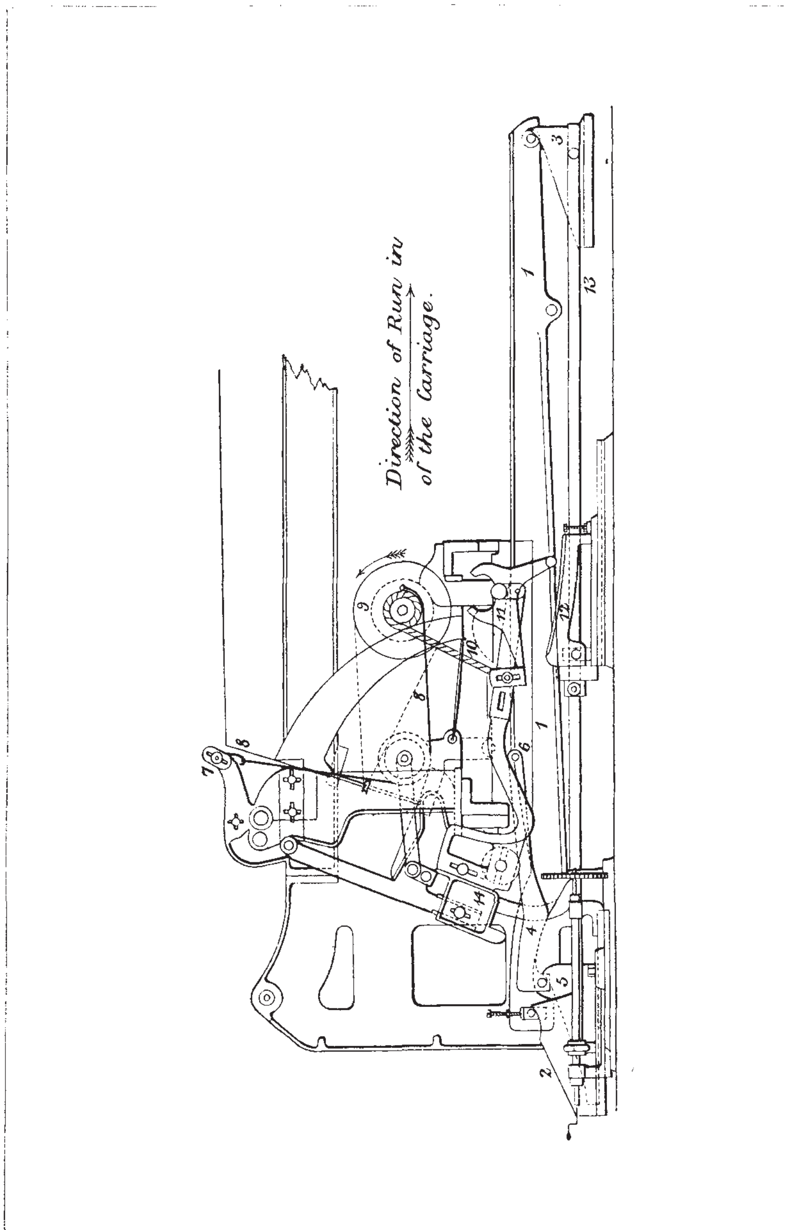



PLATE 22.—THE SELF-ACTING MULE, WITH PLATT'S BACKING-OFF CHAIN TIGHTENING MOTION.

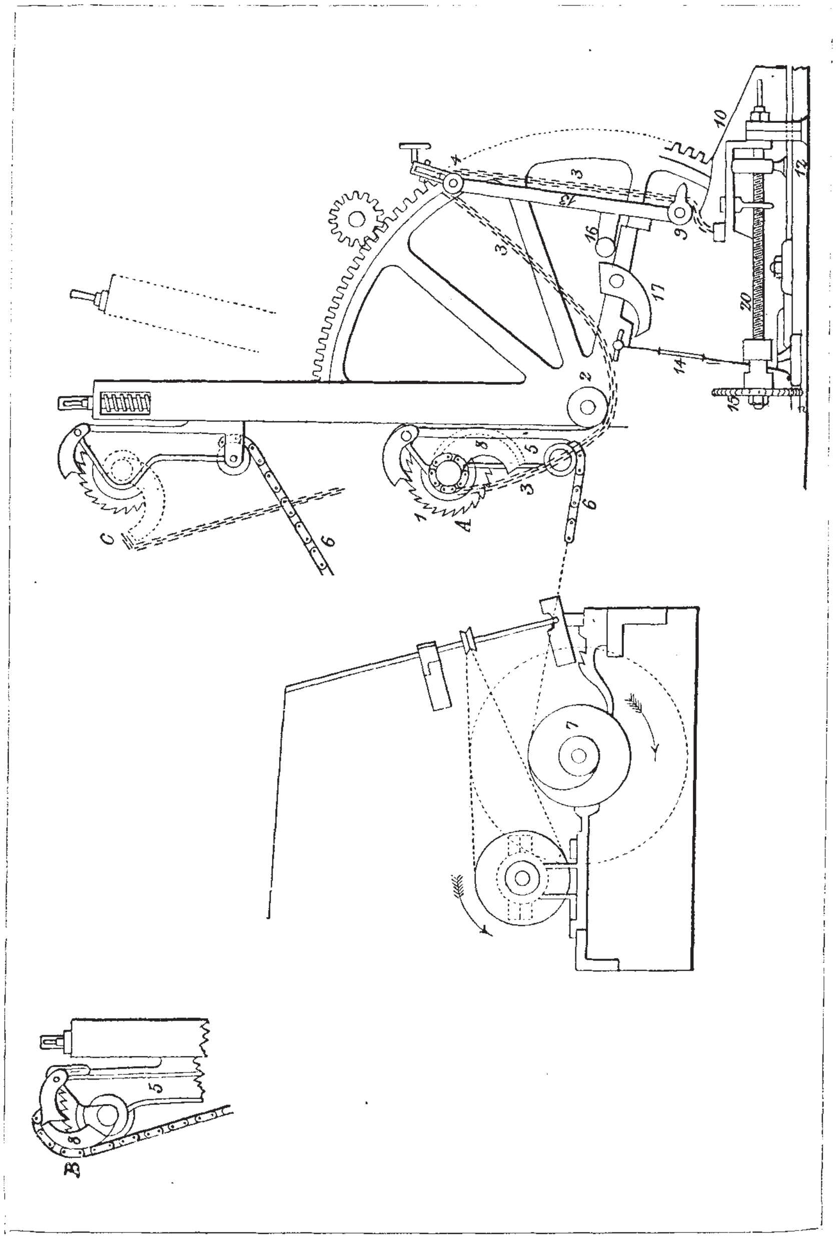


PLATE 23.—THE SELF-ACTING MULE, WITH PLATT'S AUTOMATIC NOSING MOTION.

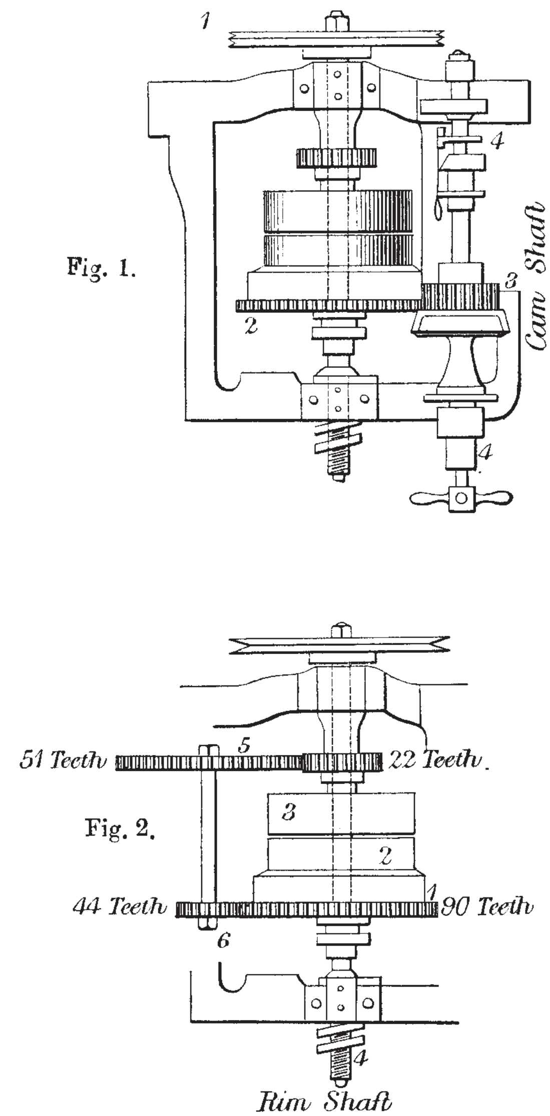



PLATE 24.—THE CAM SHAFT.

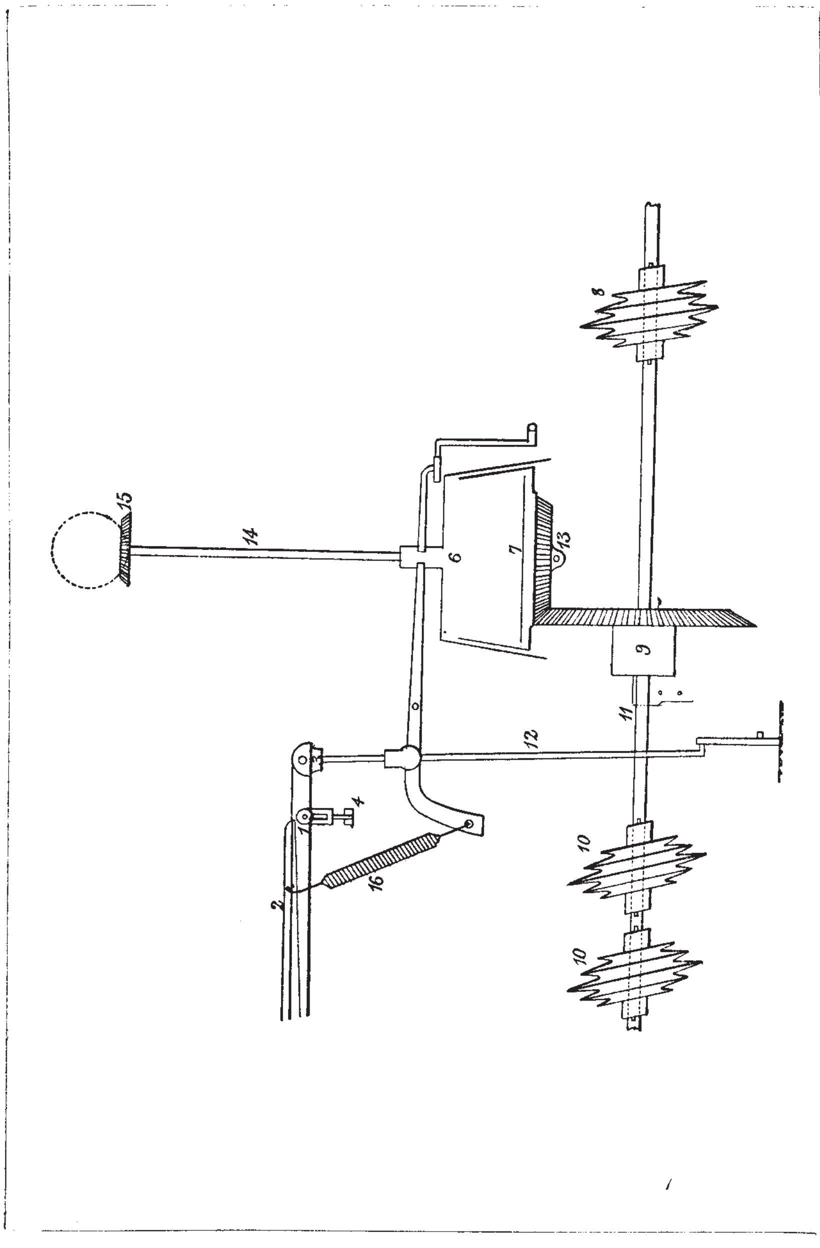



PLATE 25.—THE TAKING-IN MOTION.

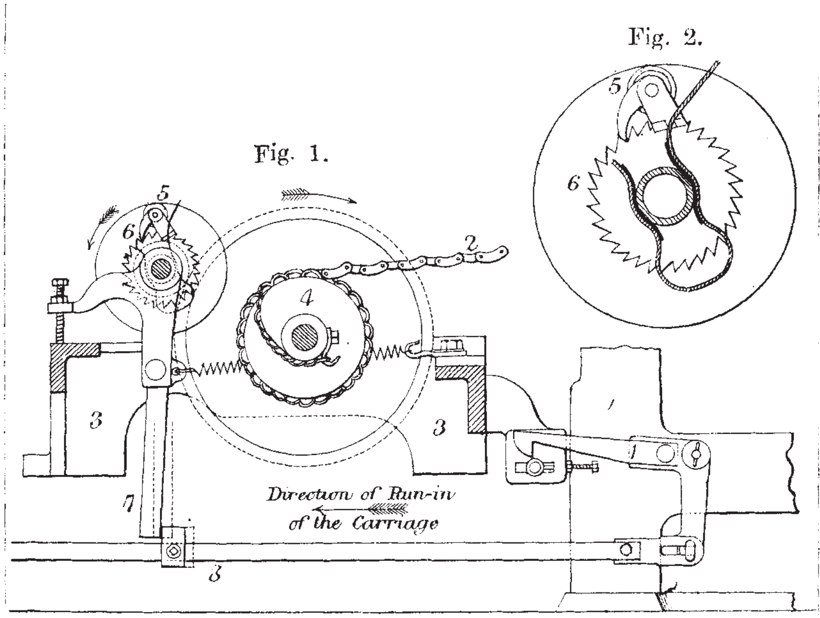



PLATE 26.—THE WINDING MOTION.

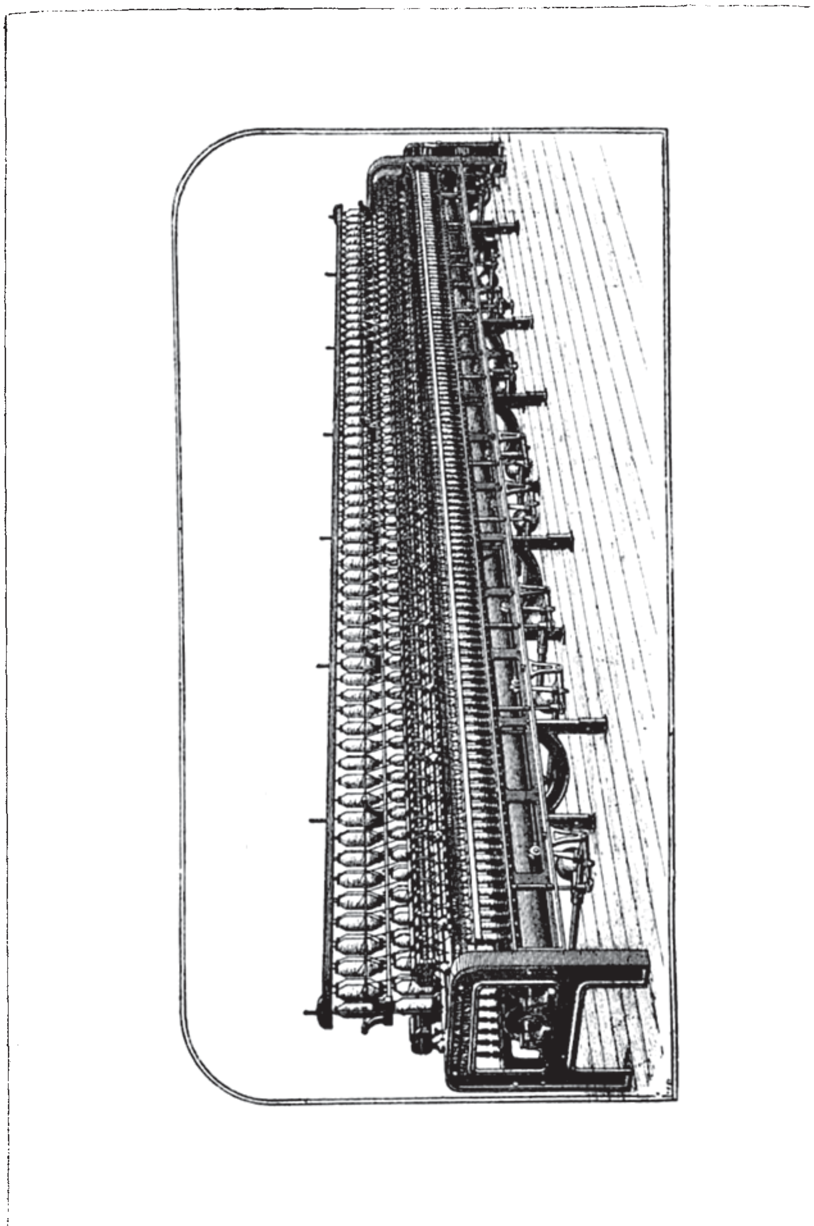


PLATE 27.—HOWARD AND BULLOUGH'S RING FRAME.

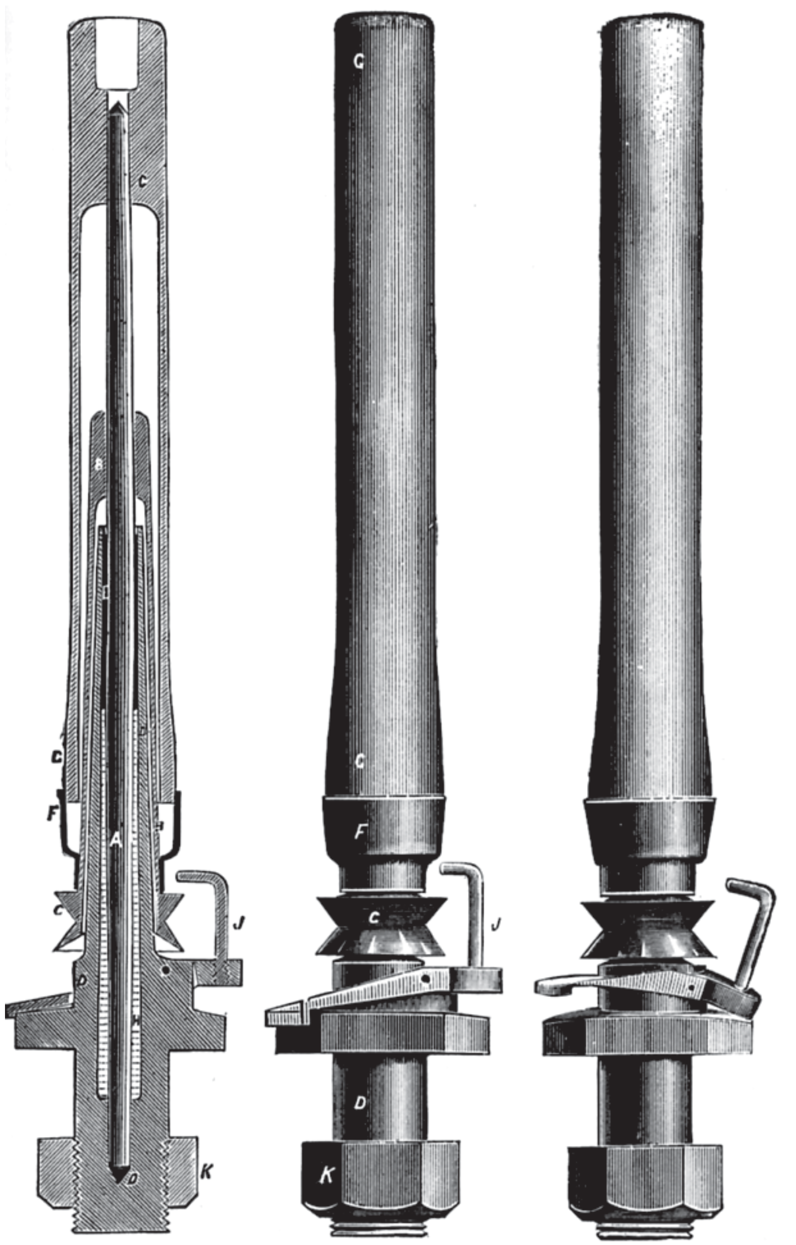



PLATE 28.—HOWARD AND BULLOUGH'S RABBETH SPINDLE.

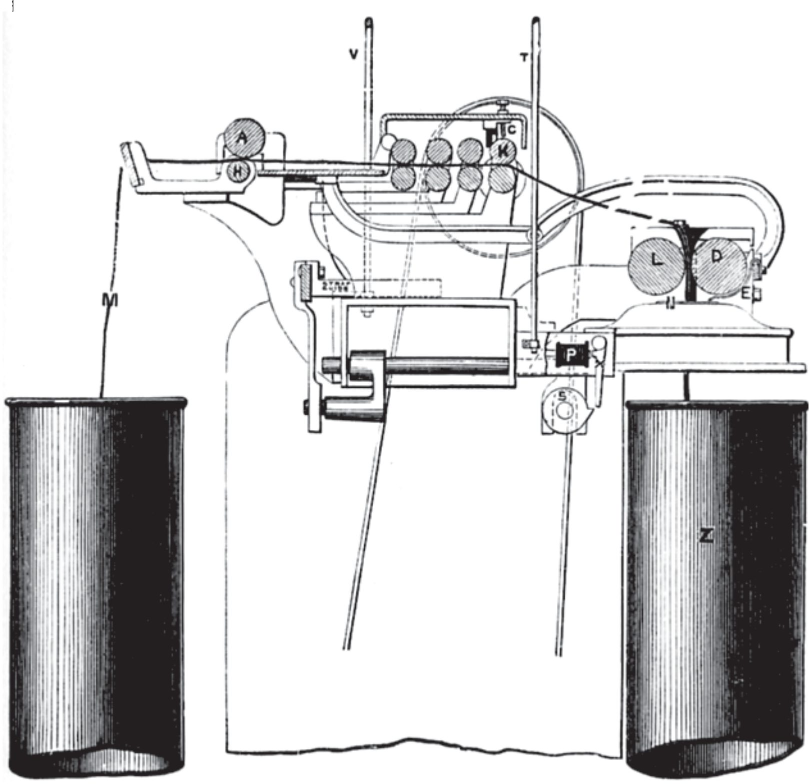



PLATE 29.—THE DRAWING FRAME, WITH HOWARD AND BULLOUGH'S ELECTRIC STOP MOTION.

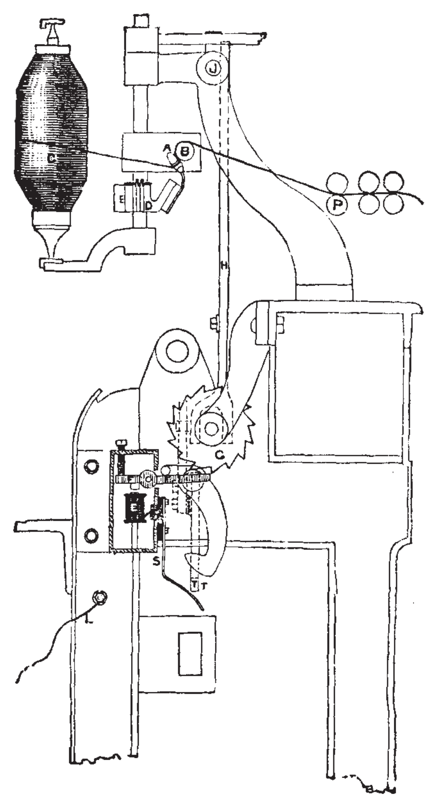


PLATE 30.—THE INTERMEDIATE ROVING FRAME, WITH HOWARD AND BULLOUGH'S ELECTRIC STOP MOTION.

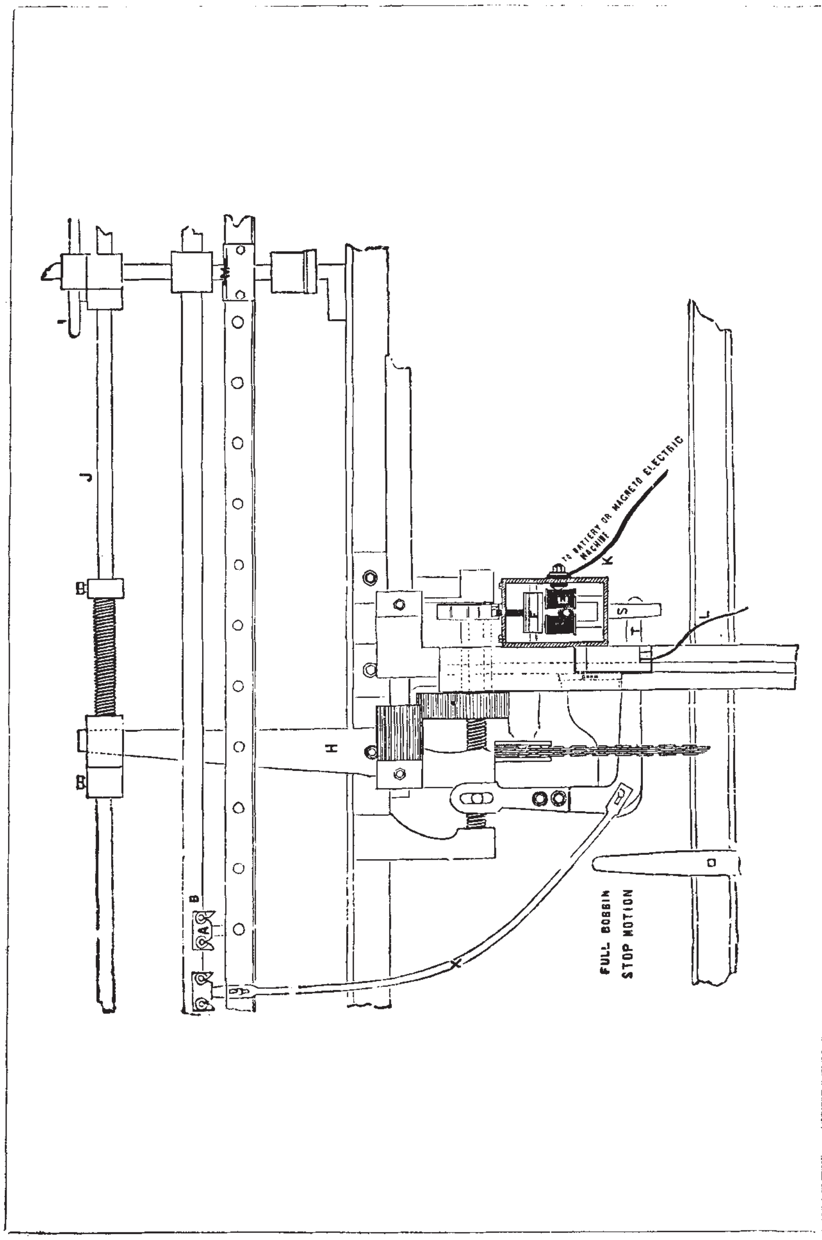



PLATE 31.—INTERMEDIATE ROVING FRAME, WITH HOWARD AND BULLOUGH'S ELECTRIC STOP MOTION.

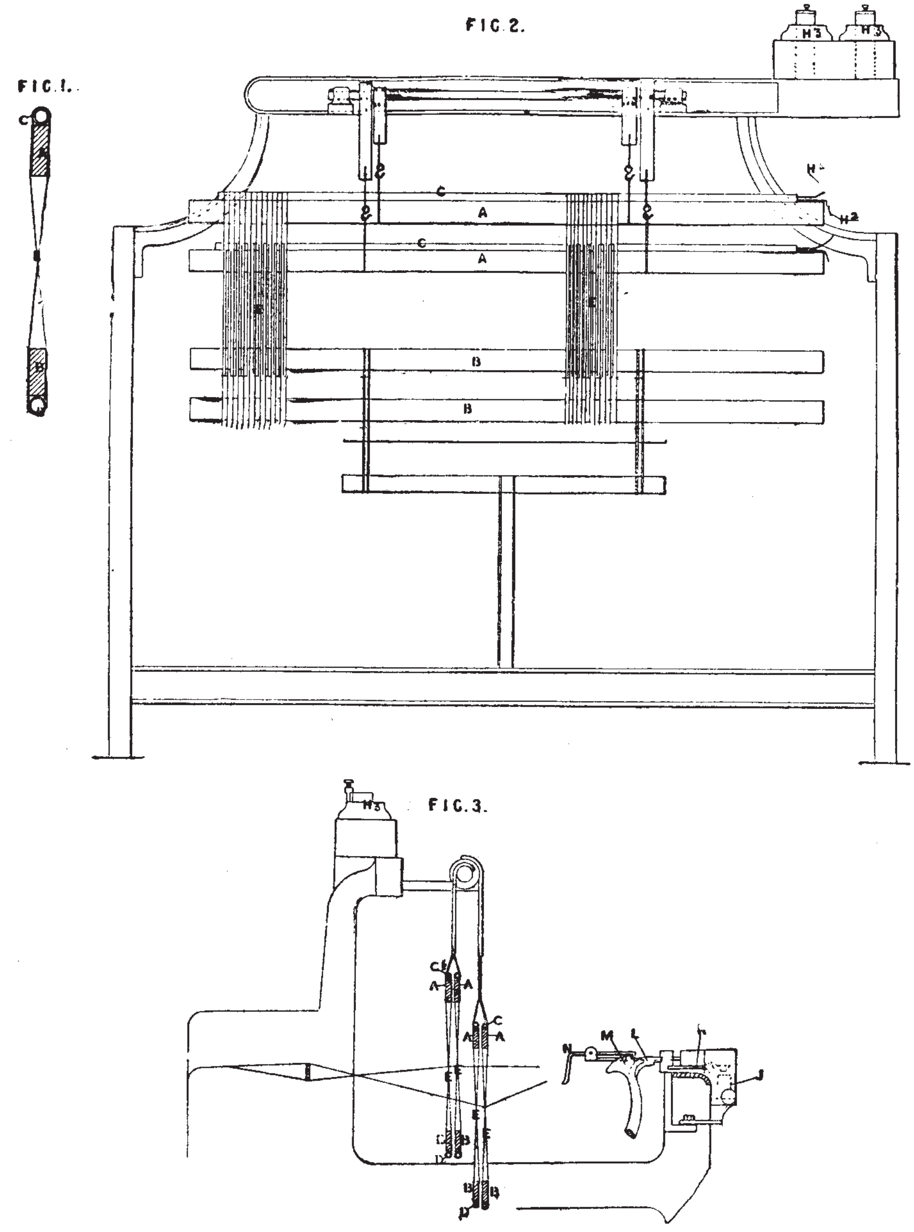



PLATE 32.—THE LOOM, WITH HOWARD AND BULLOUGH'S ELECTRIC STOP MOTION.

# INDEX.

# PROGRESS

OF

# HOWARD & BULLOUGH'S

# RING SPINNING

## THROSTLES & DOUBLERS.

1.—RABBETH'S PATENT SPINDLE purchased by us in January, 1878.

2.—FIRST American Ring Frame sent to us by the Inventor, Mr. Rabbeth, in January, 1878.

3.—FIRST Frame on this principle turned out by us in August, 1878.

4.—Howard and Bullough's Patented Improvements dated July 22nd, 1878; July 29th, 1878; May 5th, 1880; May 13th, 1881; June 14th, 1882; December 18th, 1882; January 20th, 1883; April 26th, 1884; October 13th, 1884.

5.—TOTAL ordered up to date, **1,657,864**.

NOTE.—To prove that the above statement in reference to Ring Throstles is Bona-fide, H. & B. will furnish, if any foreign spinner wishes it, a list of the firms in his own country to which these Ring Frames have gone.

[See next page.]

OTHER IMPROVEMENTS—NOT PATENTABLE, but useful in special cases may be mentioned, such as

## THE TILTED ROLLERS,

Facilitating twist getting into the nip of the rollers.

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# THE INCLINED ADJUSTABLE BEARER,

TO PREVENT CLEARERS FALLING OFF.

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## CONVERSIONS

# From FLY to RING THROSTLES.

Properly carried out, these conversions are **practically as good as new.**

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**CAUTION.**—*Howard & Bullough emphatically warn the trade against the evils arising from bad or unsuitable oil and ill fitting or badly balanced bobbins.*

*Much mischief continues to result from neglect of this warning. If our friends will send their orders to us we will take care they have the proper oil and the best bobbins, and at prices which no more than pay us for the cost of testing and packing, for we send out no oil or bobbins which we have not tested ourselves.*

[See next page.

| Repeat Orders. | |
|---|---|
| 2 Orders | Leigh, E. A. & Co., America |
| 3 Orders | Longworth, Hacking & Co., Clayton-le-Moors |
| | Longworth, S. & Sons, Whalley |
| | Merrick, Boyes & Co., Russia |
| 2 Orders | Marsden, R. & Co., Manchester |
| 2 Orders | Micholls, Lucas & Co., Stockport |
| | Moncton Cotton Manufacturing Co., Canada |
| | Montreal Cotton Co., Montreal |
| | New Ladyhouse Spinning Co. Ltd., Milnrow |
| | Oldham Exhibition, Oldham |
| 2 Orders | Ontario Cotton Mills Co., Canada |
| | Oxford Mill Co. Limited, Burnley |
| 3 Orders | Ormerod, Thomas & Co., Brighouse |
| | Paley, William, Preston |
| 2 Orders | Park Mills Spinning Co., Preston |
| | Preston Cotton Spinning & Manufacturing Co. Ltd., Preston |
| | Prestwich, James, Oldham |
| | Rankin, Gilmour & Co., Liverpool |
| 2 Orders | Rishton Victoria Cotton Mill Co. Ltd:, Rishton |
| | Rockcliffe Cloth Co., Blackburn |
| | Roe Greave Commercial Company, Ltd., Oswaldtwistle |
| | Roper, Joseph, Pemberton, nr. Wigan |
| 2 Orders | Rawtenstall Cotton Manufacturing Co. Ltd., Cloughfold |
| | Scott, James & Co., Bombay |
| 2 Orders | Stephenson, Thomas & Co., Padiham |
| | Sumner, J. M. & Co., Manchester |
| | Simpson & Jackson, Preston |

| Repeat Orders. | |
|---|---|
| 2 Orders | Sugden, H. & J., Brighouse |
| | Stead, L. Brothers, Ramsbottom |
| 18 Orders | Peltzer-Teacher, G., Manchester |
| | Temple and Sutcliffe, Rose Grove |
| | Thompson, T. & Sons, Blackburn |
| | Thompson, William & Sons, Burnley |
| | Todd, Peter & Co., Wheelton |
| 2 Orders | Tootal, Broadhurst, Lee & Bolton |
| | Tunstill, Bros., Brierfield |
| | Simpson, A. & P., Preston |
| | Sarasin & Heussler, Basle |
| | Smith, T. H., New York |
| | Shanghai Cotton Cloth Mill. Co., China |
| | Sharrock, James, Rouen |
| | Stormont Cotton Manufacturing Co., Canada |
| | Shorrock, Christopher & Co., Darwen |
| 4 Orders | Storey, Thomas & Co., near Lancaster |
| | St. Ann's Spinning Co., Canada |
| | Slater, Clayton, Canada |
| | Voss & Delius, Manchester |
| | Walmsley, Benjamin, Accrington |
| | Walmsley, Edward, Stockport |
| | Whitaker, Hy., Rio de Janeiro |
| | Whitaker, J. H., Padiham |
| 3 Orders | Whitehead, D. & Sons, Rawtenstall |
| | Whiteley, Geo. & Co., Blackburn |
| | Wood Mill Cotton Spinning & Manufacturing Co. Ltd., Newchurch |
| 3 Orders | Watson, R. & Co., Oswaldtwistle |
| 4 Orders | Wernhard, Dilthey, & Co., Rheydt |
| 4 Orders | Wuchner & Müller, Germany |

## This List comprises 9,898 Deliveries.

The List being now too long to extend further, we can only give the total number of deliveries to which the Electric Stop-Motion has been applied; but as a proof of the bona-fide nature of the tatement we make, we are ready to furnish a complete list of firms, covering the whole number of deliveries stated, to which they have been sent. The Electric Stop-Motion acts when a sliver breaks at the front or at the back, when a roller laps and when a can is full. It produces more work than any other. It makes far **less waste** than any other, owing to its stopping instantaneously and with certainty. It requires **no adjusting**, consequently requires far less skill and attention than the Mechanical Stop-Motion. **NOTE** number of repeat orders: no stronger proof could be given that Spinners have found it advantageous, or they would not have ordered again and again.

## Letter.

Messrs. Howard & Bullough.

HARTFORD MILLS, PRESTON,
*March 6th*, 1880.

GENTLEMEN,—In reply to your enquiry respecting our opinion of your Electric Drawing Frame, of which we have 112 deliveries, we beg to state that we have never had the slightest trouble with it, and that we have never put a Machine into our Mill which has given us greater satisfaction.

We are, yours sincerely,
A. & P. SIMPSON.

# DRAWING FRAMES
## WITH ELECTRIC STOP-MOTION.

**The unvarying success of these Machines has emboldened us to offer them on trial for Twelve Months to any English firm desirous of testing their merits for themselves. If, during that time, they do not establish the superiority claimed for them, we will take them back at our expense.**

[See next page.]

## This List comprises 70,726 Spindles.

**This List being now too long to extend further,** we can only give the total number of Spindles to which the Electric Stop-Motion has been applied, but as a proof of the bona-fide character of this statement, **we are ready to furnish complete** list of firms to which these Spindles have gone. The Electric Stop-Motion accomplishes what has often been attempted unsuccessfully by mechanical means, viz.: the prevention of "single." In consequence of this Stop-motion it is becoming common for one hand to "mind" two Frames, it being impossible for a hand to make bad work by carelessness. **NOTE** the number of repeat orders. No stronger proof is needed that spinners who have adopted it, find it advantageous, than the fact of their ordering the same thing again and again after years of experience.

### Letter.

From Horrockses, Miller and Co., Preston.

To Messrs. Howard & Bullough, Accrington. July, 19th, 1881.

We have had your Electric Stop-Motion in use for some considerable time, and are perfectly satisfied with its working.

# INTERMEDIATE FRAMES,

WITH ELECTRIC STOP-MOTION.

**The unvarying success of these Machines has emboldened us to offer them on trial for Twelve Months to any English firm desirous of testing their merits for themselves. If, during that time, they do not establish the superiority claimed for them, we will take them back at our own expense.**

# HOWARD AND BULLOUGH,

*ACCRINGTON, LANCASHIRE.*

**Accrington is distant from Manchester only 20 Miles. Frequent Trains run daily from Victoria or Salford Stations, on Lancashire & Yorkshire Railway.**

### FOREIGN AGENTS:

Messrs. HOWARD & BULLOUGH & RILEY, Boston, Mass.: for the United States and Canada.
Messrs. GREAVES, COTTON, & Co., Bombay: for India.
Mr. THOMAS EVANS, Manchester and Moscow: for Russia.
Messrs. TATTERSALL & HOLDSWORTH, Burnley and Enschede, (Sizing, Beaming and Winding) for Holland.
Messrs. JOHN M. SUMNER & Co., Manchester: for Italy.
Mr. G. PELTZER-TEACHER, Manchester, Rheydt and Basle: for Northern Europe.
Messrs. WUCHNER & MÜLLER, Accrington and Dresden: for Austria, Bohemia, and South Germany.
Mr. JAMES SHARROCK, Rouen: for North of France.

*March 9th*, 1885.